The Institute of Man and Resources

ENERGY DAYS

E N E R G Y   D A Y S

PROCEEDINGS OF AN OPEN SEMINAR
OF THE LEGISLATIVE ASSEMBLY OF
PRINCE EDWARD ISLAND

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PREFACE

Early in the Spring of 1976, the Legislative Assembly of Prince Edward Island met for four days of intensive briefing on energy. These sessions, organized by the Institute of Man and Resources, first laid a broad fact-and-figure basis for understanding the energy picture, then branched into the more controversial areas of Energy Alternatives and Energy Futures.

Open to the public and televised live, the hearings provoked the Island-wide, and even nation-wide, interest which has led to the publication of these Proceedings.

The text which follows has been closely derived from transcripts of the hearings. While these have been edited to eliminate redundancy, it is hoped they reflect both the substance and the spirit of the four day hearings.

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March 30, 1976 A.M.

1. PREMIER'S INTRODUCTION

PREMIER ALEX B. CAMPBELL: Good morning, Mr. Speaker, ladies and gentlemen of the Legislature. This is one of the rare occasions we have to welcome Prince Edward Islanders into this historic Legislative Chamber. A few minutes ago a CBC radio national news headline read something as follows: 'Ottawa will let Maritimers solve their own energy problems'. I see Mr. Rossiter has a smile on his face - he probably heard the same thing. Well, ironically, this is the first of four days which members of the Prince Edward Island Legislature have unanimously agreed to set aside for energy considerations. I may forewarn our general public that energy is not simply confined to the subject of electricity, but includes in the presentation we will see during the four energy days energy in all its forms. We've asked the Institute of Man and Resources to offer the presentation to the Honorable Members of the Legislature. For your information, the chairman of the Institute is the Honorable John Maloney and the directors also include myself, Mr. Mel McQuaid, the Leader of the Opposition, Dr. Tom Connor, the Deputy Minister of Development, and Mr. David Catmur, the Director of Planning in the Department of Agriculture. I wish to thank in advance all visiting speakers and all those who will present evidence to Members of the Legislature during these days. I wish, also, to recognize that the media representation is about double that of the membership in the Legislature itself. We welcome this evidence of public interest through the media. And, finally, I take this opportunity now to introduce the gentleman who has organized the presentation and who fills the position of Executive Director of the Institute of Man and Resources. I call, on your behalf, Mr. Andrew Wells to begin this session.

2. OVERVIEW

Introduction

MR. ANDREW WELLS: Thank you, Mr. Premier, Mr. Speaker, and members of the Legislature. Before getting into some brief remarks which I have prepared, I'd like to introduce to members of the Legislature my colleague who has been giving me some considerable assistance in helping to put together this program, Mr. William Zimmerman.

As some of you may already have noted, we've had a few technical difficulties in accommodating modern media and modern methods of presentation to a very old chamber. I certainly hope that we've overcome the major difficulties and perhaps we'll be able to improve upon things as we move through the session and identify problem areas.

I believe that what we are about to unfold is probably a first for a Canadian body of law makers. That is, a first in examining in a comprehensive fashion present energy problems and situations in a

Mr. Wells (continued):

province, and in taking a look at possible future options open to us. I think it's most appropriate that this opportunity fell to the Institute of Man and Resources in its early beginnings, because it in part fulfills a mandate of the Institute, which is to examine the application of appropriate energy, food and crop production, and living and shelter systems which are socially desirable and ecologically sustainable. An approach such as this, that is a comprehensive examination of any subject, and certainly energy, is, I believe, essential in policy formation - both from the public's point of view and certainly from that of the legislators. I realize, too, that it must be very difficult for legislators to have to grapple with day-to-day problems of their constituents while at the same time handling problems which are not immediately pressing but perhaps of much greater significance for the future. Certainly the problems of energy in Prince Edward Island have ingredients of both the day-to-day sort of problems and the longer range questions. But it is extremely important, in my view, in matters of energy, not to respond exclusively to the immediate situations. For to do so could have serious implications for the effectiveness, if not the very possibility of solutions in the future. In other words, I believe we must be cautious of grasping immediate gains to the detriment of longer-term possibilities. A subsidy today may indeed create problems tomorrow. It's quite possible to create an artificial situation or a series of artificial situations which just cannot be sustained economically in the long run.

It might be useful now if I just quickly run through the format for the four days. This morning we'll be examining the current situation in Prince Edward Island. This afternoon we'll take a look at conservation. Tomorrow morning we'll have the Public Utilities Commission of Prince Edward Island testifying before us, and we'll have representatives of Maritime Electric discussing the generation of electricity. We'll also have representatives of the government explaining the involvement of the government in that process. Then in the afternoon we'll take a look at nuclear power. On April 12 we'll look at alternatives, and I believe we're putting together an extremely interesting package for that particular day. On April 13 we'll be discussing energy futures, taking a look at the possible social and political possibilities and ramifications of various options in our energy pictures. We've arranged for each participant to give a prepared presentation, and following that presentation questions from Members of the Legislature will be invited. And if time permits all participants in each area of discussion will be available for exchanges amongst themselves and with Members of the Legislature.

By way of introducing the program, I have a few general remarks to make, which I hope will help to place into perspective energy on Prince Edward Island. As the Premier has already mentioned, in the minds of many energy is equated to electricity.

Mr. Wells (continued):

However, I think it's important to note that of all energy used in Prince Edward Island, electricity accounts for less than 8%, The rest is represented by farming and fishing, transportation, home heating and commercial and industrial uses: direct uses of fossil fuels. Now I have a slide outlining in graphic form the way in which our imported fossil fuels are used, (see Figure 1). You will note on that slide that 28% (I don't have the numbers in the slides) of the fossil fuels imported into Prince Edward Island are used to generate electricity - that's the largest block at the top left-hand side of the slide. You'll further note from the block entitled "Electrical Generation" that 78% of that fuel imported to generate electricity is lost through heat losses at generating stations. Or another way of looking at that is to say that the waste is equal to over 27% of the energy reaching users in the province, or 27.5 million gallons of light fuel oil, valued at $12 million, which would heat 70% of Island homes now using light fuel oil to heat residences. So the point I'm trying to make is that there is a tremendous loss, through waste heat, of the imported oil that goes into the generation of electricity. And yet, as I said a moment ago, less than 8% of our current energy use is now consumed in the form of electricity. It's been estimated from the figures available to us that 46% of the energy consumed in Prince Edward Island is converted to low quality heat, that is, heat less than 100°C. It's been estimated that 51% is converted to work, that is, transportation, shown in a large block in the bottom part of the slide. And it's been estimated that only 3% is converted into high quality heat, that is, metallurgic processes and so on. An example of mismatching of supplied energy quality with actual energy required is that of using resistance electric heat for space heating of homes and for providing hot water in homes as well, for in the conversion of the energy produced by burning oil into electrical energy, waste results from an unnecessary upgrading of energy quality. It is far better to heat water and air for domestic purposes by means of direct application of oil in the home or other energy sources such as the sun, than to use oil to generate electricity to heat air or water to relatively low temperatures, less than 100°C. In 1974, 2.3% of all electricity generated was used to provide space heat in homes. In 1974 approximately 6% of all electricity generated was used to heat domestic hot water. So we can see that approximately 10% of all electricity generated was used for purposes better and more economically served by other energy sources.

You'll further note on the slide that the single largest consumption of imported fossil fuels is in the area of transportation. Over 39% of all imported fossil fuels goes into transportation. The next large block of fossil fuels goes to residential demand. And here, I think is the greatest promise for adjustments and changes

ENERGY IN PRINCE EDWARD ISLAND 1974

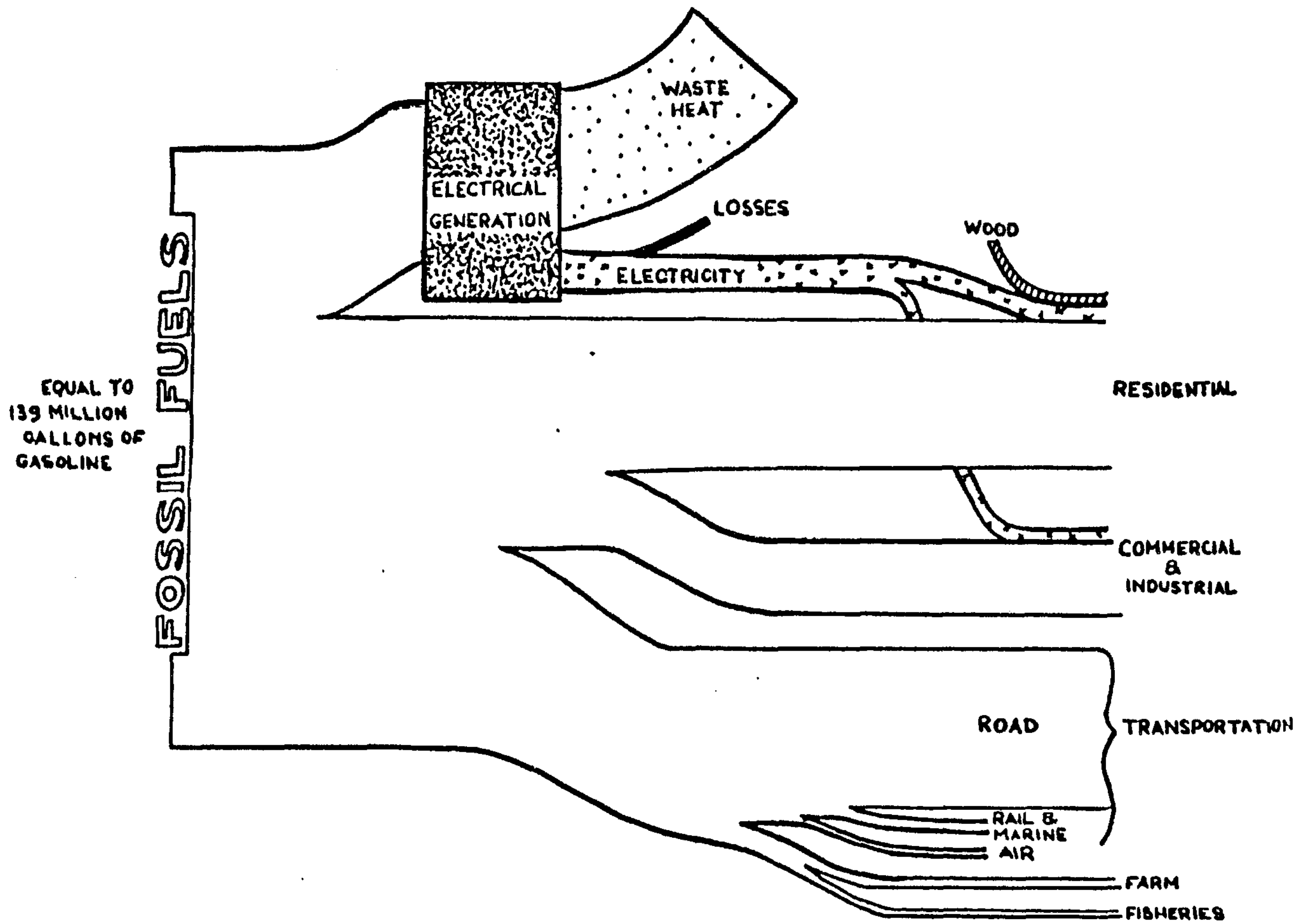

FIGURE 1

Mr. Wells (continued):

to our present systems. Considering that 31.1% of imported fossil fuels is used for heating homes and hot water, when we begin to look at a mix of possible systems involving solar, wind, and wood, and the current prices available to us, we begin to realize where we can make some very significant savings in the area of importing fossil fuels. I should point out that the illustration before you does not include a number of additional energy inputs into Prince Edward Island's society, most notably fertilizers, pesticides and herbicides, which will be dealt with in detail later this morning.

In our examination of energy over the four-day period, I think it will be useful to keep in mind these various uses in our province so that information from various sources may be placed in perspective. When we examine alternatives to our present systems, it is useful to remember which sectors demand what amounts of energy and in what form these amounts are now delivered.

We have a great deal to cover in four days. We have assembled what we believe to be an impressive list of participants. It is our hope that with the information presented here over this period a comprehensive understanding of the energy issues will be possible, and that the result can be wise and judicious policy decisions in the future.

Now, Mr. Speaker and Members of the Legislature, I would like to call upon our first participant: Mr. Norman Hall, of the provincial Department of Industry and Commerce, head of the Conservation Division.

The Energy Situation in Prince Edward Island

MR. NORMAN HALL: Mr. Premier, Honorable Members. Where does our energy come from? What do we use it for? How much does it cost and why? What can be done? These questions are the essence of our discussion today. Slide 2 shows that in 1975 Prince Edward Island ranked fifth in per capita consumption of petroleum products, petroleum products being virtually our only source of energy (see Table 1). Our consumption of 7% above the national average may not give the casual onlooker much to worry about, but when our national average is viewed in relation to other countries, then we have little pride in knowing that our consumption in Prince Edward Island not only ranks high in Canada but is amongst the highest in the world. Part of the problem is our dependence upon fossil fuels for electricity generation.

Referring to Slide 3, Prince Edward Island produces 100% of its electricity from fossil fuels (see Table 2). Compare this to Quebec, where electric power is virtually 100% hydro-generated, and to Canada as a whole, where the dependence on oil for electricity is a mere 3%. Even when we remove the amounts of oil consumed for electrical generation from our per capita consumption, we find that our consumption is still about the national average of 26 barrels annually, or equivalent to about 800 gallons of fuel for each man, woman, and child on

CANADA

PER CAPITA SALES OF PETROLEUM PRODUCTS

JULY 1974 - JUNE 1975

	BARRELS	DEVIATION FROM NATIONAL AVG.
N.W.T. & YUKON	71.2	+45%
NOVA SCOTIA	42.8	+17%
NEW BRUNSWICK	38.1	+12%
NEWFOUNDLAND	34.0	+ 8%
P.E.I.	32.7	+ 7%
QUEBEC	28.1	+ 2%
ALBERTA	25.9	----
SASKATCHEWAN	25.0	- 1%
BRITISH COLUMBIA	24.2	- 2%
ONTARIO	22.6	- 4%
MANITOBA	19.7	- 6%
CANADA	26.1	

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TABLE 1

PROVINCIAL GENERATION OF ELECTRICITY BY FUEL USED

PROVINCE	OIL %	NATURAL GAS %	COAL %	NUCLEAR %	HYDRO %
CANADA	3	4	14	6	73
PRINCE EDWARD ISLAND	100	-	-	-	-
NOVA SCOTIA	62	-	24	-	14
NEW BRUNSWICK	38	-	11	-	51
QUEBEC	-	-	-	-	100
ONTARIO	-	6	26	18	50
MANITOBA	-	-	1	-	99
SASKATCHEWAN	-	10	47	-	43
ALBERTA	-	31	56	-	13
BRITISH COLUMBIA	1	1	-	-	98
YUKON	30	-	-	-	70
TERRITORIES	33	-	-	-	67

TABLE 2

Mr. Hall (continued):

Prince Edward Island. Add to this the fact that we have little in the way of energy-intensive industry, such as steel making or mineral processing, and the extent of our personal dependence on fossil fuels is apparent. Where then is the energy being used, and why are we using so much?

The three main sectors of energy used in Prince Edward Island are space heating or home heating, transportation, and electrical power generation. The third of these, electrical generation, will be covered in detail tomorrow, and I'll confine my remarks to heating and transportation. And in so doing, I'll attempt to point out some little known but significant features of our energy consumption in these two areas.

Going on to Slide 4, in the one-year period ending in June, 1975, Prince Edward Island spent almost $72 million on 134 million gallons of petroleum products. About 60% or roughly eight and a half million dollars worth of light fuel oil in addition to about $4 million worth of stove oil went primarily for domestic space heating and hot water heating (see Table 3). In other words over $12 million was spent by home-owners who heated their homes entirely or in part with oil. Less than 5% of homes in Prince Edward Island are heated by electricity, but almost one-quarter have electric hot water supply, primarily those homes recently constructed in urban areas. We've heard many stories lately on the cost of heating homes with electricity, with bills in excess of $200 per month not uncommon. An examination of the cost per unit of heat readily explains why.

Slide 5 depicts the as-used energy cost of the various energy sources that we have (see Table 4). Using the commercial residential average rate of around 3.6¢ per kilowatt hour, the cost for every million BTU of electrical energy is $10.60 when used for space heating. Compare this to the cost of fuel oil to do the same job, in this table $3.60, and it is apparent that for a house with the same insulation and design standards current electricity costs are three times those of fuel oil. Even when we consider that most fuel oil-heated homes in Prince Edward Island are deficient in insulation, such that perhaps up to 50% of the heat is wasted, the cost of oil heating is still lower to attain the same level of comfort. Does this mean, then, that those with electric heating are stuck with an overly expensive heating method? Not necessarily. Tomorrow's discussions will no doubt deal at length with the prospect of stabilizing electricity costs through inter-connection with the mainland and ultimate access to lower-cost power supplies such as nuclear and hydro. Given that those depending on electric heat have a definite near-term problem, let us look at the other 95% of the population who depend on oil heat. Referring again to Slide 5, we can see that the relative costs per million BTU of stove oil, wood and light fuel oil are very similar (see Table 4). It could be argued quite validly that the cost of wood is set too high. The number quoted of $60 per cord

PRINCE EDWARD ISLAND

PETROLEUM PRODUCT SALES AND VALUE

JULY 1974 - JUNE 1975

	GALLONS MM	VALUE $MM	AVERAGE $/GALLON
GASOLINE	39.7	33.8	0.85
LIGHT FUEL OIL	32.7	14.4	0.44
HEAVY FUEL OIL	32.3	7.1	0.21
DIESEL OIL	14.8	7.6	0.51
OTHER	14.4	8.9	
TOTAL	133.9	71.8	

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TABLE 3

PRINCE EDWARD ISLAND

AS USED ENERGY COST

JULY 1974 - JUNE 1975

SPACE HEATING	COST PER UNIT	COST PER MMBTU
ELECTRICITY	3.6¢/KWH	$10.60
STOVE OIL	48¢/GAL	3.90
WOOD	$60/CORD	3.90
LIGHT FUEL OIL	44¢/GAL	3.60
HEAVY FUEL OIL	21¢/GAL	1.75
TRANSPORTATION		
GASOLINE	89¢/GAL	5.75
DIESEL	82¢/GAL	4.90

TABLE 4

Mr. Hall (continued):

using hardwood mix as a base is not so much the cost of the wood but indeed represents its value for heating purposes relative to the alternatives. Since wood is available for considerably less than $60 per cord,especially if you own your own wood lot, then it's apparent that using wood as a supplement or even as a replacement for oil can be extremely worthwhile. Using the unit costs of energy shown on this slide, let us look at what it cost the average household on Prince Edward Island for its basic requirements for home heat, hot water and electricity: in other words, household energy costs.

We go to Slide 6. Prince Edward Island homeowners pay 50% more than homeowners in any other province for their basic household energy requirements. The average household consumes over $80 worth of energy monthly, ranging from $50 a month in the summer to $100 per month in the wintertime. The lowest energy cost per household is in Alberta where low cost natural gas and coal-fired electricity result in an average of about $25 monthly, even considering the colder climate in the prairies (for it must be stressed here that the heating costs shown are based on the same housing type corrected for local climatic conditions: also in each example the lowest-cost available option for heating and hot water has been used.) (See Table 5.)

Going to Slide 7, we can see the relationship between this household energy cost and average salaries (see Table 6). To further emphasize the concern we must show over energy costs in our lives on Prince Edward Island, we can see the effect energy costs have on our disposable income vis-a-vis the rest of Canada. Here on Prince Edward Island, on the average 12% of gross annual income goes for basic household energy costs compared with 3-4% in Western Canada..

In summary then, for space heating, we can safely say that our dependence upon existing technology and energy supplies is extremely costly for Prince Edward Island and is likely to become more so. There is a very definite need to fully evaluate new technology and alternative energy sources specifically applicable to Prince Edward Island. The initiative to do this must come from us, because it is we who have the greatest problem in Canada as far as space heating costs are concerned, and we cannot afford to sit back and wait for someone else to solve what in the immediate term is our problem.

At this point in the presentation I'll stop, and if you have any questions on space heating aspects, I'd entertain them at the moment before I go on to transportation.

LEO F. ROSSITER, MLA: Slide 1 showed that as far as you're concerned 78% of fuel used for electricity is lost through waste heat. Is there any way to retrieve that or harness it?

MR. HALL: There are ways. The application of something called district heating is being studied in Canada (and there are federal funds now available for such studies) whereby heat, processed steam or hot water, can be recovered from generating plants and used to heat other

CANADA

AVERAGE ANNUAL FAMILY ENERGY EXPENSE
March 1, 1976

CITY	HEATING OIL or GAS $	HOT WATER OIL or GAS $	ELECTRICITY* 8000kwh/yr $	TOTAL $
Charlottetown	410	90	480	980
Halifax	335	80	225	640
Montreal	365	85	140	590
Toronto	305	80	140	525
Winnipeg	290	60	150	500
Regina	205	45	150	400
Edmonton	130	25	150	305
Vancouver	195	60	180	435

*Lighting and Appliances Basic Requirement

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TABLE 5

HOUSEHOLD ENERGY COST COMPARED TO AVERAGE SALARIES

CITY	AVERAGE SALARY $	ANNUAL AVG. ENERGY EXPENSE $	%
Charlottetown	8,100	980	12.0
Halifax	9,300	640	6.9
Montreal	10,700	590	5.6
Toronto	11,000	525	4.8
Winnipeg	10,000	500	4.9
Regina	10,000	400	4.0
Edmonton	11,100	305	2.7
Vancouver	12,400	435	3.5

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TABLE 6

installations in the general vicinity of the power plant. There are a number of these installations already in place in Canada, and I understand that Nova Scotia is looking at one in downtown Halifax. We have a limited opportunity to do this in Charlottetown, and our Department of Municipal Affairs in conjunction with the Office of Energy Conservation in Ottawa, are looking to see just how feasible it would be to have a district heating operation in Charlottetown.

MR. ROSSITER: Is this heat loss in the Charlottetown plant and the Borden plant and all the generating plants?

MR. HALL: Our heat loss in conversion of oil to electricity in Prince Edward Island is very much a function of the size of the units we have. We must realize that when they put in a unit of electricity generation in other parts of Canada they talk about 300 megawatts. Our total generating capacity in Prince Edward Island is in the order of 115 megawatts, and most of it is in the Charlottetown plant. So our conversion efficiency of the BTU in the oil to the equivalent BTU in the electricity generated is in the order of 22%. A large scale 300 megawatt fossil fuel plant can achieve up to 30-35% conversion efficiency of the BTU in the oil to the electricity. This is as a result of the larger boilers and so forth and there is less heat loss in the heating side of the electricity generation.

MR. WELLS: I think Norman, it's fair to say that there may be presently and may come along more efficient smaller units which could be used in Prince Edward Island's context, so that we don't end up with that tremendous heat loss but rather get greater efficiencies out of the actual generation. You might go from 22% efficiencies to perhaps 35% as Norman has suggested.

MR. ROSSITER: Of the 78% heat loss, in your opinion just how much is it possible to retrieve or to harness or save?

MR. HALL: Perhaps you should save that question for tomorrow's discussion on electricity. You'd be talking to the people who really know.

MR. WELLS: A lot would depend on the actual physical location of the plant and the availability of buildings around it to use that heat for space heating.

HON. GEORGE PROUD: Mr. Chairman, aren't there three buildings in Charlottetown using at the present time this heat loss - Canada Packers, Holland College, and one other?

MR. HALL: Yes, there are. A good example of this kind of mini comprehensive heating system - electricity generation system is of course this school in Southport which has its own diesel generators and supplies its heat requirements from the process heat supplied during the generation process. So they don't have to use fuel oil or electricity for heating. They generate all their own electricity requirements and the heat is taken off the motors and used for heating purposes.

MR. ROSSITER: Do you have any comparative figures for that school and any other school in the province with about the same volume?

MR. HALL: I think the comparison is that the electric costs are the same but there are no heating costs for the Southport school. What you actually save are the heating costs. It saws off that the electricity costs are about the same for that school as any other school given the size of it, but the heating costs are nil. I don't have the numbers to tell you just exactly how much that is.

MR. WELLS: I think the point that emerges from this kind of discussion is that we have relied so long on very cheap imported oil that we haven't looked at all the possible efficiencies and savings that we think are around; but now with oil going up, we have to start examining the various mixes and possibilities.

MELVIN J. MCQUAID, MLA: You've suggested wood as a supplement to oil. Now is that a practical suggestion in view of the fact, first of all, that you'd have to have converters on your furnaces, and secondly, that you're faced with the problem of storage? According to your chart, actually wood is more expensive than oil, $3.90 as compared to $3.00.....

MR. HALL: I qualified that cost of wood with the remark that this is not so much the cost of the wood per se, but its value relative to other energy sources that can do the same job for space heating. The wood might readily be available for $30 a cord or may be $10 a cord, I really don't know.

MR. MCQUAID: Where would it be available for that now?

MR. HALL: Well, I think you can direct that question to our forestry people when they give you some indication of what our forest resources are.

MR. WELLS: There will be a full presentation on the forestry end of things, and in addition on April 12, when we look at alternatives, there will be an examination of alternative wood-burning systems.

MR. HALL: There are available on Prince Edward Island to my knowledge add-on systems to furnaces that will burn wood.

EDWARD CLARK, MLA: Have you come to any conclusion on the actual costs?

MR. HALL: We have really done no rigorous financial analysis of it. The comparison is on the first cost of energy, not on the capital cost of additional equipment - the perhaps higher insurance cost because you're using wood-burning equipment and so forth. It hasn't been worked out in detail and I don't think it is possible to do that; you'd have to relate it to specific applications. Anybody who's thinking of doing it would have to look at his own particular situation and evaluate it just the same as they evaluate any economic decision.

HON. JOHN H. MALONEY, MD: Your estimates here are based on $8 a barrel for your oil.

MR. HALL: Yes, of course. There's another factor there - that this is based on the current prices of oil and it is entirely likely that oil prices are going to go up.

MR. WELLS: About 10% of the homes in the province now are heated exclusively with wood.

MR. ROSSITER: It used to be 100%.

MR. WELLS: I think about 15% use wood to cook with.
MR. MCQUAID: That 10%, is that mostly in the rural areas? It seems to me that storage would be a big problem as far as wood is concerned.
MR. WELLS: We don't have very good figures for the distribution, but certainly it would seem that most of them are in the rural areas, yes.
HON. BRUCE STEWART: An analysis has been carried out on the Mount Stewart School in recapturing the heat and using its energy both for electrical and heating purposes. This is an overall saving over a school of similar size of 40%.
MR. CLARK: What percentage of heat is wasted due to poor insulation in the home?
MR. HALL: Well, this varies depending on the vintage of the home. Some homes in Prince Edward Island, I would venture to say, are losing in excess of 50% of their heat that they're generating in their furnaces. The ones of most recent construction, especially those that are built to be heated by electricity, have much higher insulation requirements in order to get the special home heating rate for electricity. These requirements will probably bring a house up to around 85% efficiency. It's virtually impossible to get an 100% efficient home as far as heat loss is concerned, but you can get very close to it. And this is one area in the province where we have the opportunity to make significant savings in heating - in upgrading the insulation standards. We'll talk a little more about that this afternoon when we talk conservation.
PREMIER CAMPBELL: I'm just wondering if you have been able to place a dollar value on all that heat that's thrown out into the atmosphere or into Charlottetown harbour.
MR. WELLS: Well, it depends upon what equivalent figures you like to use. If it's converted to the same amount of light fuel oil which is what you burn in your home furnace, it amounts to about $12 million.
PREMIER CAMPBELL: That's of the total of Prince Edward Island production of electricity?
MR. WELLS: That's right.
MR. HALL: As a further illustration of the amount of waste there is in converting heavy fuel oil to electricity, if you'd like to turn back to Slide 5, you'll see the ratio of the cost of heavy fuel oil per million BTU (see Table 4). You're talking about a factor of approximately six to one, which takes into consideration the losses in processing; and of course the additional cost of electricity over and above the direct ratio of fuel cost is return on capital and operating costs and so forth other than fuel costs incurred by the generating utility.
J. WALTER DINGWELL, MLA: When you speak of costs of fuel here, you don't mention coal here anywhere....
MR. HALL: Coal consumption on Prince Edward Island is pretty minimal. There's a certain amount of it used in stove heating and a minor amount used for domestic purposes as far as heating is concerned

in fireplaces. But these are very, very minimal amounts and at the cost of local coal coming from Cape Breton, in the order of $30 per ton, it's not a viable alternative in relation to what we have right now. If there were a readily available source of stripminable coal in the Maritimes that was suitable for home heating, such as they have in Western Canada, it would be something worth looking into, but we just don't have it. The coals we do have are clean-burning coals, but they are extremely expensive because they are deep-mined, and the mining costs in Cape Breton are extremely high.

MR. DINGWELL: It would be interesting to know the possible potential of a ton of coal versus a cord of wood.

MR. WELLS: It will be dealt with by the forestry people later in the morning.

HON. T. EARLE HICKEY: Is it possible to convert a residential unit from light oil to heavy oil?

MR. HALL: I don't think it is. Current technology is such that heavy fuel oil, the best application, is in large boiler-type units. The geometry of the furnaces requires lighter fuels, and that's just the way it is.

MR. WELLS: Heavy fuel oil won't flow at room temperature, so you have to preheat the oil and that brings you into another requirement.

MR. HALL: Almost all systems are the flowing or jet system into the firing chamber.

VERNON MCINTYRE, MLA: Did I understand you correctly, Mr. Hall, to state earlier that our electricity costs in this province are 50% more than in any other province?

MR. HALL: No, that figure was relative to household energy costs, basic household requirements for energy. They are in the order of 50% higher than the next highest which are in Nova Scotia. You have Halifax with a total basic household energy requirement of $640 versus $980 in Charlottetown. Looking at the electricity costs you see that it is not 50% more - it's considerably more than that. We're talking at least twice that of Halifax and in many cases close to three times.

MR. MCINTYRE: How can we justify that with our compact geographical area?

MR. HALL: Well, the fact is that we have a small generating unit relative to the size of the units in other areas and other provinces and the economics just are not there.

MR. WELLS: 15% of Nova Scotia's generation is hydro-electric, which will help to bring their overall costs down in the total province.

MR. HALL: And may I say that Nova Scotia is faced with a crunch come the end of the year because right now they are buying fuel oil on a long term contract from Imperial Oil for less than $2 a barrel. This of course will jump to $8 or whatever the price will be at the end of the year. And they're looking at the possibility of a 50% increase in electricity cost in the coming year, much more than we are here. It's quite possible that we will see another 25% increase in the next year, but Nova Scotia is faced with a much bigger crunch because of their somewhat curious situation as far as their fuel source is concerned. It's an aberration, it's not .....

MR. WELLS: It's an aberration that's presently before the courts.
MR. HALL: Imperial is suing the Nova Scotia Power Commission for the difference in that contract which amounts to something like $100 million.
MR. MCQUAID: On Slide 6 you've left out the province of New Brunswick in respect to average annual family energy expenses; and that, of course, is where we expect to get some of our energy when the power cable is laid. What is their cost?
MR. HALL: In looking at the rest of the Maritime provinces, they're all very similar. Newfoundland is somewhat higher, but New Brunswick is very comparable to Halifax at this point, perhaps a shade lower. Their electricity costs are lower than Halifax's at this point in time but not by that much. I believe the cost per thousand kilowatt hours in New Brunswick is in the order of $25, whereas in Halifax it's in the order of $27. So there's not much difference right now, but that gap will widen considerably since New Brunswick has about 50% of hydro and 11% generated by coal which is stripminable coal and is very reasonable in cost. And they have a 38% dependence on oil.
MR. MCQUAID: So New Brunswick then is generating electricity much cheaper than Nova Scotia?
MR. HALL: Yes. But you must bear in mind that Nova Scotia is a very artificial situation because of that fuel contract they have. When that fuel contract terminates at the end of the year, their costs will then in all likelihood jump 50% so they will be considerably higher, they'll be in the order of perhaps $35 or $37 per thousand kilowatt hours versus New Brunswick's which will still be probably in the order of $25 to $27.

If there are no further questions, I'll refer back to Slide 4, petroleum products, sales and values (see Table 3).

Here we see that the gasoline and diesel oil represent about 40% of our petroleum usage by volume and almost 55% of the value of petroleum products used. The higher cost per gallon of fuels for internal combustion engines is the result of the higher cost of producing such premium fuels and also the taxes and distribution costs involved.

We go to Slide 8 (see Table 7). There's been quite an outcry about gasoline costs of late, and the focus of the public's attention has been what I prefer to call an inferred rip-off that the oil companies are supposedly perpetrating. Let's look at the cost of a gallon of gasoline and see where the costs and the opportunities for so-called windfall profits lie. Starting from the bottom line we see that at current prices the cost of crude represents 25% of the end product price. This is crude at $8 a barrel. Bear in mind that three years ago crude was in the order of $3, so you can see right there that you've had a considerable jump in the cost of gasoline directly attributable to the cost of crude oil. Getting the crude to the refinery from the field, whether it be by ocean transport from the Middle East or pipeline from the West to Eastern Canada, takes another 3%, and the refinery takes 8% or 7.2¢ per gallon to

PRINCE EDWARD ISLAND

REGULAR GASOLINE COSTS

	¢/GALLON	$/BARREL	%
PUMP PRICE	89.9	31.47	100
DEALER MARGIN	10.5	3.68	12
WHOLESALE PRICE	79.4	27.79	88
EXCISE TAX	10.0	3.50	11
FEDERAL SALES TAX	4.1	1.44	4
PROVINCIAL TAX	21.0	7.35	24
POSTED PRICE	44.3	15.50	49
WHOLESALE MARGIN	10.1	3.54	11
TRANSPORTATION	2.0	0.70	2
REFINERY PRICE	32.2	11.26	36
REFINERY MARGIN	7.2	2.46	8
TRANSPORTATION	2.2	0.80	3
CRUDE OIL PRICE	22.8	8.00	25

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TABLE 7

Mr. Hall (continued):

pay its refinery costs and provide a return on the capital employed. At the very best, if the refinery operates at full capacity, the profit portion of this margin is less than 2¢ per gallon or 6% of the refinery gate price of about 32¢ a gallon. And bear in mind that in the Maritime provinces at the moment we have a considerable excess refining capacity brought about by large refinery expansion in the last two or three years, expansions which were committed before the oil prices started to rise and which were completed, and some of these expansions, such as the Gulf Refinery in Nova Scotia and the Shaheen Refinery in Newfoundland, were built aiming at selling their products in the international market. When the United States banned petroleum product imports or slapped a tax on them effectively binding them, these refineries had to look elsewhere for their market. The glut of petroleum products on the market has been such that many refineries in the Maritimes are not operating at their full efficiency - consequently the refiners are not able to take the best advantage of the margin that's available to them. Now I'm not saying that's an excuse for them. Perhaps they were caught in a situation such as everybody else has been caught. This sudden hike in oil prices caught them quite unprepared for the changes in the market that have occurred. Transportation of the products to market, in our case by ship to bulk terminals in Charlottetown and distribution by truck throughout the Island, adds 2¢ more per gallon. Now this 2¢ per gallon has been in effect for many many years. The differential between ourselves and Halifax has amounted to basically 2¢ on transportation costs. The transportation cost hasn't varied for many, many years which I think is significant in that it shows that the efficiency of the transportation and distribution network is such that they're able to hold their cost down. The wholesale margin is added on which represents the cost of administration and marketing and provides a return on the investment in marketing and distribution facilities such as bulk storage, service stations, trucks, pumps, etc. Again in this margin the opportunity for profit over and above the basic cost in return on investment requirements is less than 2¢ per gallon if the marketing and distribution is efficiently carried out. We have reason to believe that the Public Utilities Commission in Prince Edward Island has ensured a reasonably efficient distribution system in Prince Edward Island. The location of a service station has to be proved on the basis of need - that there is need for such a service in a particular area. Other provinces have an acknowledged surplus of service station capacity. I don't think such is the case in Prince Edward Island, especially when you look in the rural areas where a network of service stations such as we have is absolutely essential for the servicing of our agriculture, tourist and fisheries industries. The posted price the dealer pays for his product is thus about 49% of the retail pump price. Taxes - excise tax, federal sales tax, and provincial tax add up to 39% of the price of

Mr. Hall (continued):

regular gasoline. There's a provincial road tax of 21¢ per gallon which goes to maintain the highway systems in the province. There is a federal sales tax of 4¢ and a special federal excise tax of 10¢ which was imposed a year ago last fall as a budget measure, both to encourage conservation and also to help pay the deficit incurred in subsidizing the import of crude oil to the Eastern provinces. This brings us up to 79.4¢ per gallon and leaves 10.5¢ accounted for by the dealer margin. Here again the costs of business leave little opportunity for excess profit on the part of the retailer. It's widely acknowledged that the dealer must have 7¢ to 8¢ per gallon to pay his operating costs, leaving a scant 2.5¢ to 3.5¢ a gallon for modest profit and certainly no opportunity for windfall profits. In fact, of the entire cost of the gallon of gasoline, only 6¢ to 7¢ per gallon represents the amount that can be called "profit potential", assuming the operation is efficiently run from refinery to gas pump. The two biggest factors in the price of gasoline are the first cost of the crude oil (25%) and taxes (39%) - in total some 64% of the cost of regular gasoline.

Slide 9 helps to bring the tax portion of it more in perspective. There is a fairly high percentage of taxes on petroleum products for transportation purposes. When we look at all petroleum product revenues in the province, we can see that taxes, both provincial and federal, actually represent less than 20% of the total cost of petroleum products in Prince Edward Island, and a good portion of that goes towards the upkeep of the Island's highways (see Table 8). I mentioned the 6¢ to 7¢ per gallon profit potential that lies in an 89.9¢ per gallon of gasoline. Some of you will probably still say, "why not dip into this profit potential and pass it along to the consumer in some way, either by controlling prices or by effecting a reduction in price as a result of changing the market structure?" Let's say you could do it to the extent of 5¢ per gallon. This sounds like great stuff but what does it really mean? Obviously the 5¢ comes out of profit potential thus affecting the economic viability of the industry. The first ones to feel the effects are the retailers, who have no other income to soften the blow of a reduction in earnings. The oil companies over a short period of time could probably carry a reduction of 5¢ per gallon because they have a large operation. They are spread across Canada, and where they're not making it in one place they're hopefully making it up in the other, so that overall they're able to survive. But not so with the independent retailers. Already in Prince Edward Island 60% of the gasoline volume is pumped through the 25% of outlets located in the urban areas. The economics of operating a rural service station are marginal at the best and any downward pressure on prices would have a disastrous effect on the number of our rural outlets. These rural service stations represent 75% of the number of all Prince Edward Island service stations and they do almost 50% of all automotive and related service and repair work. A sharp reduction in their numbers

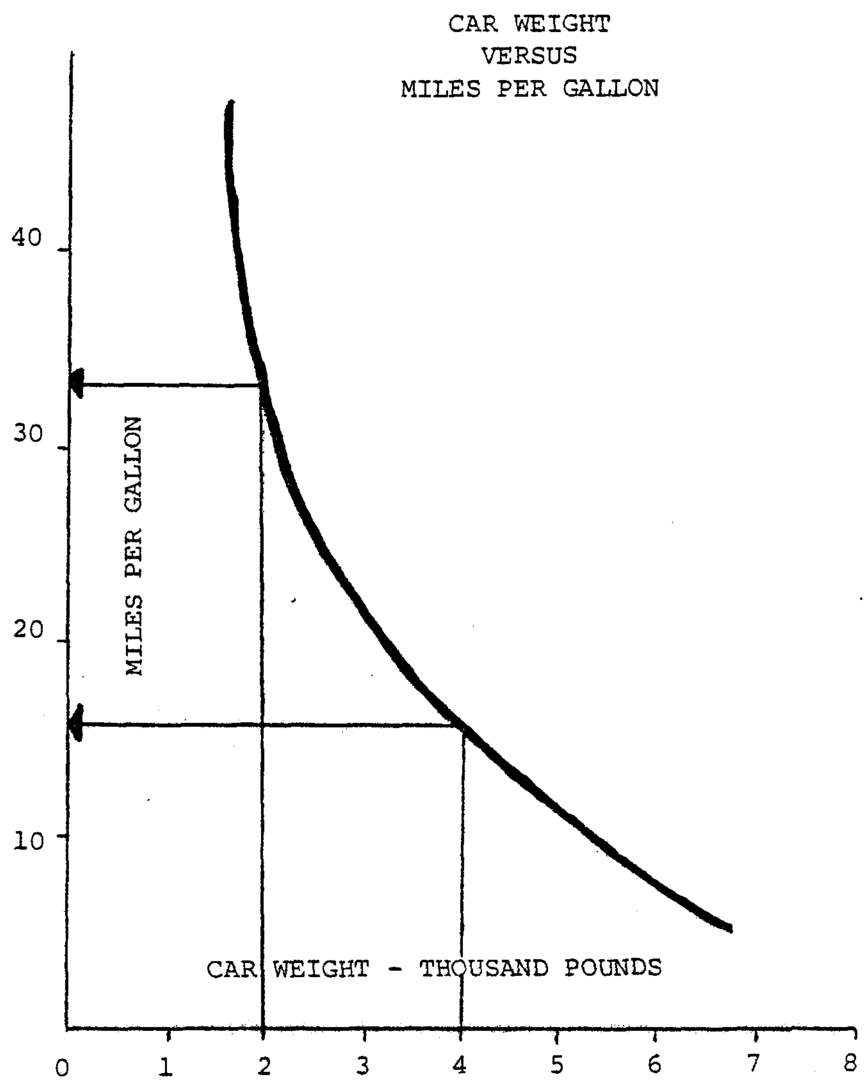
CAR WEIGHT
VERSUS
MILES PER GALLON
40
30
20
10
MILES PER GALLON
CAR WEIGHT - THOUSAND POUNDS
0
1
2
3
4
5
6
7
8

FIGURE 2

PRINCE EDWARD ISLAND

PETROLEUM PRODUCT REVENUE DISTRIBUTION

JULY 1974 - JUNE 1975

	$MM	%
TAXES		
PROVINCIAL	8.3	12
FEDERAL	4.7	7
TOTAL TAXES	13.0	19
RETAILER MARK UP		
GASOLINE	4.0	5
OTHER	0.4	1
TOTAL	4.4	6
WHOLESALE		
ALL PRODUCTS	54.4	75
TOTAL REVENUES	71.8	100

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TABLE 8

GASOLINE

SAVE 5¢ PER GALLON?

5¢/GALLON EQUALS A 6% SAVING IN COST.

AVERAGE P.E.I. CONSUMPTION IS 750 GALLONS/CAR.

THIS IS EQUIVALENT TO:

1. A $3.00/Hr increase in auto labour rates for the average driver.
2. A reduction in car weight from 4000lbs. to 3500lbs.
3. A reduction in average highway travel speed of 5 M.P.H.

TABLE 9

Mr. Hall (continued):

will inevitably result in a similar reduction in availability of service facilities with a consequent increase in service costs. We need only look to the Moncton area, where service costs have doubled recently to $12-$15 an hour, and this is for basic servicing of a car, not elaborate tune-ups and transmission jobs and so forth. Montreal rates, by the way, for the same kind of basic service requirement are in excess of $20 per hour. So when you look at our situation in Prince Edward Island where our rates for basic service requirements are less than $10 an hour for the most part and quite often in the order of $6 or $7 per hour, you can see that we are getting a pretty good deal in the overall package from the service station industry in Prince Edward Island. Some people may quibble with the quality of car care and say that we don't have the good mechanics in the service stations. That's anybody's personal opinion. There are, however, the specialized service facilities in Prince Edward Island which are capable of doing the more complicated repair work at the car dealers and at specialty shops. The fact is, there's more than one way to reduce the impact of high transportation costs than to put pressure on prices.

Let's go to Slide 10. A reduction of 5¢ per gallon amounts to $35 to $40 annually for the average Prince Edward Island driver using 750 gallons. That's our average consumption per car in Prince Edward Island. Such a saving would be offset by an increase of $3 an hour in service costs. That's assuming that the average Prince Edward Island driver takes his car in once a month for an hour to the service station - very minimum repair requirements (see Table 9). Such a saving as 5¢ a gallon could be achieved equally well by a reduction in the weight of the car (see Figure 2). If the next time you trade in your car if you would opt for a 3500 pound car rather than a 4000 pound car, the reduction of 500 pounds will constitute at the very least a 6% increase in your gasoline economy. Similarly if you reduce your usual highway travel speed by 6 mph you can effect the same kind of saving. Car weight, in fact, is the biggest single factor in gas consumption, and that's something we'll discuss in a little more detail when we talk on conservation this afternoon. What, then, does all this mean? Are we stuck with paying higher and higher costs for our transportation needs? The answer has to be a qualified yes. The unit costs will almost certainly go up in future as the operating costs of the industry and the cost of crude oil increase. But our concern over cost must not be obscured by a contentious or perhaps even phony issue such as windfall profits. We cannot make the industry the scapegoat and make the oil companies provide the solution. Again, the solution will be in our hands to formulate. We must put the emphasis of our concern not on the cost of uses but on the efficiency of use. We must rethink our priorities with respect to our private car mentality. Public transit has a part to play, as do smaller cars, conservation driving habits and alternative transportation modes.

In summary then, it is apparent that there's an immediate problem in both space heating and transportation costs for the residents of Prince Edward Island. To a degree we are locked into the status quo of current technology. The prospect of new, alternative technology is at hand, but needs time to develop. How we buy that time will be discussed this afternoon when we look at the part energy conservation can and must play in Prince Edward Island.

That concludes my presentation and I'll entertain any more questions on the transportation side if you wish.

MR. MCQUAID: Would you elaborate on the statistics in Slide 8?
MR. HALL: These are based on breakdowns provided by the Energy Supplies Allocation Board in the Federal Government. The margins are somewhat different here than they are in their survey because they were using Ontario prices, and of course the taxes are different and so forth. The margins here are slightly higher than in Ontario because of the much more competitive marketing situation they have there. And with the higher volume that they're able to market in Ontario, it's reasonable to assume that the unit costs of the profit portion of a gallon of gasoline would be smaller.

If there are no further questions, I shall turn the lectern over to the next speaker. Back to Andy.
MR. WELLS: Thank you, Mr. Hall. I would now call on our next speaker, Dr. Lloyd MacLeod, who is Director of the Federal Research Station, Agriculture Canada, here in Charlottetown.

Energy in Prince Edward Island Agriculture

DR. LLOYD MACLEOD: Thank you, Mr. Chairman, Honorable Members, members of the media, ladies and gentlemen.

The topic now is the energy situation in the Prince Edward Island agricultural industry. Dr. Lovering and Mr. McIsaac from my staff, and I have prepared our estimation of the situation in agriculture. Before getting into the tabular material, there are a few comments I would like to make with regard to agriculture. Agriculture as a primary resource industry is in total an energy-producing system, although it both consumes and produces energy. The amount of energy that is produced as food far outweighs that which is consumed in its production operations. In fact, agricultural crop production draws more utilizable energy from the sun than any other, with the possible exception of forestry, which is not a food production system. Since time immemorial, agricultural crops have been solar converters, and the efficiency of these food crops in converting the sun's energy to plant material, and therefore to food, has been greatly increased in recent years. Dr. Hooker of the University of Illinois has stated that American agriculture produces about twelve times as much energy in the plants it grows as it uses from fossil fuels. Agriculture's share of the total United States consumption is estimated at 3-4%; that is about one-eighth that of transportation. Since agriculture is the major food production system, it is essential that it have

Dr. MacLeod (continued):

access to a continuing supply of energy inputs needed to produce the food that will feed ourselves and the world's population. We consider food production to be a high priority energy user, since food, next to air and water, is a priority requirement for human and animal survival. Nevertheless, in a period of decreasing availability and increasing cost of conventional energy resources, agriculture has a responsibility to use energy efficiently and to minimize waste. It must also seek alternative sources of energy, renewable and otherwise.

Dr. J. C. Rennie, Director of Education and Research with the Ontario Ministry of Agriculture and Food, has said that while energy costs are not yet prohibitive, the day is coming when farmers will have to shift from present methods of tillage, harvesting and storage and will have to consider systems which will result in 20% to 30% savings in energy. Dr. Rennie also stated that the total food system, that is from producer to consumer, uses from 12% to 15% of all energy consumed in Canada. Of the energy required in this total food system, about 18% of it is used on production on the farm. So farm production, then, represents 3% of the national energy consumption. That's slightly lower than the figure for the United States, which was quoted as 3% to 4%

It must be remembered that agriculture has increased its efficiency during this century more than any other industry. Much of this increased efficiency has come from mechanization and the use of fertilizers and pesticides,all of which have increased the conventional energy requirements necessary for crop production. Thus, while increasing our agricultural efficiency has kept our food costs at a low or reasonable level, this same efficiency has greatly increased energy requirements and has reduced labour requirements, which, incidentally, are a source of energy as well. It has been a trade-off between greater mechanical efficiency and reduced labour requirements, with greatly increased requirements of nonrenewable energy resources in order to keep food prices at a relatively low level. The pressure on agricultural production has been to produce food cheaply for our consumers. The pressure has not been on producing food using minimal energy requirements or inputs.

Our purpose today is to try to get a handle on energy consumption or requirements by agriculture and to relate this in an overview to our total energy requirements for Prince Edward Island. Within the agricultural sector we were asked to provide an understanding of energy inputs into the industry, such as fuel, electricity, fertilizers, pesticides, and to provide some accounting of energy inputs required for the production of different kinds of crops. These inputs included energy requirements to produce, but not to bring into Prince Edward Island, the necessary inputs such as machinery, fertilizers, etc. We have approached this by detailed calculation on a crop and animal enterprise basis. Two major crops,

Dr. MacLeod (continued):

potatoes and cereals, will be budgeted in detail to show the inputs and their relative magnitudes on a per acre basis. Comparisons of various crops and animal enterprises will be shown in summary form in terms of calories, a common energy unit. To make it clearer, our data will also be presented in relative terms as percent of total energy requirements, and we will try to relate the energy used in terms of oil and electricity. We will also show the estimated total requirement of fuel and electricity for agriculture. Trying to compute the total energy consumption in Prince Edward Island agriculture is difficult because of the varying input requirements, different machinery sizes, different operations required for the various crops and animal enterprises. However, computing these requirements is much easier than trying to report them in a way that the layman can understand. Energy is provided and is used in many forms, such as diesel fuel, gasoline, electricity, labour, feed, etc. Before you can total the inputs to get an energy budget, the various forms must all be reduced to a common denominator. This common denominator is the calorie, the amount of energy required to heat one cubic centimeter of water by one degree centigrade.

I will ask you to bear with me as I try to get this point across on equalizing the energy from different sources; it's not simple, I realize, but to get some concept of it we have to go through it. In the next three tables are the different units (see Tables 10 - 12). I said the basic unit is the calorie; the next unit up is a kilocalorie or a thousand times that great; a megacalorie is a million times that great; a gigacalorie, which we call Gcal, a billion times a calorie; a teracalorie, a million million times as great as a calorie. So in the first three tables we tried to relate these and put them in perspective. If you'll just try to remember: a Gcal, for example, is equal to 25 gallons of fuel oil, and one Tcal to 25,000 gallons of fuel oil, or the equivalent fuel to heat 20 houses. In kilowatt hours it's similar: one Tcal equals 1.2 million kilowatt hours or sufficient electricity for 200 houses. So just remember that one Gcal equals 25 gallons of fuel or 1,200 kilowatt hours of electricity and one Tcal equals 25,000 gallons. It's summarized on the next slide (Table 12).

Several assumptions were made in calculating the energy requirements for various crops and livestock enterprises. For example, it's kind of hard to get a handle on how much it costs to make a machine. From machinery manufacturing and repair energy calculations we used a factor based on a study in the automotive industry where they found that in manufacturing a 3,500 pound car, 9,400 kilocalories were required per pound of car for a total of 32.9 million kilocalories per car. This factor was used to calculate the energy input per pound of machinery for manufacture or construction and repair over the 10-year life of the machine. The energy required to operate each machine was calculated knowing the work rate per hour and converting the fuel and the oil used to energy. So the machinery part of the energy budget

ENERGY IN TERMS OF FUEL OIL

1 Kilocalorie (KCL) = .000025 gal.
1 Mcal = 0.25 gal.
1 Gcal = 25 gal. fuel oil
1 Tcal = 25,000 gal. fuel oil

NOTE: 1 Tcal would heat 20 houses

TABLE 10

ENERGY IN TERMS OF KILOWATT HOURS OF ELECTRICITY

1 Kcal = .0012 KWH
1 Mcal = 1.2 KWH
1 Gcal = 1,200 KWH
1 Tcal = 1,200,000 KWH

NOTE: 1 Tcal provides electricity for 200 houses

TABLE 11

A HOUSE USING 1200 GAL OF OIL PER YEAR WOULD USE:

49,000,000 Kilocalories of energy (Kcal)
OR 49,000 Megacalories of energy (Mcal)
OR 49 Gigacalories of energy (Gcal)
OR .049 Teracalories of energy (Tcal)

1 KILOWATT HR OF ELECTRICITY = 860 KILOCALORIES

A HOUSE USING 6000 KWH/YR WOULD USE:

5,160,000 Kilocalories (Kcal)
OR 5,160 Megacalories (Mcal)
OR 5.16 Gigacalories (Gcal)
OR 0.0052 Teracalories (Tcal)

TABLE 12

Dr. MacLeod (continued):

for plowing, for example, was calculated from the energy used to construct and repair the tractor plus the fuel to run it. We assume 600 hours use per year for the tractor and 100 hours use for other machinery, which may be high for some machines. In calculating for potatoes, we assumed 125 acres and all the labour and machinery required to handle this size operation. For the cereal enterprise, size is assumed to be 400 acres for labour and machinery and we assumed the combine would harvest 500 to 600 acres per year in total.

Energy calculations for fuel and lubrication are reasonably accurate, but machinery size is much less important than estimating energy requirements. When we come to the animal enterprises, we calculate only electrical and feed energy. These figures do not include cost and repair of buildings, labour, equipment and marketing, hauling of feed or handling and spreading manure. Please remember when we get to the animal enterprises that much of the feed energy input was already accounted for in crop production because it is home-grown feed. Another point to try to remember is that energy put into production of crops is gross energy, while the energy output from crops is measured as digestible energy, or that part which the animals use.

We'll move on to energy requirements on crop enterprises on Prince Edward Island and the next slide (see Table 13). This is per acre energy requirements for cereals on Prince Edward Island. For cereal production the energy requirement per acre is 1.1 Gcal, or the equivalent of 27.5 gallons of fuel oil. So you can think of it in terms of producing one acre of cereals as requiring in total equivalent of 27.5 gallons of fuel, and it makes little difference whether it is diesel or gasoline. The high energy requirement inputs are fuel, nitrogen fertilizer and seed. Looking at the inputs as percent of the total energy requirement, which we figured would be simpler to understand, we see that machinery construction and repair plus fuel represents 38.8% of the total energy requirement. Nitrogen fertilizer represents 23.3%, and seed is 21%. Labour is only 0.1% and pesticides 1.1%.

Moving to potatoes on the next slide (see Table 14) we find that compared to cereals potatoes require four Gcals of energy or the equivalent of 100 gallons of fuel, and are therefore a higher energy requirement crop. Once again machinery and fuel, including electricity in this case, has the highest input at 33.1% of the total requirement, with nitrogen fertilizer a close second at 29.4%, and seed coming third at 20.4%. Labour at 0.4% and pesticides at 3.4% are both higher than for cereals. It is significant to note the high energy input for measuring fertilizer which is manufactured, in comparison to phosphorus and potassium, which are mined and processed. Transportation to Prince Edward Island is not included in either case, since sources and distances vary widely.

PER ACRE ENERGY REQUIREMENTS FOR CEREALS*, P.E.I.

	Kcal/Ac	%
LABOUR, 2.6 hours at 544.25 Kcal/Hour	1,415	0.1
NITROGEN FERTILIZER, 30 lb at 8400 Kcal/lb	252,000	23.3
PHOSPHORUS FERTILIZER, 40 lb at 1520 Kcal/lb	60,800	5.6
POTASSIUM FERTILIZER, 40 lb at 1050 Kcal/lb	42,000	3.9
LIME, 660 lb at 102 Kcal/lb	67,320	6.2
PESTICIDES, 1.06 lb at 11,000 Kcal/lb	11,688	1.1
SEED, 100 lb at 2272 Kcal/lb	227,200	21.0
FUEL, LUBRICATION, MACHINE CONSTRUCTION & REPAIR	420,454	38.8
TOTAL	1,083,000	100.0
	1.1 Gcal/Ac	

* In farm store

TABLE 13

PER ACRE ENERGY REQUIREMENTS FOR POTATOES*, P.E.I.

	Kcal/Ac	%
LABOUR, 29.5 hours at 544.25 Kcal/Hour	16,055	0.4
NITROGEN FERTILIZER, 140 lb at 8400 Kcal/lb	1,176,000	29.4
PHOSPHORUS FERTILIZER, 200 lb at 1520 Kcal/lb	304,000	7.6
POTASSIUM FERTILIZER, 170 lb at 1050 Kcal/lb	178,500	4.5
LIME, 500 lb at 102 Kcal/lb	51,000	1.3
PESTICIDES, 12.5 lb at 11,000 Kcal/lb	137,500	3.4
SEED, 1800 lb at 454.5 Kcal G.E./lb	818,181	20.4
FUEL, LUBRICATION, MACHINE CONSTRUCTION & REPAIR, & ELECTRICITY	1,324,132	33.1
TOTAL	4,005,000	100.1
	4.01 Gcal/Ac	

*Graded, F.O.B. Farm

TABLE 14

Dr. MacLeod (continued):

The next slide (see Table 15) shows similar calculations made for a variety of other crops. Here the inputs were grouped into the major categories for comparison among eight crops - our major ones on Prince Edward Island. Here you can compare the relative energy inputs for machinery and fuel, fertilizer and lime, pesticides and other, which includes labour and seed. Note that the low energy inputs for hay and pasture compared to tobacco, for example, which has an extremely high energy requirement, or to potatoes and vegetables. The high figure under "other" for tobacco is because of the oil and electricity for curing, high labour and seed.

In the next slide (see Table 16) this is expressed as percentages - the energy input distribution by percent for each crop. The total machine column includes energy to build, repair machines and the fuel oil to operate them, while the column under machine, fuel and oil is an estimate of the energy consumed as oil or fuel as a percent of the total. If you're trying to add these columns up, you can add column one, three, four and five and it comes to 100. The difference between column one and two is the machine cost, the machine requirement for energy. For hay the machinery inputs for harvesting and transporting, a bulky product, represents 71% of the total, while for pasture which is harvested by animals, the highest input is fertilizer and lime. Corn and processing peas also have relatively high inputs in machines. The highest input for corn, which is a heavy nitrogen user, is fertilizer. With vegetables, fertilizer and lime representing over 70% of total energy inputs, and machinery and fuel inputs are only 25%. Processing peas, on the other hand have 46.3% of their energy inputs as machinery and fuel.

In Table 17 this is summarized and probably a little easier to follow. In this table the total energy input required by various crops is shown as a percentage of the total crop requirement for Prince Edward Island. The cereal and potato crops have the greatest energy requirements, followed by hay and tobacco. Note that the total energy requirement for crops is 511.7 Tcals which is the equivalent of 13 million gallons of fuel, or 595 million kilowatt hours of electricity. This is equivalent to enough fuel to heat 11,000 homes or to provide the electricity for 100,000 homes. Crop production in Prince Edward Island, therefore, consumes less energy than is required to heat the 25,000 or so homes on Prince Edward Island. Agriculture, which is the major industry on Prince Edward Island, is, therefore, not the major consumer of energy. The heating and lighting of homes exceeds agriculture's requirement for fuel and electricity by roughly seven and one-half times.

As I said earlier, agriculture produces much more energy than it consumes, and those of us who wish to eat should not forget this. The crop energy budget is presented in Table 17 for eight main crops.

PER ACRE ENERGY REQUIREMENTS FOR CROP PRODUCTION, P.E.I.

CROP	TOTAL MACHINE	MACHINE FUEL, OIL	FERTILIZER AND LIME	PESTI-CIDES	OTHER
	-----------------------	Mcal/Acre	-----------------------		
CEREALS	420	334	422	12	229
HAY	246	200	97	-	3
PASTURE	23	21	29	-	-
POTATOES	1,324	1,052	1,710	137	834
CORN	773	628	978	33	72
TOBACCO	1,627	1,459	1,000	160	9,417
VEGETABLES*	689	605	1,938	66	48
PROC. PEAS	881	730	440	11	570

*Includes broccoli, brussels sprouts, beets, cabbage, beans, cauliflower, fresh corn, cucumbers, lettuce, parsnips, tomatoes.

TABLE 15

PERCENTAGE DISTRIBUTION OF ENERGY USE IN P.E.I. CROPS

CROP	TOTAL MACHINE	MACHINE FUEL, OIL	FERTILIZER AND LIME	PEST-CIDES	OTHER
	------------	% of total energy requirement	-------		
CEREALS	38.9	30.8	39.0	1.1	21.1
HAY	71.1	57.8	28.0	-	1.0
PASTURE	44.2	40.4	55.8	-	-
POTATOES	33.1	26.3	42.7	3.4	20.8
CORN	41.6	33.8	52.7	1.8	3.9
TOBACCO	13.3	12.0	8.2	1.3	77.2
VEGETABLES	25.1	22.1	70.7	2.4	1.8
PROC. PEAS	46.3	38.4	23.1	1.0	30.0

TABLE 16

Dr. MacLeod (continued):

In the first column the total energy inputs, which were the same as you saw previously, are presented for each crop. In the second column is shown the total output of digestible energy per acre for that same crop. In other words the energy it produces. In the right hand column, output over input ratio or 0/1 shows by how many times the output exceeds the energy input. For example, cereals produce in the grain 2.6 times as much energy as is required in inputs to grow an acre of cereals. If straw is included as output, the ratio is about 4.7. Potatoes produce 2.04 times as much; corn 5.13 times and pasture, which has a low input requirement, produces over 100 times that required as inputs. The major reason for the favourable output over input ratio for hay and pasture is because of the small inputs, particularly chemical fertilizers, applied to these crops, and current recommendations call for much more than is being used. So while the low input levels lead to high ratios in terms of energy, they do not necessarily lead to higher ratios in dollar terms. In other words, pasture would be much better off if it had more fertilizer inputs and would have a higher total energy output. In the case of forages, production would be more profitable at higher output-input levels. Please notice as well that vegetables and processing peas, on the other hand, produce less energy per acre than is used in their production.

Going to the next slide, energy requirements for animal enterprises on Prince Edward Island, you'll see that the energy requirements in terms of electrical and feed energy are presented for various categories of livestock (Table 19). Feed energy is the major category for animal enterprises. The right hand column shows the percent of all animal energy required for each category of livestock. For example, dairy cows use 31.4% of Prince Edward Island's total energy requirement, animal energy requirement, while hogs use 20%. Note, also, that only dairy cows have a substantial requirement for electrical energy. The total energy requirement for animals on Prince Edward Island is 1,385 Tcals or the equivalent of 35 million gallons of fuel, whereas the actual electrical requirement of livestock is 24 million kilowatt hours. Remember, however, what I said earlier, that the greatest proportion of the animal energy requirement has already been accounted for in the feed which we have produced, since most of our feed is locally produced.

In the next slide we can cut this down to show the relative use of energy by various livestock enterprises - cut out some of the classes and group it into dairy, beef, hogs, sheep and other, dairy having the greatest requirement of 39.1%, followed by beef at 31.8%, and hogs at 24.7% (Table 20). Looking at the feed energy requirements of livestock (on the next slide) provided by the various crops, you will notice that only 6.8% is feed that is feed-freight assisted or imported, the remainder being locally produced. Hay and pasture still account for a major proportion of livestock feed energy used in Prince Edward Island agriculture (see Table 21). The estimated requirements of fuel and electricity actually used by agriculture for animal and crop pro-

PERCENTAGE OF TOTAL CROP ENERGY USED

BY VARIOUS CROPS, P.E.I.

Total energy requirement for crops is 511.7 Tcal

CROPS		% OF TOTAL USED
CEREALS		36.8
HAY		8.6
PASTURE		1.2
POTATOES		36.8
CORN		4.4
TOBACCO		8.4
VEGETABLES		0.5
PROC. PEAS		3.3
	TOTAL	100.0

TABLE 17

PER ACRE ENERGY REQUIREMENTS FOR CROP PRODUCTION, P.E.I.

CROP	TOTAL ENERGY INPUT	TOTAL ENERGY OUTPUT	O/I
	--------Mcal/Acre--------		
CEREALS	1,083	2,812	2.60
HAY	346	4,172	12.06
PASTURE	52	5,261	101.17
POTATOES	4,005	8,164	2.04
CORN	1,856	9,525	5.13
TOBACCO	12,204	--	--
VEGETABLES*	2,741	2,062	0.75
PROC. PEAS	1,902	647	0.34

*Includes broccoli, brussels sprouts, beets, cabbage, beans, cauliflower, parsnips, tomatoes, fresh corn, cucumbers, lettuce.

TABLE 18

ANIMAL ENERGY REQUIREMENTS, P.E.I.[1]

ANIMAL	NUMBER OF HEAD*	ELECTRICAL ENERGY Tcal	FEED ENERGY Tcal	TOTAL ENERGY Tcal	% OF ALL ANIMAL ENERGY REQUIREMENTS
DAIRY COWS	23,000	16.1	418.9	435.0	31.4
HEIFERS, 1 Yr +•	16,300	0.4	100.9	101.3	7.3
BEEF COWS •	15,800	0.4	149.2	149.6	10.8
STEERS, 1 Yr +	28,100	0.5	186.9	187.4	13.5
CALVES, UP TO 1 Yr	29,600	0.7	109.0	109.7	7.9
HOGS	135,400	1.7	286.2	287.9	20.8
SOWS AND BOARS	14,000	0.8	53.3	54.1	3.9
SHEEP AND LAMBS	8,500	N.A.	16.1	16.1	1.2
HORSES	3,000(?)	N.A.	20.3	20.3	1.5
HENS****	141,000	0.1	23.8	23.9	1.7
TOTALS	-	20.7	1,364.6	1,385.30	100

1. Does not include construction and repairs of buildings, labour, equipment used in buildings, marketing, hauling of feed or manure handling and spreading.

* Approximate numbers in 1973 and 1974
• Includes both beef and dairy
• Includes all bulls
**** Includes pullet feed

TABLE 19

USE OF ENERGY BY VARIOUS LIVESTOCK ENTERPRISES

ANIMAL	NUMBER OF HEAD	% OF TOTAL ENERGY USED
DAIRY*	47,700	39.1
BEEF**	65,100	31.8
HOGS	149,400	24.7
SHEEP	8,500	1.2
OTHER***		3.2
	TOTAL	100.0

* Milk cows, heifers and calves
** Cows, heifers, steers, bulls and calves
*** Horses, poultry, etc.

TABLE 20

PERCENTAGE OF TOTAL FEED ENERGY FROM VARIOUS CROPS

	TOTAL ENERGY (Tcal)	% OF TOTAL
CEREALS	489.29	26.3
HAY	529.84	28.5
PASTURE	599.75	32.2
CORN	114.30	6.1
FFA* GRAIN	127.37	6.8
	1,860.55	99.9

*Feed Freight Assistance

TABLE 21

Dr. MacLeod (continued):

duction on Prince Edward Island are shown on the next slide, which is an accounting of the actual estimated consumption for the various crops or animal enterprises, and just remember I have been talking about equivalents in fuel or electricity. Cereal and potatoes are the biggest users of fuel, with dairy, tobacco and potatoes being the biggest users of electricity. The actual total fuel requirement is approximately 3.7 million gallons, and the total electrical requirement is 36 million kilowatt hours. These estimates do not include labour, transportation of goods to and from farms, nor the handling of feed and manure, nor the construction or maintenance of farm buildings (see Table 22).

In the next slide the total energy required for Prince Edward Island agriculture at the present time is shown for the input categories of fuel, electricity, fertilizers and pesticides (Table 23). It is interesting to note that the energy inputs from fertilizers, when expressed as equivalent gallons of fuel, exceed the actual fuel consumed by the agriculture industry. In other words the equivalent is 4.7 million gallons, and the actual use is 3.7 million gallons. The comparison is even more striking when expressed in kilowatt hour equivalents for fertilizer compared to kilowatt hours used for crops and animals. Note, also, that the energy input through pesticides is relatively small in terms of both fuel and electricity, and it should be remembered that the use of pesticides for weed control, for example, saves a lot of fuel and machine energy that would otherwise be required for cultivation to control weeds. Fertilizers are obviously a high energy-requiring input. Fertilizer is also a relatively high cost input to most crops, particularly in Prince Edward Island and Atlantic Canada where native soil fertility levels are low, and where our relatively high rainfall leaches nutrients from the soil more rapidly than in some major agricultural areas.

In the next slide, in addition to commercial fertilizers, Prince Edward Island utilizes almost $7 million equivalent fertilizer value in the form of animal manures which are returned to the soil (see Table 24). The manure is equivalent to almost 15 million pounds of nitrogen fertilizer, 6,500 pounds of phosphorus fertilizer and 16 million pounds of potassium fertilizer. The nitrogen in the manure is about equal to the nitrogen purchased in chemical fertilizers. Manure phosphorus is about one-third and manure potassium is about equal to the amount purchased in chemical fertilizers. While these quantities of N, P and K are estimated to be present in fresh manure, it should be noted that its nutrient levels may fall very substantially during storage and through leaching of bacterial action.

And in the final slide, the value of manure in fertilizer equivalent has doubled in the past five years, increasing from $2.75 per ton to $5.50 per ton for dairy manure (see Table 25). Some five years ago it was questionable whether the nutrient value in the manure warranted hauling it out to be spread; however, you have to do something

FUEL AND ELECTRICITY USED
FOR CROPS AND ANIMALS, P.E.I.

	FUEL USED (GALLONS)	ELECTRICAL ENERGY USED (KWH)
CEREALS	1,425,980	
HAY	621,324	
PASTURE	58,824	
POTATOES	1,106,373	4,988,000
CORN	184,804	
TOBACCO	126,471	7,342,800
VEGETABLES	14,951	
PROC. PEAS	161,029	
DAIRY		19,314,000
BEEF		1,682,000
HOGS		2,900,000
OTHER		116,000
	3,699,756	36,342,000

TABLE 22

TOTAL ENERGY REQUIRED FOR AGRICULTURE, P.E.I.

	ALL CROPS	ALL ANIMALS
FUEL (GAL)	3,699,756	
ELECTRICITY*(KWH)	12,420,800	24,012,000

- -

FERTILIZER - 221,092,520 KWH or 4,671,495 GAL
PESTICIDES - 11,198,640 KWH or 236,618 GAL

* Crops - Potatoes and tobacco only

TABLE 23

VALUE OF MANURE PRODUCED IN P.E.I.
(IN TERMS OF CHEMICAL FERTILIZERS)

	NUTRIENT CONTENT LBS	VALUE OF MANURE $ 1975*	$ 1970**
NITROGEN	14,768,000	4,430,400	2,215,200
PHOSPHORUS	6,532,000	1,306,400	653,200
POTASSIUM	16,188,000	1,618,800	809,400
		$7,355,600	$3,677,800

*N at $0.30/lb, P at $0.20/lb and K at $0.10/lb
**N at $0.15/lb, P at $0.10/lb and K at $0.05/lb

TABLE 24

ESTIMATED VALUE OF MANURE
IN FERTILIZER EQUIVALENT

1975	DAIRY	$5.50/Ton
	HOG	$5.40/Ton
1970	DAIRY	$2.75/Ton
	HOG	$2.70/Ton

TABLE 25

Dr. MacLeod (continued)

with it so most of it ends up back in the soil. Now I'd say the situation is more favourable with regard to nutrient value because of the high fertilizer costs. In the feed budget for animals, 62% of what they eat is digested and goes to the animal; 38% is secreted as manure. But recycling of 38% of the feed produced on Prince Edward Island cannot be assumed and credited to crop energy, since only about 15% of it is directly chargeable in the crop. In other words the amount that provides the equivalent nutrients to fertilizer amounts to 15%. Animal manures alone are not sufficient for the high level crop production that is required to produce our food on reduced acreages of land compared to 100 years ago. Returning crop residues to soil is a recommended practice for soil rebuilding, but remember that it also, in many instances, encourages proliferation of disease organisms and frequently intensifies the need for pesticides to control insects, diseases and weeds. While we can possibly reduce the requirement for fertilizers and pesticides, we cannot eliminate them unless we wish to return to the much lower crop yields of the 1800s; and, let's face it, we no longer have the land nor the labour to go that far backwards. On Prince Edward Island we in research have been calling for about five years for reduced fertilizer usage on potatoes, for example, because of the beneficial effect on their quality for processing. It is just when the fertilizer prices went up that we started having some success in being listened to.

We are also striving for increased yields at economical input rates, so that our farmers can remain competitive on a price basis with producers in other provinces and nations; and we might as well face it - if you aren't competitive, you aren't going to be in it. Now with both financial and energy restrictions to consider, agriculture is under the gun once again, the objectives being low food prices for the consumer and a minimal energy utilization. Imposition of either energy supply restrictions or restrictions through energy cost will increase the cost of food at the farm gate, and there's no question about it. Let us be careful, then, to protect the priority requirement of the agricultural industry for energy; but let's face it - food is a priority item if you want to survive. At the same time, agriculture must use energy as efficiently as is practicable, and new cropping and soil management techniques will have to be developed. If we are to accomplish this, governments must avoid financial strangulation of: 1) research for developing these new methods; 2) extension activities that will promote their use; and 3) the farmers who will implement them to the advantage of us all.

Please remember Dr. Rennie of the Ontario Ministry of Agriculture and Food, whom at the start of my presentation I quoted as saying that of the total food system from producer to consumer, about 18% of the total requirement is used on the farm. The remainder, 82%, is used getting the food to the consumer's table. Please remember also that of Canada's total energy consumption only about 3% is used by farm

Dr. MacLeod (continued):

production of food. Other sectors of our society are wasting energy or using it inefficiently, and they have obligations to conserve as well. But this is not a session to fix blame nor to point a finger; it is an information session to see where we are at and to decide how we can best proceed in the future. I think that agriculture's history indicates that it can adapt to change, and I am sure that it can adapt in the future, providing that society's demands aren't unreasonable and providing that society is willing to pay for its food in relation to what it costs to produce it, and providing that our soil resources and our farmers remain available in sufficient quantity to meet our future food requirements.

Thank you for this opportunity to appear before you and to try to evaluate Prince Edward Island's agricultural energy requirements. Government is to be congratulated for sponsoring this session as an effort in communication and understanding. Until we can understand our situation with regard to energy, we cannot plan a solution. When we understand it and begin to plan solutions to our problems, then we must be able to communicate with society as a whole and get their support and cooperation to implement an objective energy policy. I think that it has been in these areas of understanding and communication that we have fallen down in the past. In my opinion, greater savings in energy will be made from a change in attitude by our people than from changes in design and machinery or changes in crop and practices.

Thank you very much ladies and gentlemen. I have with me Dr. Lovering, our research economist, and Mr. McIsaac, our assistant engineer, whom, if the questions get too difficult, I'll call in to assist me.

PREMIER CAMPBELL: Thank you, Dr. MacLeod. If I might start out the questioning with a "Gordon Sinclair" type of question, you've shown how .... (another voice: "What's your income?")... yes, well, you've shown how, because of rising costs of fertilizer, the equivalent value of manure has almost doubled in the last five years. Can you place a value on all the manure piles in Prince Edward Island now in terms of millions of dollars?

DR. MACLEOD: I think the total was $7 million in terms of the nutrient value. There's a lot of energy in manure, but we're only crediting the nutrient content that replaces the fertilizer energy. Now a lot of energy goes into the soil and undoubtedly a lot of it has been beneficial, but we haven't been able to calculate that.

PREMIER CAMPBELL: Well, that question leads to correspondence you and I have exchanged over the last year or more on the question. The discussion seems to take place on the extremes, where the question seems to be asked whether we should go totally to fertilizer and pesticides or whether we can go to alternatives. Could you give us the benefit of your present-day assessment, and the direction you would recommend agriculture to follow in Prince Edward Island over the next 10 to 20 years?

DR. MACLEOD: I could certainly give you my opinion, and that is that agriculture has obviously been using manure, or the Island would be piled so high now that it would sink. So it's going to the land - I'm not saying it's going to the land in entirely the best form it should; I indicated there's some loss in storage and leaching. I would recommend, certainly, that manure be used to the full extent we have it available. It can't be used on any crop; it can be used on corn and grasslands, etc., but presents problems in cereals. I don't buy either all organic or all fertilizers, because all organic is the way they operated 150 years ago and their crop yields didn't approach what we have now. Admittedly, some parts of the country which are much better endowed with soil and climate than we, have successfully implemented such systems. But these aren't automatically transferrable because of climate and because of soil capability. I don't opt for full fertilizer either, as you know. I opt for a middle way, using all the organic materials possible, and enough fertilizers and pesticides to maintain our food production rate at a level where we can all eat.

DR. MALONEY: About what percentage would that be? Would it be 50-50?

DR. MACLEOD: Well, with the exception of phosphorus there was as much nutrient going on in manure as we're buying in fertilizer, if you'll recall the table. There was only about one-third as much phosphorus, but nitrogen and potassium were almost equivalent. Right now it's 50-50. I presumed we were using all the animal manure we had.

MR. DINGWELL: What other possible ways have we for fertilization of the land here on Prince Edward Island, for example cover crops being plowed down into the soil?

DR. MACLEOD: Well, certainly there's nothing wrong with growing a cover crop for plough-down. It requires energy in the form of fertilizer to get it growing, so you're adding energy when you're ploughing the crop down. Your benefit is the difference between what you add as fertilizer and what you have when you ploughed it down. It's still good for soil structure, yes. Our year begins a little shorter than in some places in North America, we don't have quite as much opportunity to get a crop off in a year and still have a plough-down. You have to equate the economics of it - whether you're going to leave it for a year, fallow it, grow something to plough down or get some money out of the acre that you're producing. Sure, if you have something on the sod or something actually seeded to plough down, it increases the organic matter and biological activity in the soil, and that's beneficial. We aren't recommending yet to spend a year growing a crop to plough it down on too many acres because that does not pay very much.

MR. CLARK: Have you any information on the use of mussel-mud on our soil?

DR. MACLEOD: No. I've seen lots of farms with mussel-mud on them, and it's a very long term effect on the pH of the soil, but I would suspect with the current labour costs it would be out of the question.

MR. MCINTYRE: You stated that farmers will have to change methods of tillage because of the cost. Just what did you have in mind for a change in methods?

DR. MACLEOD: Well, Dr. Lovering and Al McIsaac have been doing some work on sizing machinery for different sized farm operations and it is, I think Jim's opinion that we cultivate by tradition more than by requirement in some cases. In other words maybe it's standard that you have to harrow it three times when maybe harrowing it once is enough with weed control and herbicides. This is one immediate aspect. I suspect that research will have to develop methods whereby a crop can be produced without going over the land so many times with heavy machinery because each time you go over it, it costs money. As you saw from the energy budget, pesticides have a very low energy requirement to produce. A very small quantity goes on, but it might replace quite a bit of activity by a tractor and machinery. There are rumblings from the mid United States again about no-till cropping, where you crop without tilling at all. This has been tried in Ontario and while they acknowledge that it works fine in the corn belt, their reaction is that right now it doesn't work in Ontario. We just can't take a practice developed somewhere else and automatically apply it here until it's been tested. These are some of the ways- cutting down the number of times over the land and keeping your machinery size down to what you need. In other words you don't need a 100 horsepower tractor if you're pulling a machine that requires 50.

MR. MCINTYRE: Are you saying that we are overcultivating our soil at the moment?

DR. MACLEOD: In some instances we think so, and that results in soil compacting as well. If you don't have to go over it four times then you shouldn't go over it four times.

MR. DINGWELL: Did you work out a percentage figure of loss on this $7 million value of manure in relation to its storage and proper use?

DR. MACLEOD: No, I'm afraid I haven't. That would vary entirely with the method of storage. The value will decrease some under any storage conditions because the nitrogen in the fertilizer volatilizes and goes off into the air. The other nutrients you don't lose unless you have leachate or something running away from them, but the nitrogen will escape as air. If it's outside and rained on on the side of a hill, half of it ends up down in the stream.

MR. WELLS: I wonder, Dr. MacLeod, if you would comment on whether or not any examination has been made in the Atlantic region in respect to methane generation.

DR. MACLEOD: Not in the Atlantic region, but there is a federal research contract out - I don't know if it's Manitoba or Ottawa - where this is being looked at. Of course methane in Manitoba is no different than methane in Prince Edward Island. If it's going on somewhere in the country within our branch then we don't duplicate.

MR. WELLS: Excepting, I gather, that climate has some significant bearing on whether or not methane can be economically produced.

DR. MACLEOD: Yes, we can tell that pretty well from temperature value of course.

LLOYD G. MCPHAIL, MLA: Dr. MacLeod, in reference to your statement earlier having to do with the increased cost of energy affecting the cost of food at the farm gate: I'd like to ask - assuming that other input components remain the same, let's say if there was an increased energy cost of 25%, what increase would this probably provoke in the increase of food at the farm gate to allow the farmer to maintain the same percentage profit?

DR. MACLEOD: Well, you'd have to go back to the tables per crop and determine what percentage of the energy input came from fuel; I think some of those were fairly high. For example, potatoes: actual fuel was 26%, so if it went up 25% you would have 25% of 26 or about 6 or 7% increase in the cost of food at the farm gate. It wouldn't be a straight across-the-board increase equivalent with fuel but it would be about one-quarter of that.

MR. MCPHAIL: I was wondering what the possible average would be for all crops.

DR. MACLEOD: It's pretty hard to get an average figure. You have to calculate each of these crops individually. Because there are so many different operations in potatoes compared to hay, we didn't have an average.

DR. JIM LOVERING: I might speak on the question of potatoes. The figure is estimated at about 33 gallons of fuel per acre and at about 50¢ a gallon to make it low. That's about $16.50 and if you increased that by 25%, you're talking about $20.00.

DR. MACLEOD: That's about a 20% increase in fuel.

DR. LOVERING: That was not, of course, including cost for pesticides, manufactured machines and so forth.

DR. MACLEOD: Well, on the fuel it's interesting to note that the Prince Edward Island Government reported for 1974 the usage of one million gallons of marked gas and 1.6 million gallons of tax-exempt diesel fuel for farm purposes for a total of 2.6 million gallons. We figured out about 3.7 million gallons which is a difference of a million gallons. We don't know where the difference lies but it would appear that they aren't burning too much marked gas in their cars if they are a million gallons under our estimated consumption.

MR. DINGWELL: The emphasis seems to be still on the production of cheap food. Is this realistic in relation to our dwindling source of land and our dwindling number of people in the agricultural community?

DR. MACLEOD: No. We maintain that society as a whole must pay sufficient for their food so that the producer, the farmer, can have a standard of living equivalent to the rest of society. If this is done, it's going to entail an increase in the cost of food. I think that there's no way we can avoid it; it's just a matter of time.

MR. MCPHAIL: I wonder, Dr. MacLeod, if the consumer does not pay sufficient to maintain the farmer in the way he should live, will that not in the long run provoke even a greater increase in the cost of food?

DR. MACLEOD: It certainly will. If we can't feed ourselves, then other countries will export it to us to eat and we will pay through the nose for it then, I can assure you.

MR. WELLS: I wonder if you'd care to comment about the relative cost situation of processed food versus unprocessed food.

DR. MACLEOD: I don't have the actual breakdown, but I think I said 18% of the energy requirement was at the farm, which means that 82% is somewhere between the farm gate and your dinner plate. What proportion of this is processing, transportation, packaging, handling in stores, I don't know. Obviously there's five times as much energy input into the food after it leaves the farm gate as there is at the gate, and I've said on many occasions that most people automatically think that the price of food is high because the farmer's asking too much for it. Most of the increase in the price of food takes place after it leaves the farm gate.

PREMIER CAMPBELL: Dr. MacLeod, I'd like to go back to the mussel-mud again, because it seems to me that mussel-mud, if it has agricultural value for our farmers in Prince Edward Island is a resource, an undeveloped and unexploited resource in Prince Edward Island. Your comment was that the labour costs would likely be too high, and I'm sure that by traditional ways of digging mussel-mud that is true. But to replace it, we go to all parts of the Maritime provinces for lime which comes through very expensive lime quarry and trucking or rail facilities; and we go all over the world for fertilizer, and there are immense capital investments there which contribute to the cost of them. I'm wondering if, either publicly or through private enterprise, let's say a large dredge could be made available to dredge up the mussel-mud and leave it in piles to be sold to farmers who want it and take it to their own farms, thereby removing the labour elements, or much of them. Are there studies available at the present time which would show this to be of equal or better value to farming enterprises than our present dependence on imported lime and fertilizer?

DR. MACLEOD: Well, there are none that I'm aware of. The mussel-mud as a product would be much less concentrated than the limestone materials you know as limestone, but, as you pointed out, it would have other nutrients in it. In the old days, of course, it was a hand operation with lots of labour and wintertime activity. It's quite possible that dredging could certainly bring it up and pile it. It would be a more labour-intensive operation even getting it onto the land than with limestone now with large trucks that spread it on quickly. I honestly can't answer as to the economics of it.

HON. A. E. (Bud) INGS, DVS: You would have to use about three times as much mussel-mud as limestone.

DR. MACLEOD: Probably. That's a lot of weight, but it's long-lasting and it's beneficial, because you can still see the shells on many farms throughout the Island.

PREMIER CAMPBELL: What would be the thickness of that mussel bed in the Hillsborough River?

DR. MACLEOD: 20 to 22 feet.

MR. WELLS: Would it not add tilth to the soil, too, Doctor?

DR. MACLEOD: Oh yes, sure. A lot of the finer soil particles have eroded off the soil and ended up in the river, and that's what you're hauling back. Plus you're putting your land back in your fields by taking mud, but it's a pretty costly operation, I think. It probably could be piped from the shore with present day mining machinery.
ARTHUR J. MACDONALD, MLA: Are there any studies done, Dr. MacLeod, on the relative value of seaweed and kelp as compared to manure?
DR. MACLEOD: We concluded about two or three years ago an experiment with potatoes in which seaweed was used along with animal manures and fertilizers; fertilizers and manures were used in combinations for some 15 or 20 years. The value of the seaweed was only that of its organic content and a few nutrients. It wasn't as good as manure, and manure alone wasn't as good as manure and fertilizer. After fertilizing for 20 years with fertilizer only and no manure, the yields had dropped somewhat. We went back to the plots to see how long it would take to recover full production, and the first year, by socking the fertilizer to it, you might say, we got 75 to 80% of the potential yield and the second year we got 100% with just fertilizer. But without either, yield had dropped and potatoes had practically stopped growing.
MR. WELLS: Thank you, Dr. MacLeod. I would now like to call on a representative from the Provincial Department of Forestry, Mr. Ian Millar, who's currently the Assistant Director of Forestry as well as being responsible for provincial forest inventory, forest fire control and crown land management. Mr. Millar will discuss with us the present situation in Prince Edward Island insofar as forestry is concerned. Mr. Millar.

Energy and Forestry in Prince Edward Island

MR. IAN MILLAR: Thank you, Mr. Chairman, Members of the Legislative Assembly, press, general public. This session will deal with the forest as an energy producer and as an energy consumer. The forest is a complex of woody and vegetative plants which convert sunlight and water and nutrients into organic material. Our prime concern will be with those plants which produce woody stems of sufficient size to make a positive economic return to the landowner. This first map shows approximately 300,000 acres of merchantable forest areas on Prince Edward Island (see Figure 3). The map does not show the many small wood lots which are scattered throughout the Island, nor does it show those areas of forest land which do not have a presently merchantable forest crop. You will note that the concentration of woodland occurs in the eastern and western regions of Prince Edward Island and it is in these areas that the vast majority of the pulpwood is produced. The production of lumber is more evenly distributed throughout the province by approximately 50 sawmills. The size and location of these various mills are shown on the map (Figure 4). The production is approximately equal in each county of the province. The total production of lumber on Prince Edward Island has generally remained relatively constant at approximately 13 million board feet per year. The market share of each mill also

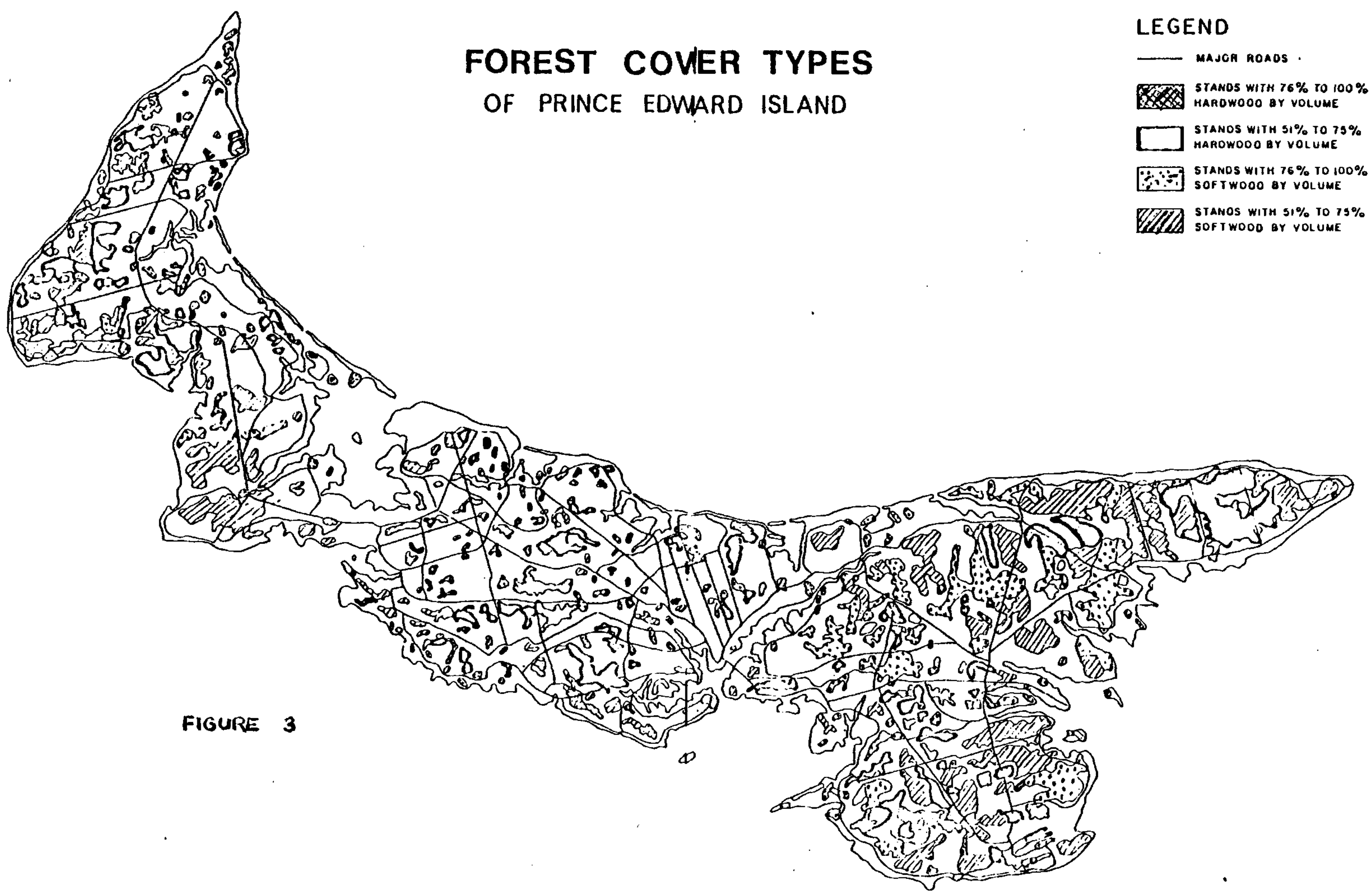

FOREST COVER TYPES
OF PRINCE EDWARD ISLAND
LEGEND
MAJOR ROADS
STANDS WITH 76% TO 100% HARDWOOD BY VOLUME
STANDS WITH 51% TO 75% HARDWOOD BY VOLUME
STANDS WITH 76% TO 100% SOFTWOOD BY VOLUME
STANDS WITH 51% TO 75% SOFTWOOD BY VOLUME

FIGURE 3

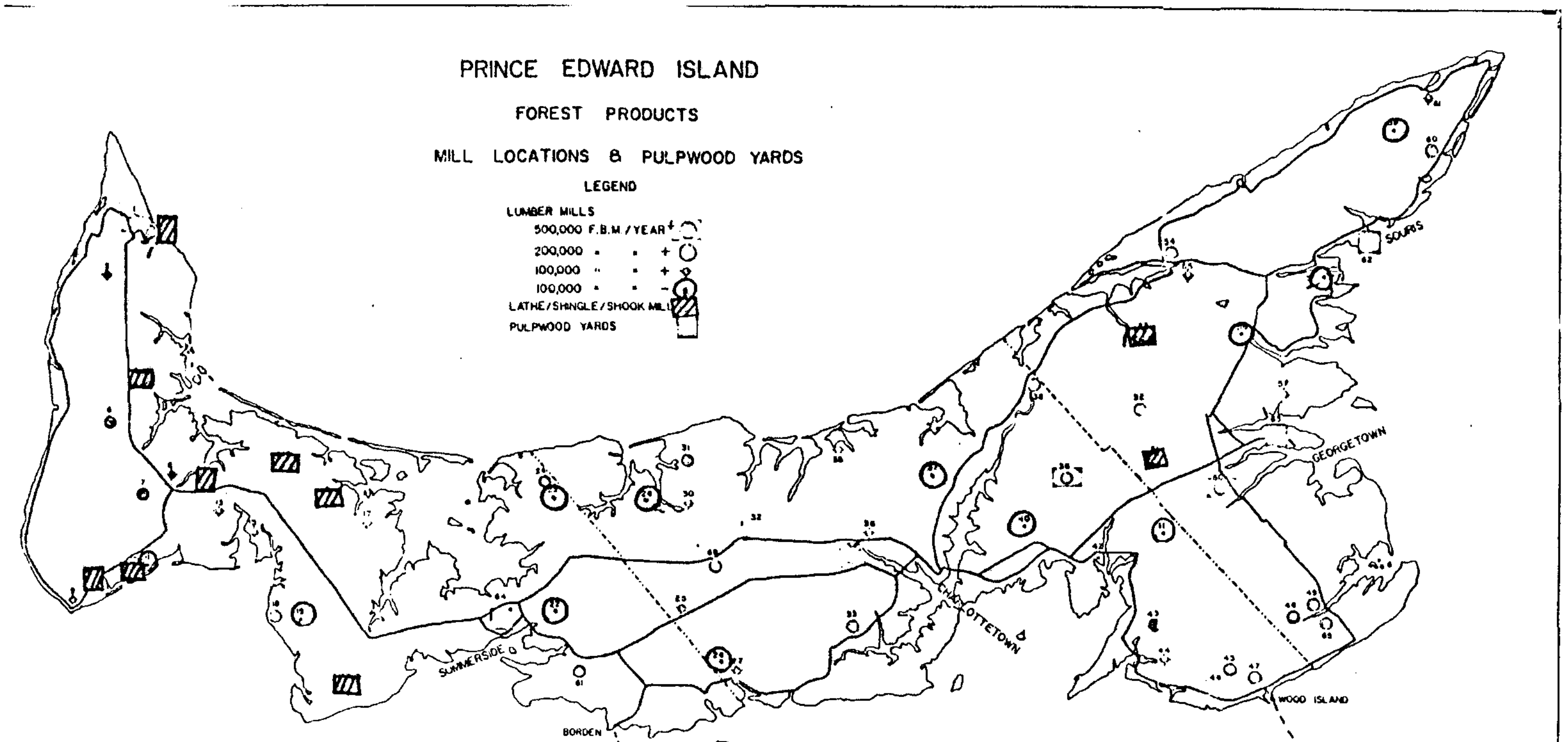

PRINCE EDWARD ISLAND
FOREST PRODUCTS
MILL LOCATIONS & PULPWOOD YARDS
LEGEND
LUMBER MILLS
500,000 F.B.M./YEAR +
200,000 " " +
100,000 " " +
100,000 " " -
LATHE/SHINGLE/SHOOK MILL
PULPWOOD YARDS
SOURIS
GEORGETOWN
CHARLOTTETOWN
SUMMERSIDE
WOOD ISLAND
BORDEN

FIGURE 4

Mr. Millar (continued):

appears to be relatively stable. The foregoing map shows the mill sizes and locations while the present slide shows the diagram of how the mill production of lumber is related to mill size (see Figure 5). The largest ten mills on Prince Edward Island produce over 50% of the lumber, while the next ten mills add an additional 20% of the total production, indicating that 70% of our total sawmill production on Prince Edward Island is produced by the 20 largest mills in the province. Actual production figures for forest products are difficult to obtain because there's no requirement for producers, sellers or buyers to report their activity to the Forestry Branch. Thus the slide showing the figures on forest harvesting are based on our best estimates and personal interviews with others closely connected with the forest industry (see Table 26). There is approximately 13 million feet of lumber produced annually. The pulpwood content is approximately 35,000 cords. We estimate there's about 24,000 tons of wood residue converting to 12,000 cords. Fuel wood is approximately 30,000 cords at present, with fence posts, etc. contributing about another 1,300 cords. Bolt wood - that's the material that's used for lobster trap lathes and sills, etc. - another 1,500 cords and other miscellaneous products at around 1,000 cords to give us a total of approximately 107,000 cords of wood. Knowing the quantities the forest products produced, it would now add to our picture of energy utilization to know how much energy or fuel is used to harvest and manufacture these products. The majority of these fuel consumption figures are variable and so in order to present some information on this subject, I have made some assumptions based on what appeared to be average conditions. This slide shows some of these assumptions (see Figure 6). You will note that the travel of the cutter to the woods is a little bit over 0.33 gallons, and the travel of the machine operator, both with the machine and on another day when he has to travel to the site, adds up to another 0.2 gallons. The chain saw is one of the largest users at approximately 0.5 gallons (these figures are all per cord), and then skidding or transporting the wood to a roadside, giving a total fuel consumption per cord of wood, cut and moved to a roadside where it can be picked up by a truck, of approximately 1.4 gallons. The material is then ready to be taken to a sawmill or a pulpmill.

The next diagram, Figure 7, will show you the fuel used in manufacturing. Here trucking is a very small portion at about one gallon, hauling is about 0.5 gallons, while the sawing uses about 6.5 gallons, and dressing about three, for a total production of 13.1 gallons per thousand board feet, and that is taking it from standing in the woods to the time that it is now ready to be manufactured or put into your house, still in the mill yard.

We have not been able to compute the energy required to convert pulpwood into paper products; however, we do estimate that it would require about 2.6 gallons of fuel per cord to harvest and transport the pulpwood to the pulpmill yard.

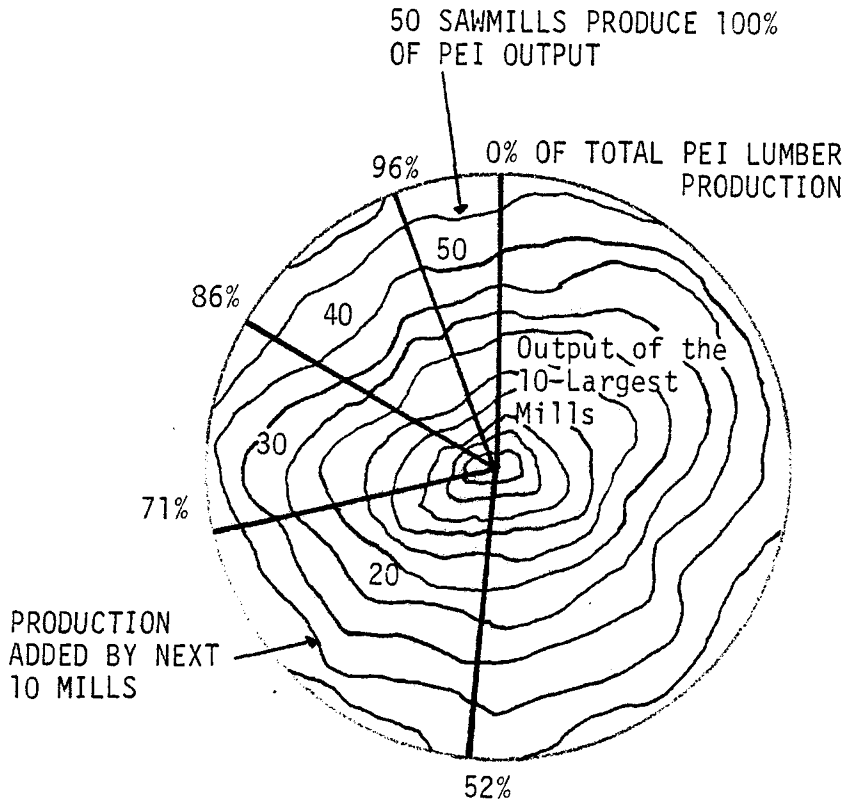

50 SAWMILLS PRODUCE 100%
OF PEI OUTPUT
0% OF TOTAL PEI LUMBER
PRODUCTION
96%
86%
71%
52%
50
40
30
20
Output of the
10 Largest
Mills
PRODUCTION
ADDED BY NEXT
10 MILLS

FIGURE 5

PRIMARY FOREST RESOURCE INDUSTRIES

FOREST UTILIZATION

	PRODUCTS	UNITS	VOLUME	EQUIV. CORDS HARDWOOD	EQUIV. CORDS SOFTWOOD	EQUIV. TOTAL CORDS
1.	LUMBER PRODUCTS:					
	Construction Lumber	M.F.B.M.	9,700	400	19,000	19,400
	Farm Lumber	M.F.B.M.	3,500	500	6,500	7,000
	SUB-TOTAL		13,200	900	25,500	26,400
2.	PULPWOOD:					
	Softwood	Cords	33,000		33,000	33,000
	Hardwood	Cords	2,000	2,000		2,000
	SUB-TOTAL		35,000	2,000	33,000	35,000
3.	PULPWOOD CHIPS	Tons	-	-	-	-
4.	WOOD RESIDUES	Tons	24,000	1,000	11,000	12,000
5.	FUELWOOD	Cords	30,000	25,000	5,000	30,000
6.	POSTS & POLES	Pieces	66,500	400	900	1,300
7.	BOLTWOOD PRODUCTS	Cords	1,500	300	1,200	1,500
8.	MISCELLANEOUS	Cords	1,000	500	500	1,000
	SUB-TOTAL			27,200	18,600	45,800
	TOTAL			30,100	77,100	107,200

TABLE 26

WOODS OPERATION FUEL CONSUMPTION

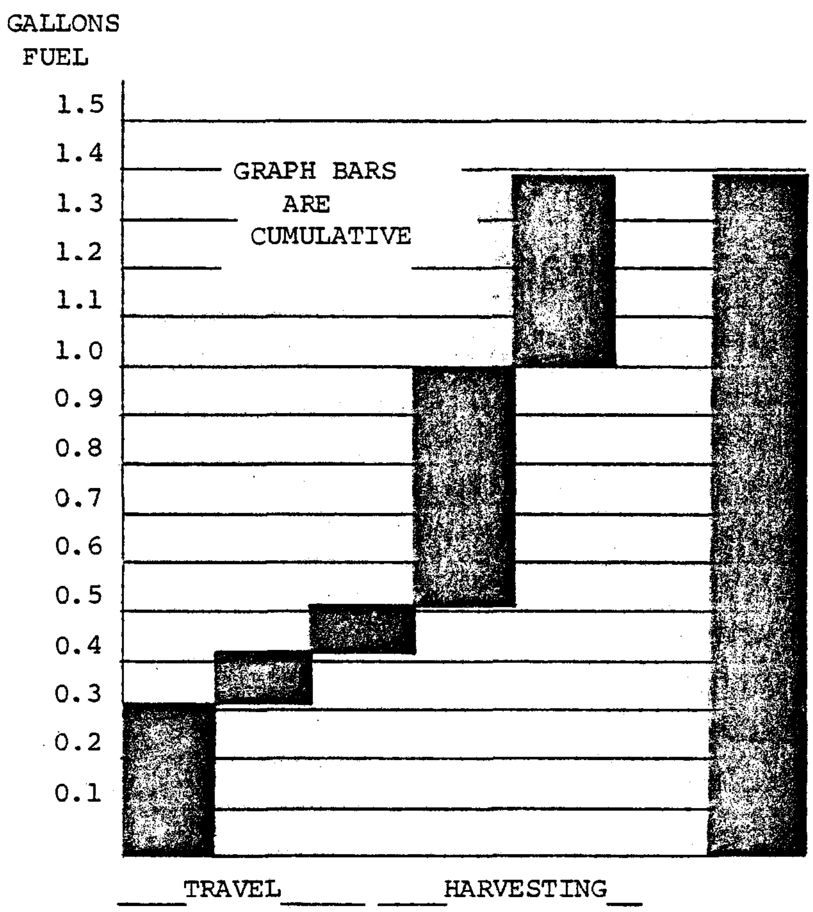


FIGURE 6

MANUFACTURING OPERATION FUEL CONSUMPTION

Per MFBM

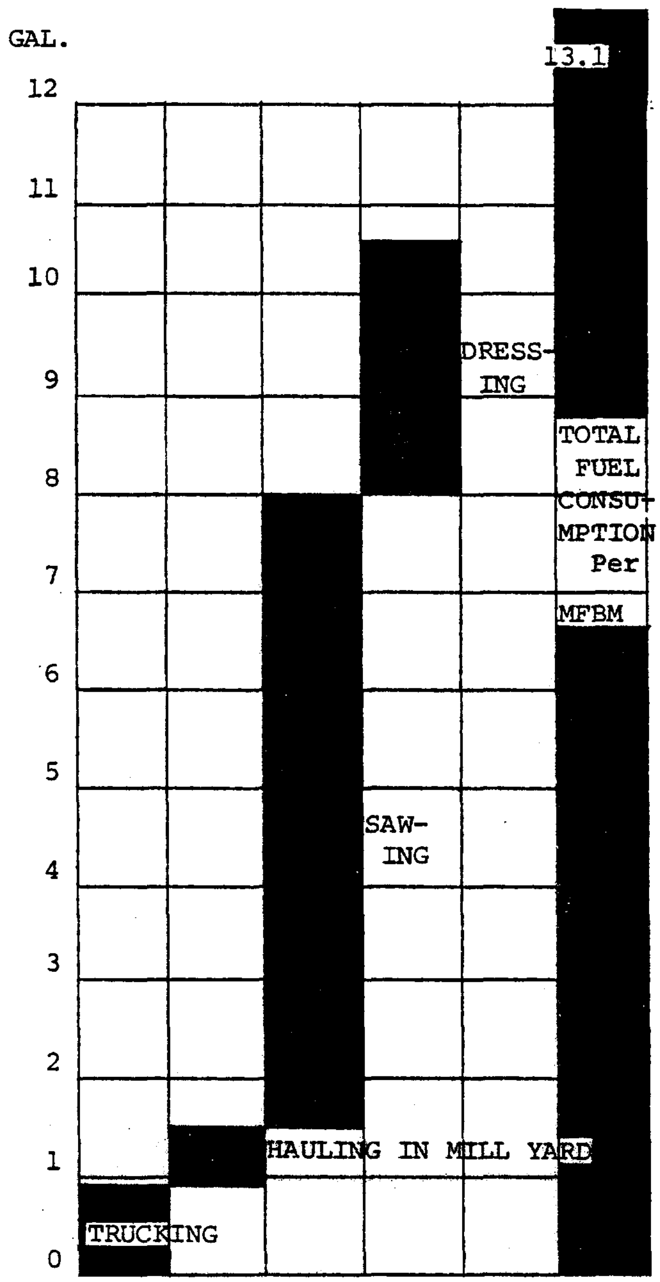
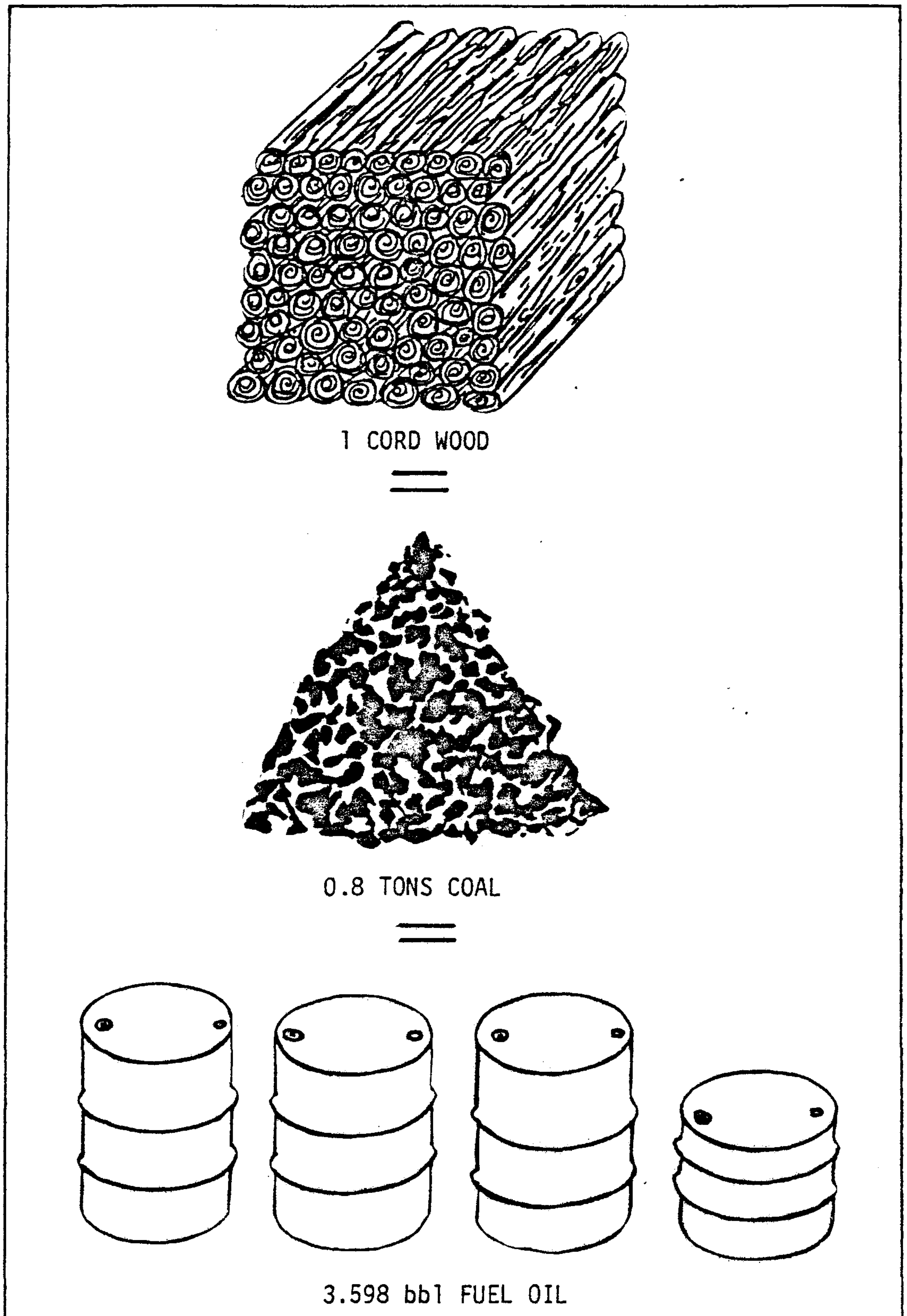


FIGURE 7



EQUIVALENT HEATING CAPACITIES

FIGURE 8

Mr. Millar (continued):

Having computed the energy consumption of the various forest operations, it is possible to calculate the annual fuel consumption of the forest industry on Prince Edward Island. Lumber production of 13 million board feet times the gallons requires about 172,900 gallons. Your pulpwood production of 35,000 cords takes about 91,000 your fuel wood about 42,000 and your miscellaneous products another 5,000 gallons. As a by-product of the lumber manufacturing process there is approximately 0.9 of a cord of wood residue per thousand board feet. The wood residue is made up of slabs, edgings, sawdust and planer shavings. The total wood residue produced as a result of the lumber manufacturing process is approximately 12,000 cords. Figure 8 shows the relationship in thermal capacity of wood, coal and oil. You will note that one cord of wood has an equivalent heating capacity of approximately 0.8 of a ton of coal or 3.598 barrels of fuel oil. Using this relationship we have computed that the residue from Island sawmills has a heating capacity equivalent to 1.5 million gallons of fuel oil. This is impressive, but we must remember that the additional energy would be required to transport the residue to conversion plants and that the conversion process will not be 100% efficient. Having determined the energy potential of wood, it is now advisable to take a more detailed look at our forest resource.

This next slide will show you the land utilization on Prince Edward Island (see Figure 9). You will note that there are approximately 600,000 acres of woodland on Prince Edward Island, about 43% of our total land area. The graph also shows that forests occupy more of our land area than do agricultural crops, and it is only when pasture and grassland are added to the total crop-land picture that agricultural use of land exceeds the forestry use.

Now let us look at the forest land in more detail, and the next slide will show this distribution. It shows a more detailed breakdown of the forest, forest cover types or similar species groupings and two classes of merchantability (see Figure 10). In those areas which are classed as merchantable, the majority of the trees exceed four inches in diameter; thus, our inventory and volume figures are related to merchantable areas, which by definition contain trees which are in excess of four inches in diameter. This next slide will show you the volume distribution of our wood (see Figure 11). We show that there are approximately 4.7 million cunits of wood. Now, a cunit for those who may not be familiar is approximately 1.17 cords or 100 cubic feet of solid wood. This is broken down into about 3 million cunits of softwood and 1.7 million cunits of hardwood. No calculations have been made to compute the total wood volume, which would include the volumes of non-merchantable trees, as this would require a new inventory and different inventory techniques than those presently involved. In order to manage our woodlands and provide a continuous yield of forest products, it is necessary to know more than the current inventory or volume figures; therefore, our next topic will be forest productivity or forest yield.

P.E.I. LAND UTILIZATION

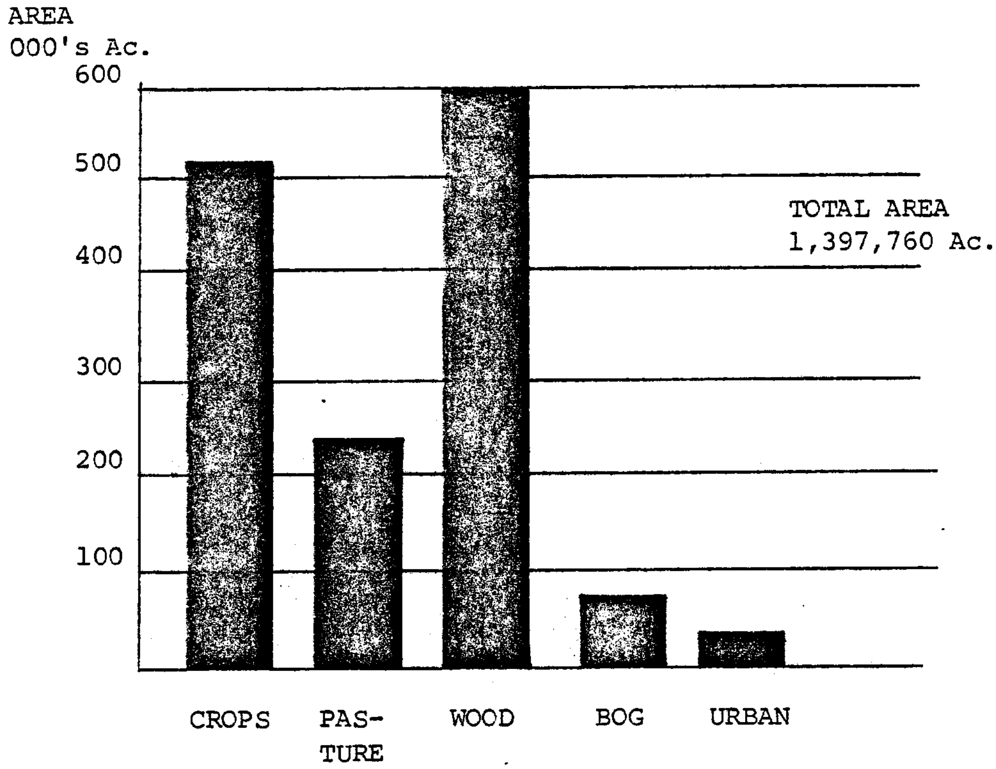


FIGURE 9

AREA DISTRIBUTION OF FOREST CLASSIFICATION

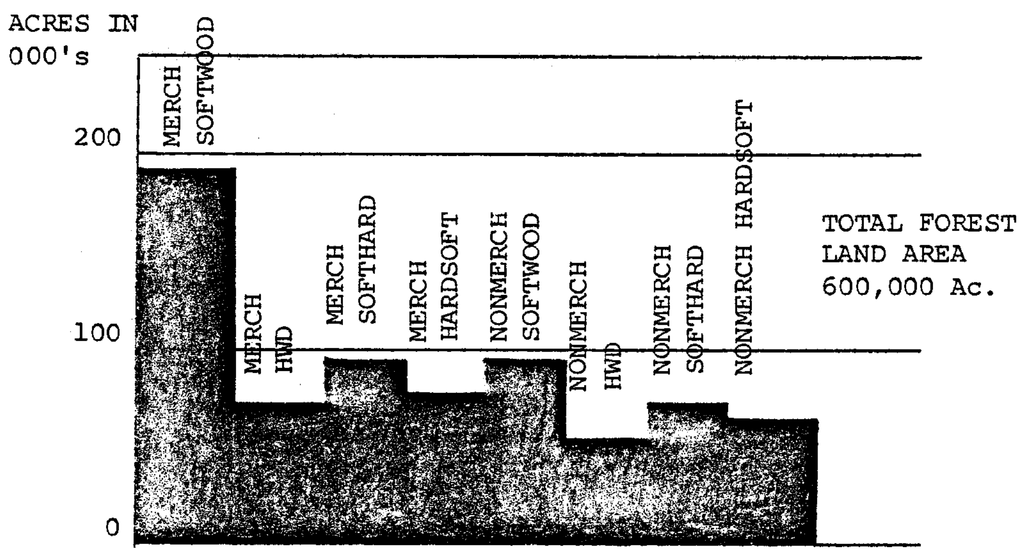


FIGURE 10

VOLUME DISTRIBUTION OF WOOD

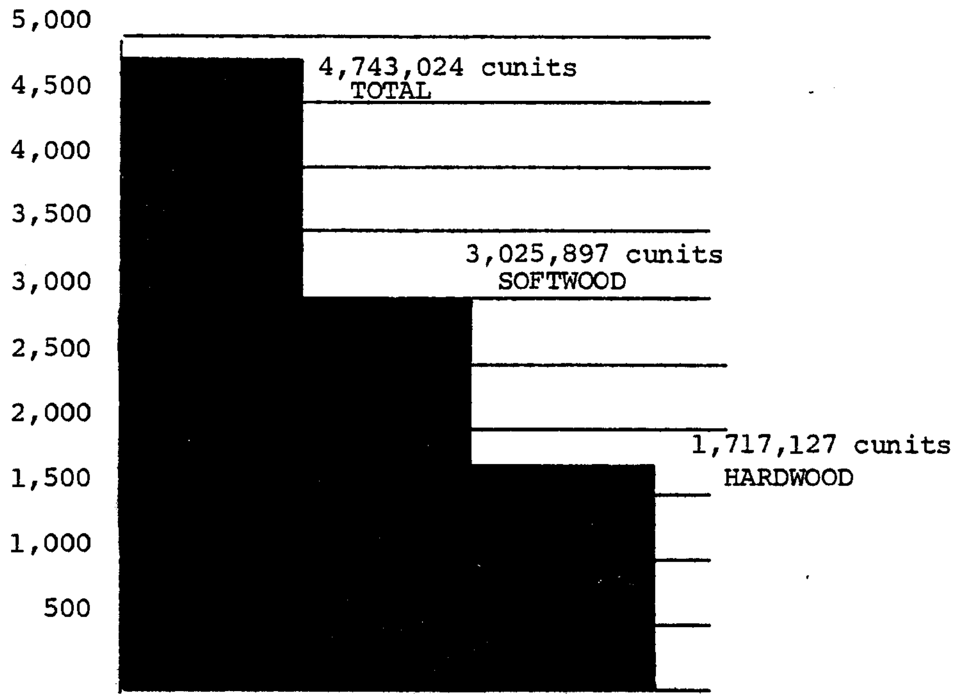


FIGURE 11

YIELD/ACRE IN CDS.

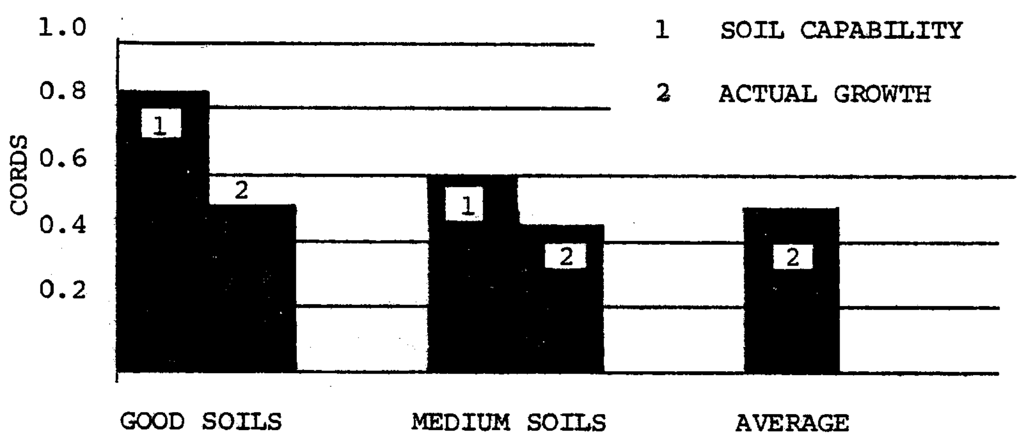


FIGURE 12

Mr. Millar (continued):

Forest yields, like those of agricultural crops, are dependent on soil fertility, texture and the moisture-holding capacity as well as the species and quality of the seed that is used. Thus the various soil types have inherent differences in yield. Figure 12 gives us the various yields in cords on the different soils. Fortunately the types can be grouped into three categories of yield capability. The Charlottetown, Alberry, Culloden and Dunstaffnage soil series are the most productive with an average capability of about four-fifths cord per acre per year. Unfortunately, because of inadequate stocking or overmaturity, the actual yield on these soils is presently just over one-half cord per acre per year. The second group of soils are the Armadale, O'Leary and Egmont series. This group has a productive capacity of about three-fifths cord per acre per year. But again, for reasons similar to those previously mentioned, the productivity is presently less than one-half cord per acre per year. When we're discussing current forests yields, we must remember that all the figures have been computed on current technology and forest utilization. This includes such items as tree species, minimum size, expected rotation period, growth and mortality. The foregoing yields are based on the above considerations and a reasonable level of stocking. By changing any of the foregoing factors the yield will be altered to reflect the changed conditions. For example, the effect of age is shown in Figure 13 where age and current or mean annual increments are shown. You will note that the current annual growth rises rapidly and then falls off again fairly rapidly at a given point. The ages in this diagram are not necessarily representative of any of the tree species in Prince Edward Island but the graph is a very typical curve. The second curve, the lower one, is what is known as mean annual growth and that is the growth computed over a five to ten year period. You note that this rises more slowly and also falls off more slowly. The point where these two curves intersect is called the culmination point, and it is at this time that the maximum yield per acre per year can be obtained from your forest land. So in a proper forest management program, it would be at this point that the forests should be harvested.

To this point we have been talking about growth per acre, and it is now time to put this information into a provincial context. Our province has approximately 600,000 acres of woodland which are capable of growing approximately 300,000 cords of wood per year. The allowable cut for the province has been established at 160,000 cords, as shown in the next slide (see Figure 14). The large difference between the allowable cut and growth is largely a result of the present poor management of our woodlands. Less than one-half percent of the 7,000 woodlot owners in the province have prepared and followed a professionally developed woodlot management plan. Thus almost one-half of the growth in the woodlot is used to replace trees which die and rot within the woodlot. Thus the management for existing woodlots would do much to increase the annual sustainable yield and cut of forest products.

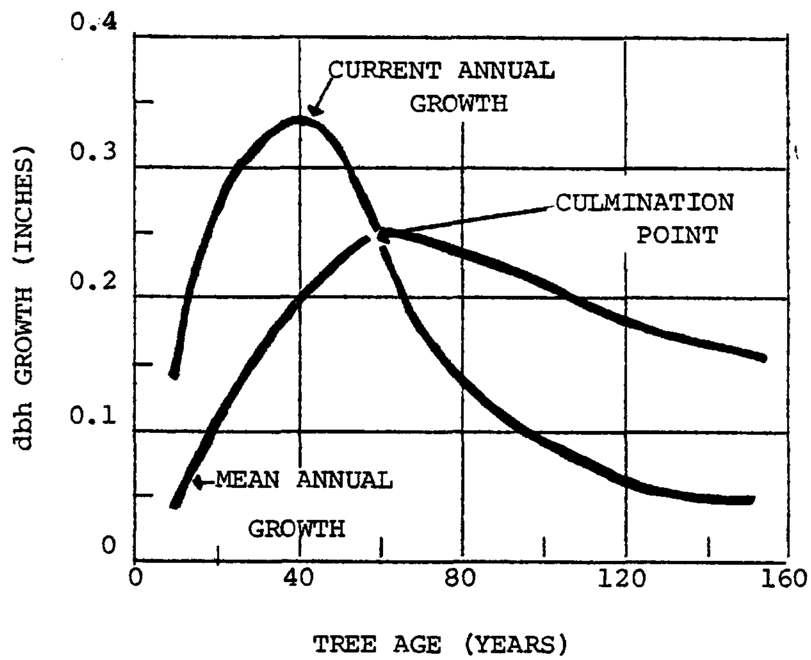


FIGURE 13

ANNUAL FOREST GROWTH ON P.E.I.

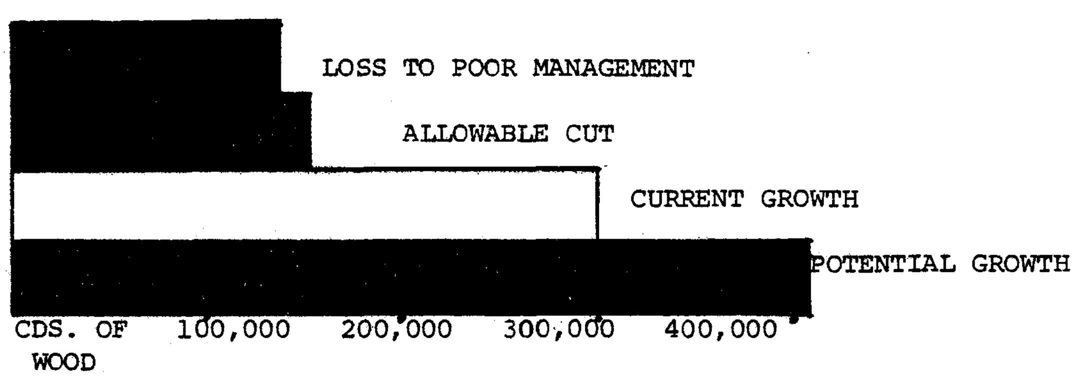


FIGURE 14

TREND OF WOOD CONSUMPTION IN CANADA

1963-71

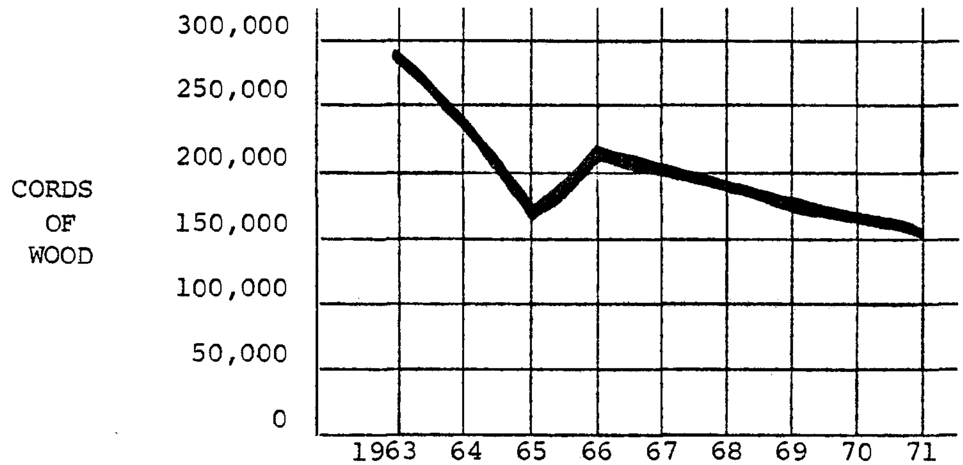


FIGURE 15

Mr. Millar (continued):

To conclude this session on wood as an alternative energy source, we shall look briefly at the current use of wood as a fuel. During the last decade the use of wood as a fuel has dropped dramatically as is shown in Figure 15. The data used to prepare this graph were taken from the 1971 census as compiled by Statistics Canada. This decreasing trend may not represent the true Island picture, but these figures were not readily available. During the last two years there appears to be a small increase in fuel wood consumption due in part to the increase in costs of oil and electricity. According to the 1971 census data fuel wood is still playing a significant role in Prince Edward Island. The census showed that of 27,785 homes on Prince Edward Island, 10% used wood as the principal heating fuel, 13% used wood for heating water and 15% used it for cooking. In 1972 approximately 22,000 cords of wood were used as fuel on Prince Edward Island. In 1973 the figure had dropped to about 13,000 cords. It was during 1973 that the increases in costs of other fuels started to be felt. We feel that with the increase in costs of other heating fuels, wood will continue to hold its own or increase slightly. Again Figure 8 shows the relationship of your various fuels for heating and as a fuel one cord of wood has a heating capacity of approximately 125 gallons of oil. It has been reported to us that the average home uses approximately 1,300 gallons of furnace oil per year; therefore to heat the average home would require about 10.4 cords of fuel wood per year. If all Island homes were heated with wood, we would need approximately 290,000 cords of fuel wood per year. The above wood to oil home heating potential is based on improved technology which is presently available but may require further refinement before being pushed onto the market.

This concludes the presentation of the energy and forestry relationships. The next session on April 12 and 13 will attempt to put forward some ideas which could lead to forestry and trees playing a more important role in the production of usable energy.

Any questions?

PREMIER CAMPBELL: Thank you, Mr. Millar. I'd like to have your definition of the term "lost to poor management". I see that we're losing about 125,000 cords a year due to "poor management". Do you mean the trees maturing and falling down?

MR. MILLAR: That's correct, yes. The trees are growing; many woodlots are not being harvested on any sort of a regular basis. As part of a study that I did back in about 1969 to 1970 about 64% of the woodlot owners either never or very seldom harvested wood commercially, and 37% of them didn't even harvest wood at all. So this represents a large portion of both our woodlot owners and woodlot resource base which is not being harvested, and therefore this wood is just going to waste. It's standing in their woodlots and falling down when it dies, because like any other plant a tree has a certain life-span and then it is replaced by other younger trees.

PREMIER CAMPBELL: Well, by your own conversion table that works out to about $4 million worth of trees falling down each year. My question then is: based on your own knowledge of, let's say, the eastern Kings or the western Prince areas of our province, what are our prospects of fueling woodburning electrical generators requiring, let's say, 20,000 cords per year?
MR. MILLAR: I think they're very good, but I think we also have to recognize that if we're going to get into the capital cost of installing a plant which burns wood as its fuel to convert to electrical energy, then we have to improve our forest management so that we will continue to get a sustained yield from our woodlot areas. At the present time, as the diagrams indicated, we're losing about 140,000 cords to rot, and this material certainly could be made available. The other larger question perhaps is whether we can persuade people to harvest their woodlands much the same as they do an agricultural crop, recognizing that it is a crop and has to be harvested, otherwise it will go to waste.
PREMIER CAMPBELL: It would be easier to persuade them, I suggest, if there were a woodburning generator in their neighborhood where they could sell....
MR. MILLAR: I would agree, yes, that presently if people harvest say pulpwood, they see it go on the truck and that's the last they ever see of it. You don't recognize your newspaper as being a product of your woodlot. Whereas the electrical energy, and certainly in a community system, would be recognized - 'this energy is being created as a result of my wood that is being sold to this generating plant'. It will require more forest management in order to maintain and even improve our capability of production. Through most of the province, as the potential yield indicated, we could be coming up close to approximately 500,000 cords of allowable cut if we managed our woodlands with some degree of care; that is, making sure that it is reforested as soon as it's cut and making sure that the proper species go on the woodlot so that you're not trying to grow, say sugar maple in the swamp, but you're putting on the black spruce which is more suited to growing in the wet site. Thus these various items become important, and it's only through proper management and some education that people can learn the best species to grow.
DR. MALONEY: How long does it take spruce in this province to reach its culmination point?
MR. MILLAR: Approximately 50 years, and that is going to depend on which species of spruce you use. When I say 50 years, I'm talking about white spruce; black spruce would be slightly older, probably in the order of 70; red spruce, which is a very desirable wood for both musical instruments and for lumber production, would probably be in the order of 120 years. But then you're talking of very specialized products; you wouldn't be talking of using that as a fuel material.
MR. WELLS: I think, to use your figures, Mr. Millar, on the question that the Premier asked; quickly computing it here we figure

that the wood wasted through improper management now would be equivalent to fueling seven 5-megawatt plants - 35 megawatts - or in 1974 figures about 80% of the production of electricity.

MR. MCQUAID: Mr. Millar, do you consider it a reasonable proposal to suggest that everybody in Prince Edward Island should try to convert to wood for fuel? Now you say it's going to take about 290,000 cords. Our reforestation program is not going too swiftly, is it? I understand that you reforested only 360 acres of woodland last year. Now we've definitely got to step up our reforestation program, otherwise we're going to run out of wood pretty fast if everybody starts converting to wood.

MR. MILLAR: I'll have to be honest. I don't think it's reasonable to expect everybody to convert, because certainly storage is going to be one of the problems. Not too many people have enough room in their basement or beside their house to store ten cords of wood. So I don't think that everybody would be able to convert. As far as your comment on reforestation, no, we certainly didn't do enough last year to attempt to maintain this type of production, and thus my comments that proper management is going to have to be instituted in our woodland areas if we are going to be able to maintain a resource base with which to either provide electricity or wood as a fuel for heating. We have the land area available to do this. It's a matter of properly utilizing the resource base, but this is going to require a large input of dollars in order to bring the resource up to its potential.

MR. MCQUAID: Regarding Figure 8, have you any comparison as to cost? You say one cord of wood equals 0.8 tons of coal and 3.598 barrels of fuel oil. Have you any idea what a cord of wood costs as compared to 0.8 tons of coal and 3.598 barrels of fuel oil?

MR. MILLAR: I don't have the figures on the coal and the fuel oil. Maybe some of the other members here can provide them. Coal, I'm told, is about $30 a ton; the cost of wood depends on how you're using it. If you're buying it in big piles eight feet long, in other words not manufactured, for fuel it would run you somewhere in the current day of $15 a cord, maybe a little bit better.

MR. MCQUAID: That wouldn't be much good for the most of us. We'd have to get somebody to saw it.

MR. MILLAR: Well, maybe it's the case where we could all get into Participaction a little bit and get out the bucksaw and cut it up.

MR. MCQUAID: How much would it be split and delivered in my yard?

MR. MILLAR: Split and delivered in your yard, it's going to run you probably between $60 and $70 a cord, maybe a little bit more.

PREMIER CAMPBELL: Well, I don't see the day when I'm going to heat my house with hardwood, but that kind of wood being delivered to a stockpile for consumption in a large electrical generator certainly seems to offer some interesting prospects.

MR. MILLAR: Yes, it offers very interesting prospects that way, and also for heating some of the larger buildings. There's a good example in Fredericton, New Brunswick, where the Maritime Forest Rangers School has been operating for the last approximately 30

years. They have the whole complex, which is three four-storey buildings, and they're all heated by one woodburning furnace. Now I'm not sure on the total wood requirement that they get, but they take that, as a management program, from the 3,000 acre University of New Brunswick forest - in their cleaning and thinning operations.
PREMIER CAMPBELL: Do they have a smoke pollution problem with that?
MR. MILLAR: I've not noticed any smoke problem any time that I've been around the school, and I've not heard any complaints about it.
MR. MCQUAID: Probably you gave us the figure and I missed it, Mr. Millar, but have you any idea of the consumption of wood to fuel one of those thermal generating plants?
MR. MILLAR: No, I haven't. You probably have as much idea as I do or the Members of this House. The task was given to us to try and outline what we presently had as a forest resource in the province, and we didn't have time to delve into the other aspects of it.
MR. MCQUAID: Do you think our forest resource would stand it?
MR. MILLAR: I think it would stand some of these types of plants. In fact, I think it would be a very good use, certainly, of some of our low-grade hardwoods. We have many areas in the province where harvesting was carried out a number of years ago, and the growth which has come back is sucker growth, many cases red maple, and it has a rotten heart in it so it is no good for lumber production or furniture wood or anything like that. At the moment, in fact, it doesn't look in the future like we're ever likely to get a hardwood pulpmill within reasonable range of the province so there would be no market for this material. Fuel wood would be the excellent use for this type of material.
MR. WELLS: I think, to answer your earlier question, Mr. McQuaid, as near as we can figure it, it's a rough estimate, it would take about 20,000 cords per year to operate a 5-megawatt electricity plant. Now, just using Mr. Millar's figures on waste wood, the wood that's falling down and rotting, it seems reasonable to believe that about seven of those 5-megawatt plants could be operated just on the waste wood alone.
MR. MCQUAID: Yes, but I'm wondering, is it feasible to get that waste wood out of the woods. As I understand, waste wood is there mixed in with good wood, and you'd have to get in and get your waste wood out without destroying your good wood, eh?
MR. WELLS: It's a matter of harvesting.
MR. MILLAR: This, as Mr. Wells says, is a matter of harvesting. It's a matter of starting to convert woodlots to an agricultural pattern where you maybe harvest one acre or two acres a year or more, depending on the size of your woodlot, and then reforest those acres so that you are using, you might be using say a 50-year rotation, that is, the time from seedling to the time that you harvest. Thus, if you had a 50-acre woodlot, which is approximately the average size of the woodlots on Prince Edward Island, you would be able to harvest and plant one acre per year. That should yield you something

in the order of 35 cords with a plantation, or better. Certainly, as we get into talking about potential in later days or in our next session where we're talking about the potential that can be obtained by genetic improvement of some of our trees, we find that that yield would approximate a cord per acre per year. Theoretically we could be ending up with 50 cords on each acre by the time we get into the second rotation. The first time through, though, you're going to be harvesting big trees which hopefully you would send to lumber production. Some of your next grade trees, just slightly smaller, would go perhaps to pulpwood and then all your waste, your tops, small ends, rotten wood would be used in your thermal generating plants.

MR. MCQUAID: Do our sawmills offer any potential by way of by-products?

MR. MILLAR: We've calculated, as I indicated, that approximately 0.9 of a cord is produced for each 1,000 board feet of wood, and this converts to about 12,000 cords of wood per year that is produced as a by-product or residue material from our sawmill manufacturing process. This is available, in most cases - some of it is currently being used (the slabs at any rate are being used) as an augment to many of the Kemac burners, and so is being used as heating fuel - but this material would be available for a generating system. The additional costs, though, would be that you would have to bring this residue together to a central point or to a number of central points, and this would involve an extra energy expenditure.

MR. MCINTYRE: I'm wondering, Mr. Millar, if in talking here about the future, you know 25 to 50 years from now, I'm wondering if in 1976 20% of the people on Prince Edward Island decide to go to wood-burning operations, how long would our woodlots stand this type of thing?

MR. MILLAR: I haven't computed that figure. I imagine we could do it for you. In the first go around, first time through, you're going to be using wood which is currently standing. There's quite a bit of that presently there, but in order to maintain that in the long run, and I think this is one of the keys of forestry, we have to recognize that it's a very long-term operation. In agriculture we're quite happy with planting our grain seed in the spring and harvesting it in the fall. The same thing happens in forestry except that your spring and fall are 50 years apart, or approximately that, depending on your species. If you take this into consideration and remember that for every acre of land that you've cut and reforested, then you'll always have a crop of forest material. Our woodlands are presently understocked. That is, they are growing only perhaps 75% of the trees that they are really capable of growing. So that on the first go around after we have harvested those and come to our plantation where we put in 100%, that is all the trees that the area can physically grow, then we will get much better yields than we are presently getting. And also there is the opportunity for planting better quality trees than nature has given us. Forestry, if I can digress, is in the state at the present time where agriculture was about the time the Indians were going out and picking off ears of corn and beating them with a stick. There've been no genetic improvements in forestry, or very little yet. The amount of genetic improvement that has gone into the corn crop or tomatoes is just fantastic, and it's because of this genetic improvement that we're getting our yields in agriculture that we do today. So this is possible in forestry, and we're working on it. But it does take a period of time before it becomes a realization.

MR. DINGWELL: Mr. Millar, perhaps as you know there are 13 different operations between taking wood out of the woods till you eventually take it out of the woodburning stove in ashes. If so many people went into woodburning operation, there're so many fixed costs in generating other types of energy like electricity. What would this do to the percentage of people who would be left in need of energy production; and also is it feasible to suppose that even 20% would go into the use of woodburning energy? You speak of the production of wood and the waste of wood, but you don't mention the very vulnerable position we are in here on Prince Edward Island today and the possible destruction of much of our woodlots due to the infestation of the spruce budworm. I wonder what your comment on that would be and what action should be taken in that regard.

MR. MILLAR: You've asked several questions there, Mr. Dingwell.

MR. DINGWELL: I usually get them answered sometime.

MR. MILLAR: It makes it a little difficult. I'm not perhaps as adept at answering and remembering the questions as the Premier is. You wonder what the implication might be to those remaining if say 20% of our people switched to wood. I suppose because of your capital cost you'd get a slightly larger amount to be spread over fewer number or same amount of capital cost to be spread over the same number of people. But I think in this case, you're talking about two different things. If we're talking about electrical energy, then that I would foresee to be fed into a total grid system for the province, so that these costs would all be balanced out. Now when you are talking about heating, really all you're doing is talking of displacing oil as a fuel, so that the companies which are going to have to replace storage tanks, etc., and trucks over a period of time, would just not put as many back in the system as they had before, so that the relative capital cost would probably remain somewhere close to the original one. Now that's a guess off the top of my head, because I really don't know the details on it, but that would be what I would foresee. Now, the second part of your question related to the spruce budworm; that is another natural phenomenon which we have on Prince Edward Island and have had before. Our previous records of infestation indicate that we have never lost significant quantities of our spruce and fir forests to the budworm.

We have never perhaps had a very long period of duration where the budworm is feeding heavily on our spruce and fir forests. Now whether we will get a long period of defoliation or a number of years of consecutive defoliation of our spruce and fir forests with this infestation is something that we can't tell at this time. The most we can do is predict a year in advance and that prediction is based on egg counts which we do in connection with the Canadian Forestry Service each fall, and our counts from last fall did indicate that probably we would have a high level of infestation again this year. However, there did not appear to be a danger of significant mortality occurring in our spruce and fir forests in this next year, that is, or in this current year, 1976. We will be monitoring the movements of the population of the budworm during 1976 as well as the condition of the trees to see how they're withstanding the defoliation which is occurring and then we will be making recommendations to government as to what should be done for the following year based on egg counts that will be taken this fall and on the condition of the standing trees. We have people from several different disciplines who are concerned with the budworm. Agriculture is concerned because of the wind protection which the forests provide and because if any control program did have to be recommended, certain chemicals would have to be used to control it which would have an effect on the agricultural scene, and we want to keep them monitored. Also, our fish and wildlife people are concerned and are working with us because most of our streams travel through woodlands, and there would be some of the insecticide getting to the streams. We also have some people from the Department of the Environment here who are also concerned about the environment, and then ourselves. So any recommendation that goes to government will be based on as many facts as possible in order to give as fair a picture as we possibly can as to what the situation is likely to be, what any problems could be and what course of action should be taken and that's about where we are in the budworm.

MR. DINGWELL: You spoke of reforestation in terms of years. Was that actually based on Prince Edward Island reproduction - I understand we have a much higher rate than other places in Canada in reproducing a species to a certain size. Were your figures actually taken on Prince Edward Island?

MR. MILLAR: I'm just not sure which thing you're referring to.

MR. DINGWELL: The growth cycle of the trees.

MR. MILLAR: Oh, the growth cycle. The actual diagram (Figure 13) which I showed on the screen was not typically Prince Edward Island; I just stole it out of a textbook because it gave me the nice curve, and we don't have sufficient information to be able to produce it for Prince Edward Island for a particular species. That is a very typical diagram and ours would follow that same shape. Now it might be displaced one way or the other slightly,but that is just a minor technical matter really, and I used the diagram to illustrate the point of when a forest should be harvested.

LEONCE BERNARD, MLA: Mr. Millar, you indicated that there were so many cords of wood left in the woods now. Were any other surveys made to see how much heating fuel is left in the woods after cutting only lumber and leaving the tops there as well as other trees that aren't suitable for lumber?

MR. MILLAR: We haven't done any here, and so it's very difficult to say. I know some of the pulp companies have found that as much as 50% of the wood is actually left in the woods when they're doing a harvesting operation. I would think that probably it wouldn't be quite that high here because we're not into the mechanized scene as much as some of the pulp and paper companies are, and many of the cutters, especially when it's an individual farmer harvesting wood for his own use, say to build a new barn or make some repairs, are generally more conscious of the additional value that they can get. Since softwood is not the primary heating fuel, hardwood is generally used for people who want to have a fire in the fireplace or want a good hot fire in the stove. They don't always salvage as much of that wood as they could. There are machines on the market now that have just come on in the last few years which are called Chip Harvesters, and that's a trade name, which will go in and turn a whole tree, limbs, branches and everything, into chips so that you get 100% utilization. This accounts for the difference in the amount of wood that they get when they go in and handcut and when they go in with a chip harvester.

DANIEL COMPTON, MLA: They would have to debark that tree before they'd put it into chips, wouldn't they?

MR. MILLAR: No. They ran into a few problems in the pulping process, but they have been able to overcome these because the bark becomes a very small content of your total pulp material. It's only when your bark is running a large content, as it would be with very small trees, that in the pulping process you would start to run into a few problems. It was a case of changing their formulation and their mix, their cooking time, and they are able to get around many of these problems. At the present time they haven't used it 100% for the pulp mix; they've been mixing this chip harvester wood, or total tree wood as they call it, with other round wood that they have taken out of their mill yard so that again this pushes down the percentage of bark in the total.

MR. DINGWALL: We seem to have gone, Mr. Millar, through two or three cycles in my short lifetime of wood insects somewhat of the nature of the spruce budworm of today, in beech and silver birch or yellow birch as we call it. We find very few older species. What is the history of those cycles?

MR. MILLAR: The birch one nobody knows really. It was called birch die-back, that's the white birch, and many eminent scientists studied it for quite a number of years to determine what caused it. Since there is something in scientific circles known as publish or perish, the individuals weren't able to publish anything except negative results and this got a little bit discouraging. The disease or whatever it was disappeared and so the problem as far as they were concerned was gone; they couldn't publish anything more on it so they ceased to study it, and they don't yet know what the definitive answer was as to why the white birch died off. Yellow birch is mostly a case of having been harvested and requiring special conditions for regeneration. It is what is known as one of the climax species; that is, it traditionally comes into a forest which has already got a number of trees in it. You have pioneer species such as poplars and cherries. Then you go through another cycle of medium trees which can tolerate a certain amount of shade, such as some spruces, and then you'll come to climax species, which are yellow birch, sugar maple and some white pines and hemlocks. These can tolerate quite a lot of shade when they're seedlings but not a lot of sunlight. So when you harvest your forest you're putting the cycle back to square one, and you'll get, if natural regeneration is let to take place, those species which traditionally come in as either pioneer or early successional stages in the forest. Thus you don't tend to get regeneration of yellow birch as adequately as it was represented in the Island when we first came here or when our ancestors came. The beech was another problem that we acquired - an aphid from Europe known as the beech gall aphid, and this character was imported either to Halifax or Boston on some trees which were brought over by some well-meaning individual and planted, and the insect found that there was a habitat to his liking here and all kinds of beech trees in which he could live with nobody else eating them. He multiplied very rapidly and is continuing to spread throughout Eastern North America. No control measures have been undertaken that I know of, certainly on a forestry scale. There may be some for ornamental trees but nothing has been done on a forestry scale for it.

MR. COMPTON: There has been quite a destruction of elm over in New Brunswick with the same or similar sort of disease.

MR. MILLAR: Yes, it's very similar. The elm is being killed off by the Dutch Elm Disease, which again was introduced, and our native elms were not resistant to it; so this disease has been spreading throughout Eastern North America. So far it's all up around Fredericton up the Saint John River Valley; it's down as far as Sackville and in the last couple of years it has got over as far as Nova Scotia. This depends on the elm bark beetle for transmitting the disease. The bark beetle, in its feeding, will pick up some of the microspores which contain the disease and then it will transport these to a new tree. This usually occurs during a spring period, during June. However, the insect can be controlled, and some of the cities, Fredericton in particular, have done a very good job of keeping it out of the town because they have operated a very good sanitation program. The beetle will usually pick up the disease during its overwintering stage or during the late fall and summer, and then it will over-winter generally on a dead tree in the bark or cracks or wherever it can find a nice quiet spot. So by removing all of your diseased trees from the surrounding area you don't provide an area in which the beetle can come in contact with the disease and thus the disease does not tend to spread into the area. Prince Edward Island is in a very fortunate position that, should the disease ever hit here, it's going to be introduced into one or two trees most likely, and probably it will be the result of some of our travels between New Brunswick or Nova Scotia and Prince Edward Island. We have a very good opportunity to control it here because it would simply be a matter of cutting out those trees which we notice to be infected and burning them or burying them just as quickly as we notice that they became infected with the disease. Thus, with probably a relatively small program we could keep our elm trees on Prince Edward Island relatively free of the Dutch Elm Disease.

If there are no further questions, Andy tells me we're running a bit short, so thank you very much, I've appreciated talking with you.

MR. WELLS: Thank you very much Mr. Millar. If I might answer Mr. McIntyre's question, we did some quick computing again. He asked what additional number of cords would be required to heat 20% more homes with wood; roughly it would come out to 50,000 cords. Putting it into Island perspectives, it's estimated we'd need somewhere in the vicinity of 250,000 cords of wood to replace all of the oil that we're presently burning in our homes for heat. To relate that to Mr. Millar's figures of cords wasted, he estimated somewhere in the vicinity of 140,000 cords; so we're not talking about adding much to the potential but rather harvesting.

MR. MCINTYRE: I wonder how many years it would take to deplete our stock at that rate, just using 20%.

MR. WELLS: That's a yearly growth, you see. We're losing on a yearly basis 140,000 cords through bad management at the present time.

Well, to round out this morning's presentation, we're going to recall to the podium Mr. Norman Hall, who will discuss with us the present oil and gas situation in Prince Edward Island and off our shores.

The Oil and Gas Situation in Prince Edward Island

MR. NORMAN HALL: The Maritime region has been the site of oil and gas exploration since the mid-1800s, with work on and around Prince Edward Island being carried on intermittently since early in this century. At present, permits covering most of the Island and a good portion of the coastal waters are held by a group of companies which form a consortium operated by Hudson's Bay Oil and Gas Limited. A block of oil and gas leases of about 80,000 acres is held in the Cable Head area which we can see on this slide 45 by Texaco Exploration Canada Limited (see Figure 16). A considerable amount of money, some $50 million, has been spent on exploration by various companies on Prince Edward Island, most of this by the Hudson's Bay group, who drilled, as you may recall, the two most recent wells in 1975 at Tryon and Naufrage. The results to date of the drilling on shore have been

PRINCE EDWARD ISLAND

DRILLED AND DRILLABLE OIL AND GAS PROSPECTS

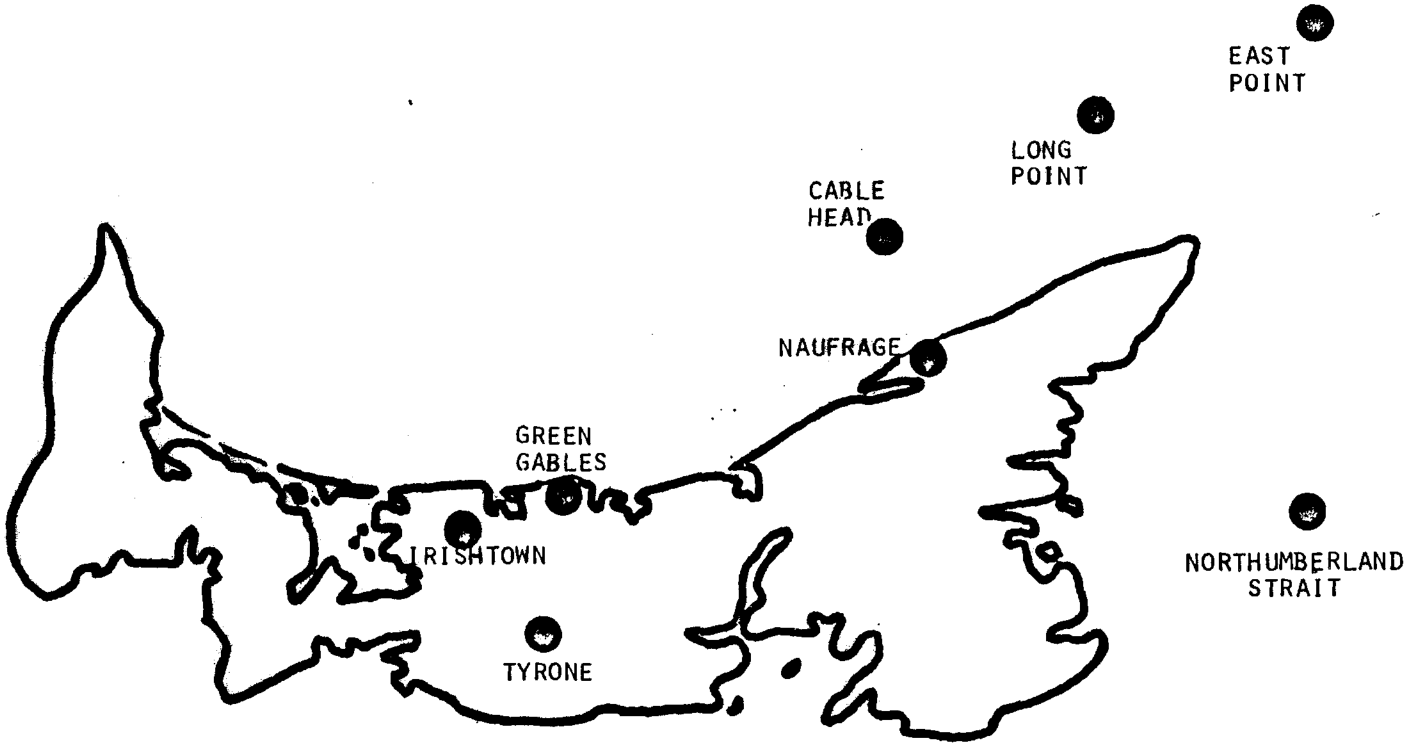


FIGURE 16

SCALE 1" = 20 MILES

Mr. Hall (continued):

very discouraging. In the estimation of the oil companies, the larger structures have now been drilled, and only minor traces of natural gas have been found in two wells, located at Cavendish and Naufrage. In the Cavendish case the gas was too small in quantity to measure. In the Naufrage case, a drill-stem test was conducted and natural gas was recovered at the surface, but it was again of very minor nature - sufficient, I guess, if you want to illustrate it, to supply about a three-foot long flame - that's the recovery on the drill-stem test. The wells in which these gas shows occurred were consequently abandoned because the economics just weren't there. The presence of natural gas in the rocks under Prince Edward Island, albeit very minor in nature in the drilling to date, does however maintain hope that somewhere a commercial accumulation of natural gas is waiting to be tapped. The most likely location now for such a possibility lies under off-shore waters to the north of the Island. The most significant discovery of hydrocarbons in our waters has been the East Point well, drilled by Hudson's Bay some 20 miles off the northeast tip of Prince Edward Island. The well tested a fairly high flow rate of natural gas in excess of 5 million cubic feet per day. If such a well was discovered on the shore of Prince Edward Island, it would in all likelihood be economic to produce. The indicated reserve at East Point of some ten to fifteen billion cubic feet, that's our departmental estimate, was however nowhere near the minimum requirement necessary to produce natural gas off-shore which for the type of structures we were considering were generally acknowledged to be at least 100 billion cubic feet. Even at this level of reserves the cost would be very high - in the order of $5 per 1,000 cubic feet, or equivalent to about $30 per barrel of crude oil. There are still undrilled structures in the off-shore waters, particularly at Cable Head and Long Point, both shown on the graph. Both these structures have an indicated area sufficient to contain natural gas accumulations in excess of the minimum target of 100 billion cubic feet. We are doing everything in our power to insure that these structures are drilled as soon as possible, for a natural gas discovery of sufficient size could be a viable option as an alternative to our current dependence on foreign crude oil for electricity generation. As an example, a 30-megawatt generating plant equivalent to about 25% of our existing generating capacity would require a minimum natural gas reserve of 115 billion cubic feet with a production capability or deliverability of at least ten million cubic feet per day.

In summary, the chances of finding sufficient natural gas on land to supply a thermal generating plant on Prince Edward Island are considered extremely low; but we remain optimistic that the off-shore area will prove otherwise. I may also add that given the experience of drilling to date on the East Coast in general and in our area in particular, we have little reason to believe that there's a significant oil potential in this area. That's the story on oil and gas to date and if you have any questions....

MR. COMPTON: I've heard that the Imperial Oil drilled 140 holes before they struck Leduc.

MR. HALL: It probably is of that order. In a new exploration area the ratio of success in the first few years is probably in the order of one success to 100 wells drilled. In some areas such as off-shore Nigeria such was the case; now, of course, Nigeria, off-shore, has become extremely productive - once they found out what it was they were looking for it became very much easier to find it. If you're going out to shoot elephants, you have to know what an elephant looks like. This is very much the case in oil drilling; it's a parallel that's drawn many, many times. Because we have had little success up until now in drilling for oil and gas in our area, it's not that unusual; we're still very, very much in the early stages of exploration on the East Coast; the density of drill holes is very sparse compared to Western Canada, and you can see that in Western Canada, despite the fact that they've had many, many thousands of wells drilled, they're still making discoveries, although they're past the hump as far as the large ones are concerned.

MR. MCINTYRE: I'm wondering how you've arrived at the $30 per barrel. Was that on the basis of volume of oil?

MR. HALL: No, on a BTU basis. There are approximately six million BTU per barrel of oil, and there are one million BTU in every 1,000 cubic feet of gas so it's about a 6:1 ratio. So for $5 gas, you're talking about approximately $30 oil.

MR. MCINTYRE: Are you saying, then, that the cost would be more here even if the discoveries were adequate?

MR. HALL: Well, I've related that to a minimum 100 billion cubic feet off-shore, and we would hope that any discovery that is made would be in excess of that. If we do get up in the order of 300-plus B.C.F. in any one reserve, the costs, of course, come down quite dramatically. They would, in all likelihood, be competitive with crude oil at the present time. Since natural gas at the present time is about 80% of commodity value in relation to oil and crude oil in Canada, there's reason to believe that if this continues, then obviously natural gas will be a better source of fuel for electrical generation than fuel oil manufactured from crude oil.

MR. CLARK: Do you have any information about coal?

MR. HALL: Some drilling has been done in Prince Edward Island in the past two years, specifically up in the MacDougall area, west of Summerside. The results of that particular program were to a degree inconclusive because of the mechanical difficulties encountered in drilling that hole. They were sufficiently conclusive, I think, to write off that particular area as having future potential for coal. The accumulation wasn't there as was indicated in the logs of the Imperial wells drilled back in the forties. There is still a small amount of coal potential in the Hillsborough Bay area which was indicated on the log of a well drilled on Governor's Island. But that particular point is a very small basin which is located almost centrally in the Hillsborough Bay area, and it's felt that the coal deposit would be primarily under water; consequently, it's very, very dubious whether it would ever be economical.

MR. MCINTYRE: On your initial studies of the East Point area, do you feel that this is worth pursuing further?

MR. HALL: The companies have looked at East Point again to see what the economics are, and they feel that that particular field doesn't have the reserves to justify an off-shore development. The well that was drilled indicated that it could be quite productive, and it gave some hope to them at that time that somewhere in this area there will be a larger accumulation; given the same kind of characteristics to the rock and the gas itself there may well be a commercial discovery. Their follow-ups since then, both on land, of course, have been disappointing. It seems that as you move westward across the basin from the East Point area, the reservoir characteristics of the rock itself become less and less the type of reservoir rocks that you need to make a very productive well. Although we're hoping that Long Point and Cable Head will show up to have something worthwhile, there is a distinct chance that the productivity of the wells won't be as good as the potential has indicated at East Point. The gas might be there so the situation is similar to Naufrage. The gas is in the rock but it's locked up so tightly that you can't get it to move out; the porosity of the rock is just so low the gas just will not move out of it.

MR. MCINTYRE: What about Irishtown and Tryon?

MR. HALL: Again you're getting further west into the basin and geolocially it's just not .... there was nothing in either one of those wells, either Irishtown or Tryon. They were geological successes but economic failures; the operation was a success but the patient died, I guess is the parallel.

JAMES M. LEE, MLA: Mr. Hall, do you think you have explored most possibilities of finding oil inland on Prince Edward Island?

MR. HALL: I think our concensus in the department and with the oil companies is that the major potential structures have been drilled. There is still the possibility of an additional follow-up in the Irishtown area, but that is low on the priority list as far as we are concerned given the nature of the reservoir characteristics of the rock. We would much sooner have that off-shore test drilled in Cable Head or Long Point, especially Cable Head, which appears to us to be the most prospective structure that we have at the present time.

MR. LEE: How does the cost compare for drilling a well on land as compared to off-shore?

MR. HALL: The Tryon well, which encountered considerable mechanical difficulties, cost in excess of $1 million; it was drilled to a depth of around 12,000 feet. The Naufrage well drilled extremely well in some 45 days or so, and consequently the cost was about a half of what the Tryon well was - it was $600,000 to $700,000, I believe. A million dollars, in this neighbourhood, would be about the cost that you would expect in drilling a well on land. When you get off-shore, you're talking a minimum of $2.5 million plus, depending on what kind of difficulties you encounter. The East Point well, I think, when all the bills were in on that one, taking into account that they had to pull out of the hole because of bad weather and then re-enter it at a later date to complete the testing, cost in excess of $5 million. So it's a pretty expensive business.

MR. LEE: There have been a number of off-shore wells drilled around the Atlantic provinces' off-shore waters. Have any of these been productive enough to put them into operation and extract the oil?

MR. HALL: There are two areas where significant accumulations of primarily natural gas have been found. One is on the Scotian Shelf, on and around Sable Island. A number of discoveries have been made there; again, if those fields that were found on and around Sable Island were located on the mainland, they would be instant successes as far as productive fields are concerned, and economic ones. But located as they are, some 200 miles off-shore, when you add the economics of pipelining that to Nova Scotia or liquifying it on site and putting it in tankers and hauling it to the mainland, the amounts that they've found so far don't justify the development. If they could double those reserves that they've found on the Scotian Shelf, I think you'd have a real good chance that you'd have something. There have been oil accumulations found on the Scotian Shelf, but again of a very minor nature. The only other area in the East Coast that has significant potential is just off the northeastern shores of Labrador, the Labrador shelf area, where several gas discoveries of fairly significant volumes have been found. Their problems up there are icebergs - how do you deflect a several million ton iceberg out of your way? One of these icebergs could pick off a drilling rig or a drilling platform quite easily, as you could well imagine; so the costs there are going to be considerable, and consequently the reserve they're going to need is going to have to be that much bigger and they haven't reached it yet, their so-called threshold reserve.

MR. LEE: I don't suppose in your studies that you've considered tapping the Irving Whale?

MR. HALL: I think what's in the Irving Whale by now has probably undergone sufficient transition that it's no longer a threat or of any use.

March 30, 1976 P.M.

3. ENERGY CONSERVATION

MR. ANDREW WELLS: Good afternoon, Mr. Speaker, Members of the Legislature. We're ready to resume the afternoon session, with the total afternoon being devoted to an examination of conservation measures and the possibilities for reduction of our total energy consumption if we practise conservation measures. Our first speaker is Dr. David Brooks, Director of the Office of Energy Conservation, Energy, Mines and Resources.

Conservation in Canada

DR. DAVID BROOKS: Thank you, Mr. Wells, Members of the Legislature and Ladies and Gentlemen. I'm really very pleased to be here, not only to come to Prince Edward Island which is always fun, but also because I think in a very real sense you're engaged in a unique exercise. It is certainly unique for Canada and I think in many ways it's unique for any political body, in North America at least. You are devoting four days just to talking about energy; that in itself is fairly unusual. But I think it's more the way that you're approaching it that really deserves a lot of attention; the fact that you're taking energy as a whole, asking where the province of Prince Edward Island should go with its energy. What sorts of energy does it want? How much energy does it want? What's the role of energy? You are actually beginning to think of energy as something that may be directing what happens in the province, something that's causing you to do things rather than a result perhaps of what you would like to have happen. Those are unusual viewpoints. They have not been widely discussed in legislatures and I think it's very exciting to participate in this first discussion. Having said that, let me tell you just a bit about the perspective with which I'll approach it. We have sort of a one-two-one punch this afternoon; I'm going to speak first; and then Norman Hall will speak again about Prince Edward Island; and then I will end up speaking a second time. I'm going to take a national approach, and I will leave it to Norm to particularize that approach to Prince Edward Island. I'll try and give a general perspective of what the energy situation is in Canada: what we see as the general potential for bringing supply and demand into better balance than they have been and finding alternatives. I guess that's the objective part of it. I also want to say that my approach certainly has a subjective element. I don't want to pretend that I come to you with an unbiased viewpoint. I am perhaps neutral in favour of conservation; I think conservation is a better way to go about things than the way, not just Prince Edward Island but all of Canada, and in fact, all of the Western World, have looked at it. I think conservation has in it the seeds for a different lifestyle than we've experienced recently, one that would fit in very well with Canadian values and that would give most of us what we want

Dr. Brooks (continued):

at a much lower cost than we have experienced to date. I guess I can express my perspective or at least the contrary perspective with a quotation. I won't name the author of it, but he was the president of one of our large provincially-owned utilities, and you know that gets Prince Edward Island off the hook - it wasn't Maritime Electric. He said, and I quote - this was about a year and a half ago now -"It looks as if conservation is a problem that's going to be with us for a long time." Well, from my perspective, if you look at conservation as a problem, you've missed the whole point. I don't think conservation is a problem; it's a better way of doing things, it's a real opportunity.

With that as an introduction, let me tell you where we're going today and how we're going to run through this. We've a long time this afternoon and a lot of material to cover. I think we can make it all quite understandable. I think the issues that political figures have to decide are essentially not technical, not engineering issues - they are essentially political issues and it's quite appropriate that you look at them. We are going to go through first a little bit about Canada's energy consumption, something about how much we as a people consume. Then I'll go through the conventional sources of supply or at least those relevant to Prince Edward Island. I won't be talking very much about solar or wind alternatives because there's a whole day coming up on those but that's why I say I'll talk about conventional. (I guess it shows how far we've come when I include nuclear in conventional but for present purposes it's a conventional source.) We'll stop at that point and see if there are questions on the present situation. Then I will speak about conservation as an alternative, both specifically what kind of conservation measures we might have, and as well, what they can do for us; and then also where putting a lot of conservation measures together would take us, some "scenarios" to use the jargon. A scenario is a picture of what might happen. It's an alternative you can look at and talk about. It doesn't tell you where you're going to go; it just tells you where you could go if you make certain decisions. That's the point at which Mr. Hall is going to come back in and say about what's happened in Prince Edward Island now. How do we take that picture from the national scene and particularize it to Prince Edward Island? He will talk about the situation vis-a-vis conservation and some of the things that have happened in Prince Edward Island. After he's done that, I will come back with a summary and something about both the federal program, what we have done to date, and I will also be frank about what we have not done to date in the Federal Government and more generally about where I think government must act, what are the roles of government in energy conservation. So roughly we're going through a sequence of what is nationally and what could be nationally and then what is provincially and what could be.

Perhaps the most unusual thing that's happened as we look back from, say, the sixties into the seventies is the very fact that energy has become a public issue and a political issue. Certainly in

Dr. Brooks (continued):

the sixties, while various public utility commissions held hearings, while they were the forum,a political system,set up to discuss issues involving energy, energy very rarely came to public attention. You didn't see it occupying the business pages, much less the news pages and editorial pages of our newspapers. You didn't see it on television; you didn't see it taking up a great deal of time of legislators. That's all changed; a whole host of factors has changed the whole climate in which energy operates. We've had an enormous growth in demand in industrial countries. We've had this trend toward a lot of consumption, high energy kinds of consumption. We've had rising expectations in the Third World. On the other hand, supplies have turned out to be more limited than we once thought. Third World countries have begun to pay more attention to the politics of developing their own resources and to the economics. We have begun to find that resource development included a lot of costs, notably environmental costs, that we had never thought about before. Now, I think, in retrospect you could see that all of these forces were operating before 1973. As I look back, and I think that I'm just echoing the conclusion of other people, the situation before 1973 was really quite unstable; we just weren't smart enough to recognize it. It really took the shock of the Arab-Israeli war, the embargo, or if you want, the abortive embargo, to bring everything to a head. It shook everything up, and I guess it's still shaking. We're in a transition where we've got to move, to change the way we've been doing things, and we've got to look around at where we've been and where we're going. What had really happened, as we now look back on the period between the end of World War II and the Arab-Israeli War, the Yom Kippor War of 1973, was that we had an enormous growth in the availability of supply like nothing that had ever happened before. All of a sudden there was supply everywhere and this supply became available just at the time that there was a lot of pent-up demand. After World War II, we wanted to catch up on our consumption, so to speak, and demand started to grow and it just never stopped growing. Let me just give you a couple of numbers (by the way, if anyone wants these numbers, they're in a paper that's available). In the decade of the sixties, the price of energy declined by 10% relative to the rest of consumer prices (all these figures are across Canada now). In the case of industrial energy, it declined by 30% relative to other prices. Well, why bother to conserve? Why worry about it? Everything looked like it was going along very nicely. People were right to use more energy. That's what the economics told them to do. Then we jumped; we doubled our rate of energy consumption in this period. Instead of growing at about 2 or 3% more energy each year, we suddenly started to grow at about between 5 and 6% a year, a rate that required us to double our energy consumption every year. That was really an energy binge. It, by the way, was duplicated in the United States and to a considerable but somewhat modified extent, in Western Europe. They didn't have the domestic sources; they, of course, could import but it never looks quite so good when you have to import. That energy binge just could not last. Let's see where

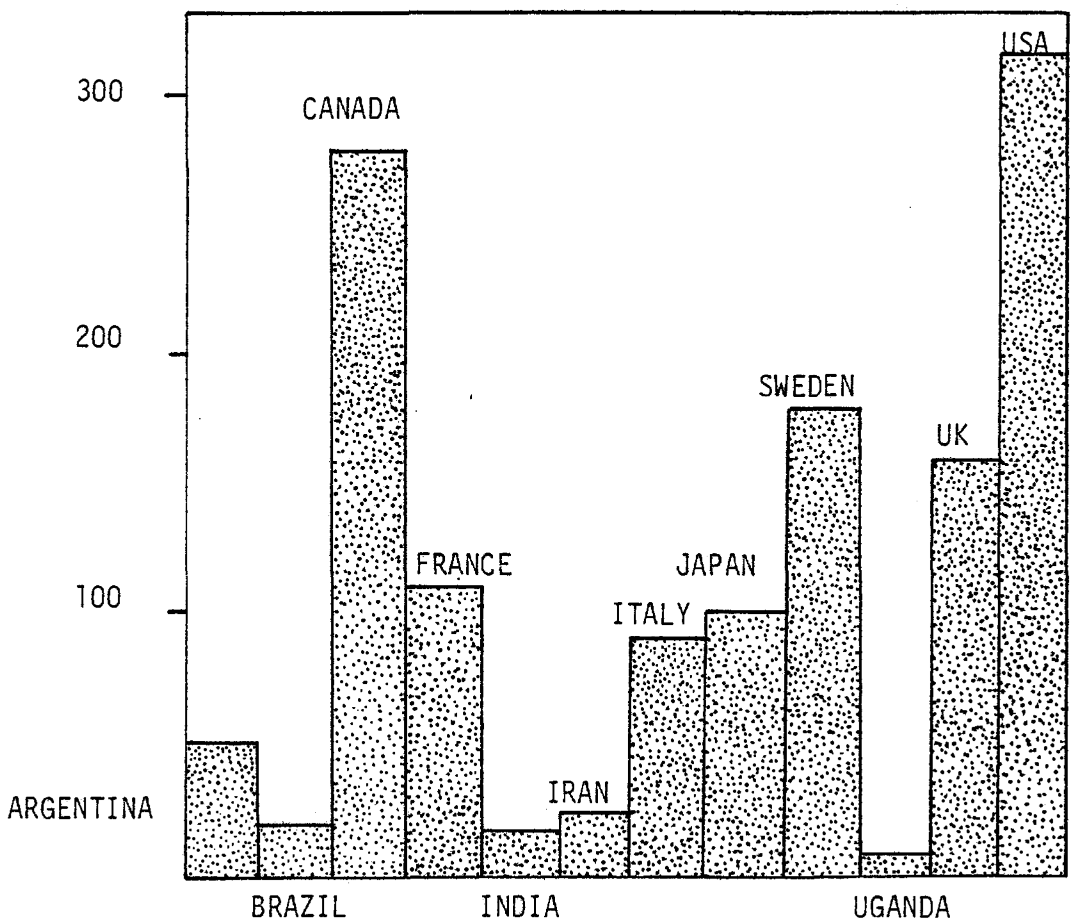
Dr. Brooks (continued):

it got us to, that good life of large cars, plug-in appliances, air-conditioning and so forth.

The first slide will give us some idea of how we compare in energy consumption with other countries (see Figure 17). This shows how Canada compares in per capita energy consumption with other nations of the world. Clearly, Canada and the United States stand way out; we're very high compared with any other nation. Now, I don't think the useful comparison here is with the undeveloped or the less developed countries down at the bottom. Nobody denies that to get a start at growing you need a lot of energy. So the comparisons with Uganda and India are not relevant and no one says that countries of that kind should start off without adding some more energy to their system. What kind of energy is another question but they do need to get some more energy working for them. The interesting comparisons are with countries such as Sweden, France, even Japan with its enormous energy-intensive export industry; all of those countries consume a lot less energy than we do. Sure, there are reasons; comparisons of this kind have to be used carefully. We are a more northerly country, we're a larger country. Those explain some of the differences, though without going into details, I can say that if you went through a statistical analysis and got academic about this, you could cancel out the factors of climate, size, things of this kind, and you would find that we still consume enormously more energy than most other developed industrial countries, with the exception of the United States.

How do we consume our energy? Figure 18 shows our energy consumption divided into sectors. You can divide our energy consumption into four quarters. Roughly, one quarter is residential, a second quarter is transportation, and a third quarter is industry. The fourth quarter is divided in half. If you divide it again, one eighth is the commercial sector (which includes the CBC, government, hospitals, schools, retail shops, and office buildings). The final eighth is the energy supply industry; that is, the amount of energy that we invest in order to get energy, plus the petrochemicals; I'll come back to that. That final quarter divided in half happens to be the fastest-growing sector; in fact, that's really quite a bit more than a quarter now, it's moving toward 30%, but let's consider each of those as an eighth. Now let's look at the stippled area which is the part that each of us as an individual is responsible for. And again, speaking roughly, one-third of Canada's energy consumption is by us as individuals; that is, we are directly responsible for a third of the nation's energy, mostly in the things that Mr. Hall spoke about this morning, space and water heating and our automobiles, and it amounts to a lot. I mention that because there are those who say, "It's not individuals, it's industry that's responsible", but that's not true, it's both. In some sense consumers are responsible for the other two-thirds, of course, but indirectly; that other two-thirds includes the energy that it takes to run the system, to produce the goods and services we require, to run the airplanes, the

ANNUAL PER CAPITA ENERGY CONSUMPTION BY COUNTRY. 1971 DATA, MILLIONS OF BTU'S



Only the United States has a bigger energy appetite than Canada. The people of Sweden, France, United and Japan all use less energy per capita than we do.

FIGURE 17

Dr. Brooks (continued):

trains and the buses, the other things that aren't personal.

Essentially our growth rate, the size of that pie, is at the rate of around 5 to 6% a year. The important thing is that it was doubling: that rate of growth meant a doubling of our energy consumption every 12 years. Now if you think about that, it's just staggering. That means that Canada's entire energy production capacity had to be duplicated every 12 years. Then if you double 12 years later it's got to be four times as large; and if you double again, it's got to be eight times as large in 12 years. I don't think that was sustainable even on its own terms. It just didn't make sense to think we could go on making investments, even physically, let's forget about the dollars, to keep growing like that. This exemplifies what we, in our jargon, have come to call 'rate and magnitude problems': you can get going so fast that it's very hard to find out what's going to happen next and you're almost like Alice in Wonderland, running faster and faster just to stay in the same place. I should say that the figures I've been using, this 5.5% growth rate, held true right through 1974. The energy crisis made almost no difference at all in Canada's 1974, much less our 1973, energy consumption. But by 1975 it had begun to show an effect. Our energy consumption in 1975 appears, according to preliminary figures, actually below that of 1974. Clearly, part of that is due to a recession. We know there was a recession and certainly industrial energy consumption is down because of that, diesel trucking and things of this kind. But it's also down in other areas; it's down very significantly in home heating fuel after we have corrected for the effects of temperature. It's off by 5 to 6% below what we would have expected. Automobile energy consumption is still growing, but instead of growing at 9 or 10% a year like it was growing, it is now growing at only 3 or 4% per year, a swing downward of some 5 or 6%. These are the effects, I think, of what people have begun to be aware of, what the energy situation is. The combination of higher prices, better information, and some specific efforts to conserve have caused the growth rate to start looking a little different.

Let me ask, how? What have we been fueling this growth with? I won't go through all of the resources; I don't think we need to talk very much about natural gas and things like that in Prince Edward Island. I'll confine my remarks pretty much to oil and electricity, although I'd be prepared to answer questions about other things. I'll go through this pretty quickly because there are people much more competent than I to give you details about potential energy supplies and cost. Figure 19 shows roughly our oil supply picture in Canada. The numbers are reasonably accurate, but it's more important to look at the general trend. The two upward-sloping lines represent the pre-energy crisis demand picture; that's the way demand was growing before 1975. The lower line is the consumption west of the Ottawa

CANADIAN ENERGY CONSUMPTION

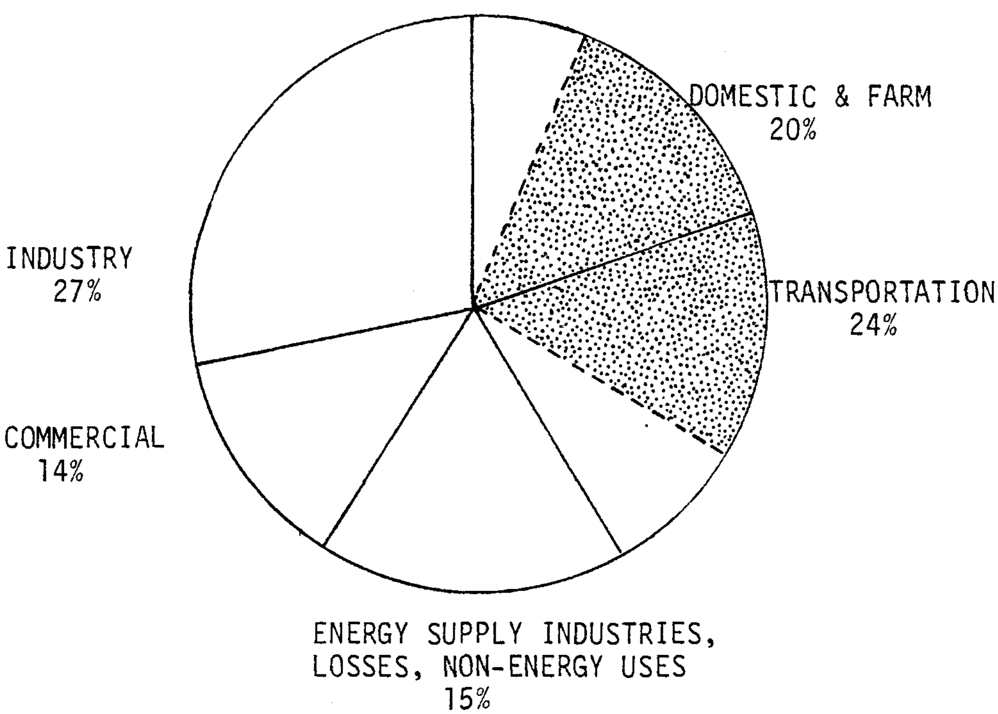


FIGURE 18

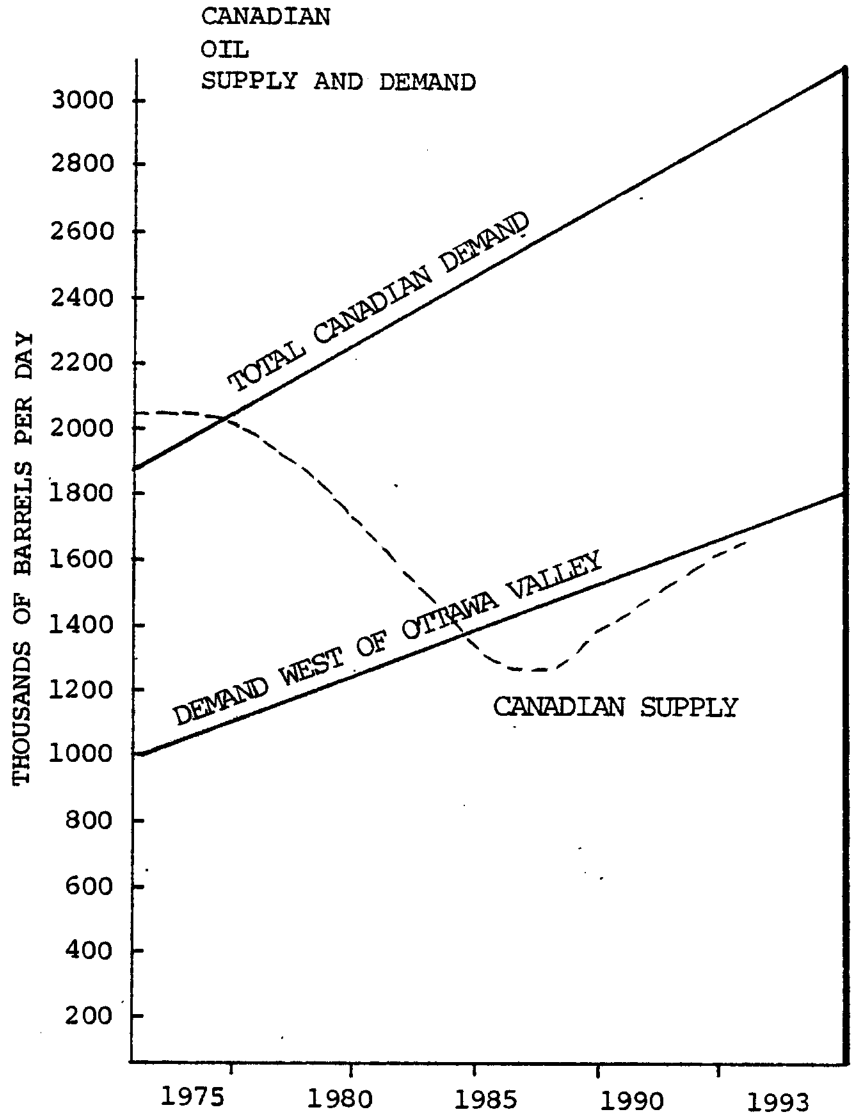

CANADIAN
OIL
SUPPLY AND DEMAND
THOUSANDS OF BARRELS PER DAY
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
TOTAL CANADIAN DEMAND
DEMAND WEST OF OTTAWA VALLEY
CANADIAN SUPPLY
1975
1980
1985
1990
1993

FIGURE 19

Dr. Brooks (continued):

Valley which, as you recall, has some important differences in where the energy came from - that's irrelevant now. Obviously what we're trying to do in conservation is to change that demand line, so don't take that seriously - it was just put there to show what was happening. The more important line, of course, is that wavy line which shows the anticipated production of oil in Canada. We are already in Canada net importers of oil. Canada has always, as you well know, always been an oil importer; however, on balance, we exported as much as we imported so that statistically we were in balance. That situation has changed in the past year. We are now importing much more than we're consuming and for that reason the subsidy program to maintain the one-price system is in a deficit; that is, the amount that is collected through the gasoline tax to keep the price of imported fuel down in Eastern Canada is running at a deficit. That wavy line is made up of our current best expectations of what we could produce from conventional fields. This means a little bit in British Columbia, a little bit in Saskatchewan, plus, of course, the main hunk of it coming from Alberta. That declines; I think we may be a little bit more optimistic than this line shows now about oil supplies in southern Alberta, but not very much. The line shifts by a year or two, but that's not significant for the general picture. The turnaround that you see about the middle eighties represents the effect of significant tar sands coming in, assuming a pipeline is built. Now, of course, there was tar sands oil before that, but not enough to turn the line around. I hasten to say again that these are scenarios, not forecasts. This just says that if a number of tar sand plants get built, and if there are significant Arctic discoveries and production, that line could turn around by the mid-1980s. There is relatively little production in there from offshore sources. I'm just relying here on the estimates that come from our geological survey; they are not optimistic about offshore potential, at least not in the near term. Now, I think this shows that even if growth does not keep on, even if our consumption does not keep going up, it's going to be a long time before we can regain self-sufficiency in petroleum, even if we spend a lot of money on mining oil sands and getting Arctic resources. There are a lot of problems with all of those alternative sources; they all look expensive, and I'll come back to that in a minute.

I want to talk about the supply picture for a minute. I won't dwell on gas; the gas picture looks just like this except it's moved about five years to the right; that is, it is a little more optimistic. Turning to electricity, I didn't draw a slide for electricity because it's rather difficult to put one together from the different sources but there are a few things we can say. I think you know well enough about the effect or the cost of electricity produced by heating oil to boil water, so we won't talk about that. I will say something about hydro sites. The fact is that most, not all, but most of Canada's readily available hydroelectric sites have been developed

Dr. Brooks (continued):

or are in the process of being developed. There simply are no more Niagara Falls close to markets with lots of potential and cheap to develop sitting there waiting for the taking. The kind of projects we are going into now, like Churchill-Nelson and James Bay, are far from consumption areas; are expensive to develop; and obviously have environmental effects. The distance from market is very important in the case of electricity. There is no cheap way to move any kind of energy, and this is particularly true of electricity. There are no cheap sources, no cheap transportation methods. That's of course why we have turned to nuclear. Nuclear is the one form of electricity that is relatively site-independent. That is, all you've got to move to the power plant is the uranium and, as you well know, that is not a lot of tonnage. There's no question that nuclear power does have potential to meet a lot of that growth. I think the discussion tomorrow will adequately involve the pros and cons of nuclear power, the environmental effects, the costs, storage problems, etc. I don't think it's those that I want to emphasize. I'd rather just rest on the fact that nuclear power is one of the things that has to be considered. It has worrisome aspects, but it certainly can supply part of the potential. But, if our demands keep growing (and as you probably are aware, electricity growth is even faster than oil), even nuclear power will not help you. And I might say solar faces exactly the same problem. I guess I wouldn't be telling anyone anything surprising if I said solar interests me much more than nuclear as an individual, but both of them face this problem of catching up with a growing demand.

Let me give an example of the kind of problem that you can get into if you keep growing. This is just a mathematical calculation, in effect. Let's assume that we keep growing at the rate of say 5% a year and that starting in January, 1976, we installed a new Pickering plant every four months - that is four units, remember, four reactors. Now that's impossible; please don't take this as a suggestion or anything, it's just a mathematical exercise. But say up to the year 2000, we built four a year. In the year 2000, we would still be using fossil fuel for over half of our energy demand, for the growth of demand is still so fast that even at that rate of constructing nuclear plants, we wouldn't catch up all that much. We'd still rely on fossil fuels for half the demand, consuming fossil fuels at three times the rate we consume them today. Unless you do something about demand, you're fighting a losing battle.

Well, let's talk about some more of the problems connected with supply, because we've talked so far simply about the physical magnitudes. But in the end maybe those physical magnitudes aren't really the limiting factor. I think, not surprisingly for an economist, that in the end what hangs you up first are the costs, and particularly the capital costs. The costs of new energy supply are enormous. You have probably heard my minister, Mr. Gillespie, and before him, Mr. MacDonald, talk about the figure of something on the order of $115 billion

Dr. Brooks (continued):

for energy investment in this next decade, that's the year 1976 through 1985. That's just to stay where we are. That amount of money is so large that nobody can really have a good feeling for it, but it amounts to $20,000 per Canadian family; that is, each of our families or somebody on behalf of each of our families would invest $20,000. No doubt it would be a combination of government and private industry. An even more important way for you to look at this than that figure of $20,000 is the fact that it requires us to double the proportion of our gross national product that we have put into energy historically. Even during the period of the sixties, when we were growing so rapidly, energy was cheap and we only put something like 3-1/2% of our gross national product back into energy production. That was a reinvestment; it was as though we reinvested that money in order to get more energy. In order to do that same thing now, it's going to take 6% of our gross national product. And the question is, where is that extra 3% or so going to come from? What is it that we are going to give up in order that we can put all of this money into energy? I don't have the answer to that, but it is again an important political question. Who is going to find that extra money? What is it we are not going to do because we have to give up something else, unless we're going to just try and do everything all at once with the obvious inflationary results?

There are a number of other problems with trying to expand so fast. For the sake of brevity I'll just mention them. There's the problem of energy costs. I had mentioned that the energy supply industries were consuming ever more energy. We're finding out that it takes not only more and more dollars to produce energy, but more and more energy to produce energy. We seem to be facing a situation of diminishing returns. I'd like to brag a little bit; I think the Office of Energy Conservation are now the Canadian experts in this area. We have looked at nuclear reactors; we have looked at alternative kinds of energy sources; we have looked at tar sands plants to see what the net energy implications are. All of these things are good energy sources from an energy point of view but they're more expensive than those of the past.

Another point, obviously, are the environmental and social costs of energy supply. These are talked about so much and you've probably heard so much about them that I won't go on. I think suffice to say, that from an environment and social point of view there are no good energy sources. There are some that are perhaps less bad than others but no matter which source you like, all have problems that are severe to one degree or another. Just run down the list, whether it's offshore, Arctic, tar sands, oil, or a nuclear plant - you pick the environmental problems and there's an energy source to match.

So that brings you up against the problem. I think what I have said so far, and I'm going to stop for questions in a moment, is that if you try to keep going through with a new supply route, if you keep trying to find more and more supply to meet that growing demand, you're almost inevitably doomed to failure; at the very least, it will cost

Dr. Brooks (continued):

you an awful lot of money. It will involve a lot of environmental degradation. It will be disruptive in various other ways. This was summed up by a senior official of my department, who now happens to be with PetroCan: "When one considers both the nature of the risks and the magnitude of the capital cost, it becomes clear that the greater our ability to make energy markets balance by slowing down the growth in demand, the lower the risks, the smaller the capital bill, and the longer the breathing space available to get a better fix on both international and domestic prospects." In other words, if you take the two alternatives, cutting demand just looks better, cheaper, faster, and less risky. Let me just throw out one quick example to tease you a little bit before we go into supply. For every one-tenth of one percent that we cut the rate of growth of energy demand, we save ourselves by 1990 the equivalent of about 150,000 barrels of oil per day, or the output of a tar sands plant. So for every tenth of a percent we cut the rate of growth, we save ourselves the investment in a tar sands plant or whatever equivalent energy source you want. I think that with that kind of magnitude of potential we would be wrong, silly, irresponsible not to consider efforts to conserve. But before I go into the potential for conservation and what it can do for us, let me stop and ask if there are questions.

PREMIER ALEX B. CAMPBELL: May I get a clarification? You mentioned that it will cost us how much to get to what year?
DR. BROOKS: $115 billion to get to 1986, roughly. $115 billion to stay roughly in the same position we are now. That will not get us back to self-sufficiency; we just won't be worse off in 1986 than we are today.
PREMIER CAMPBELL: Well, that does raise a question nationally which we have raised here provincially. Has anyone suggested there is an answer to the cost of getting to 1986 and even ten years beyond that? That's $20,000 a family.
DR. BROOKS: That's a lot of money.
PREMIER CAMPBELL: That's a lot of money, that's a billion dollars on Prince Edward Island.
DR. BROOKS: Well, we think that conservation can cut that significantly. Another way of looking at that figure that I gave you is for every percent that we cut the demand in any one year, we defer about a half a billion dollars of capital investment. So there's a lot of potential for cutting that by energy conservation techniques, some of which are almost costless, though not all, and I'll come back to that. I don't want to give you the impression that conservation is free; it's not free any more than anything else, but it's a lot cheaper than supply. So I would say the only thing you've got, apart from rationing, is conservation. There just are no flexibilities in the system.

PREMIER CAMPBELL: But is there a professional opinion on the ability of the Canadian economy to raise this kind of money for energy creation?

DR. BROOKS: Yes, there is. I think the official and considered opinion is that it would be difficult but feasible; in other words, it is the kind of rate of investments we experienced after World War II. The economy can sustain it, but it will require not going forward on some other things. It is not going to bankrupt Canada so long as we back up someplace else.

HON. BRUCE STEWART: What is the estimated increase in barrels per day in 1985 from Canadian production over what it is at the present time?

DR. BROOKS: I think it's an anticipated decrease; but I'd have to measure it off that graph there, and I couldn't do better than that. The graph you have before you is all energy sources and not specifically petroleum. I could not make a better guess than this one, which I'm given by the Geological Survey.

MR. STEWART: That's providing there are no new discoveries.

DR. BROOKS: That includes anticipated production from new fields. There's an allowance for new discoveries and new production and conventional and the existing tar sands plants plus Syncrude. By 1985 I think the Arctic is just thought to be coming in.

JAMES M. LEE, MLA: You mentioned that there's surplus of power from Churchill Falls and James Bay projects and that the transmission of this surplus power is a problem. I was just wondering what problems are involved in this transmission of surplus power to the Atlantic area; for instance, versus the USA?

DR. BROOKS: I can't answer this specific last part of your question. My comment was entirely general, that moving power over long distances tends to be costly. There are no cheap ways to move large blocks of power. You do it, of course, along a wire and you do it at very high voltages and generally now using direct current. This has cut the losses, but it's still quite expensive. By expensive I mean two things. It's expensive both for the physical structures - you need a lot of towers, you need to protect them, and you need rights of way. And second, you lose energy along the wire. If you can picture it, as the current goes along, it radiates. This radiation is a loss of energy. Now, engineers are very good at minimizing those losses but over longer distances there are greater losses. But I cannot speak to why it might be more or less expensive to move it to the Maritimes or down to New York State or wherever.

MR. WILLIAM ZIMMERMAN: Electricity delivered to New York City now is in the vicinity of 8¢ per kilowatt hour. Now that's the cheap energy from Quebec that's contributing to that higher cost. The fact is that electricity coming from Gull Island Hydro Site or James Bay or Churchill is not really cheap energy. It may be being sold currently at lower cost, but it doesn't mean that's what it's worth.

J. WALTER DINGWELL, MLA : What percentage of energy do we get out of a gallon of gasoline?

DR. BROOKS: Delivered to the customer, making an allowance for all losses along the way, it's in the upper eighties, I believe. A new refinery gets about 91 or 92% out, and then there are losses in transportation. It takes energy to move it - whether it's by train or truck, you've got to put gasoline into that to move it. So by the time it gets to the customer, it's in the eighties.

MR. WELLS: Yes, but David, after it goes through the automobile you're talking about something quite different. It's in the range of, I understand, 10 to 15%...

DR. BROOKS: Yes, then you've got to put it into your consuming device. Then the typical oil furnace in a home should be running at around 75 to 80% efficiency; it's probably running at less than 50% because it is poorly maintained. An automobile gasoline internal combustion engine is ....

MR. ZIMMERMAN: The average automobile is assumed to be now between 10 and 15% efficient in converting that energy stored in the fuel into actual work moving the vehicle down the road. The rest goes out the exhaust pipe and the radiator.

MR. DINGWELL: It looks as if there's a great deal to be done on the conservation of energy in that particular regard.

DR. BROOKS: There certainly is. We'll get into a number of those areas in the second part of the talk. I couldn't agree more.

Let's go on then and start talking about conservation. We've had the supply side; now we're going into the alternatives to the demand side. I think it is fair to say something important has happened politically in Canada; and I think you'll see it reflected in the papers that have come out of the Federal Government since 1973. I think that finally we've begun to recognize that in principle, at least, energy conservation is just as important as energy production. If you've got supply-demand problems (economists should have known but we forgot),you can operate just as easily by cutting demand as you can by increasing supply. So I think that in principle now it's accepted that conservation is just as important as production. But we've got to figure out when, where, how - what are the approaches; what exactly is it we are going to do? I have some more slides here to show you some of the things that we might do. I'm going to go through these fairly quickly because again the details aren't important. It's perhaps the general potential it has, because really the question isn't whether we should conserve - I've never run into anyone who believes we shouldn't conserve - the questions are when? where? by how much? These are the difficult questions and until you answer questions about what are you going to do about conservation, who's going to conserve, who's going to give up driving, when are we going to give up driving, when are we going to buy more efficient cars, who's going to ride the bus, it's just motherhood; until we come down to some specifics. So let me go through some, by no means all, but just a few of the specifics and I've stuck entirely to those

Dr. Brooks (continued):

that are meaningful to us as individuals. I've stayed away from industrial energy consumption and transportation except for the automobile. So let's go through quickly the next half dozen slides.

Here are again two scenarios (see Figure 20). They show the effect of what our energy consumption for residential heating might be if we build houses as in the past or if we build them to a new standard, a new standard that would, according to our calculations, cut energy costs by 50% and also pay itself back within five years. That is, we've said it doesn't make much sense to just say what you could do. You've got to say what it costs, too. As I said, energy conservation isn't free; it has an initial cost. So we've said roughly that it would be economic if it paid back in five years; that seemed reasonable for an individual. So that includes everything we could find that would pay back within five years. There's nothing unusual in the new construction. It includes more insulation, lots of insulation - the ceiling, storm doors, storm windows, a lot tighter construction (a lot more labor, I might add, in making sure the insulation gets in the corners) things of that kind. There's another thing that picture includes: it also includes an investment program in dealing with existing housing. We don't get very far if we deal with new housing; we also ask the same question about existing housing. So we assumed that we would start by investing perhaps a couple of millions of dollars every year in reinsulating, always starting with the worst houses and going on to the better. A lot of those were in the Maritimes, by the way - some of the worst insulated homes are on the two coasts, British Columbia and the Maritimes. Well, you can see the effect of even this very straight-forward thing. It doesn't cut the rate of growth; it actually offers us the potential to significantly reduce our energy consumption in the residential sector. That is, we would be consuming less by the end of that period, 1990, than we're consuming today for residential heating.

PREMIER CAMPBELL: Could I interrupt you right here? We'd all like to reduce our home heating bills by 50%, and it's an amazing projection. Have you seen such a house built and tested or are these theoretical savings?

DR. BROOKS: No. They have been done. You don't do it with your house today; you've got to buy a new house.

PREMIER CAMPBELL: Let's say the 200 co-op housing units to be built in our province this year as against those built last year.

DR. BROOKS: That's right. If you build them to the new standard that we have developed, and that is in print (we have a booklet published by the Housing and Urban Development Association of Canada), they would save 50%. The houses that were built this year; they may be at a higher standard compared with houses built in 1973 and 1974. Now, for an existing house, saving more than 25% is pretty tough. It begins to get expensive. You've got to get into the walls; you can deal with the ceiling all right, you can add storm doors and storm windows, but getting into the walls looked to us to be fairly expensive.

RESIDENTIAL HEATING ENERGY

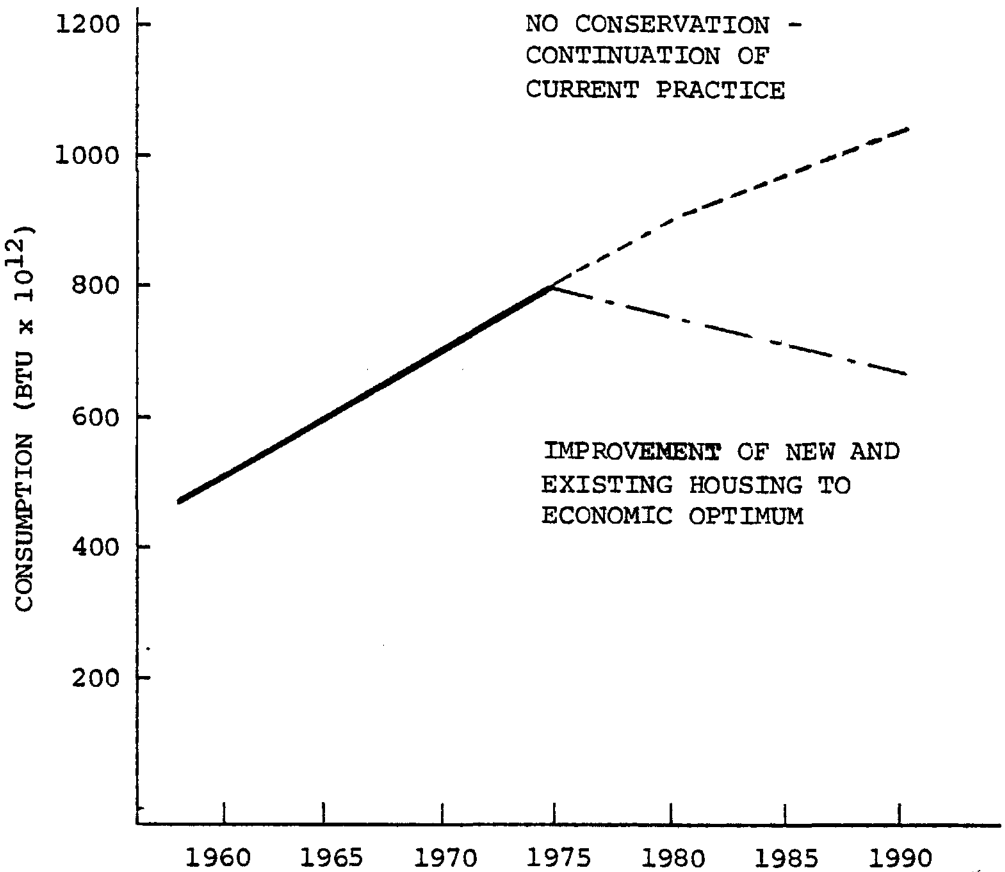


FIGURE 20

MELVIN J. MCQUAID, MLA: How much would it add to the initial cost of that house?
DR. BROOKS: I'll have to give you a range. The added initial cost for a single family house, say a bungalow style, is going to be $800 to $1,000. It's that amount of money that you'll get back within five years. If we go to the other end, an apartment unit in a medium to large building, the added cost for an apartment unit would be around $200. Then you can fit other types of housing in between there, like duplex and triplex and things of this kind. So the range is $200 to $1,000, depending on the specific kind of home.
PREMIER CAMPBELL: What kind of a heating system does it have?
DR. BROOKS: It's independent of the heating system. You take whatever kind of heating system was in the house before. We can save 50% in each case. It's a little less in electrically heated homes, actually, because they were built to a better standard before. It's up around 40, 42, 43% - I've forgotten where the final number came out. Actually, in the case of many oil-fired, the comparison is a little higher than 50%, but 50% is a good rough number.
VERNON MCINTYRE, MLA: I'm wondering what different standards are in what you're talking about for a home in 1976 and what they were in 1973.
DR. BROOKS: We felt it was not fair to compare to the worst possible cases. You can make yourself look too good if you compare to the worst possible case. So we compared with the houses built under the National Housing Act; that is, CMHC houses built in the early 1970s. The code that we referred to was the 1970 code of construction used by CMHC and we compared our new structures to that.
MR. MCINTYRE: One other point, if I might. You mentioned earlier that we had the worst insulated homes here in the Maritimes, and we in the Maritimes think that we, especially in the last few years, have insulated our homes reasonably well. I'm wondering what you foresee between what we've already done and what we can do in the future to enable us to save this $800 to $1,000.
DR. BROOKS: I think there's still a long way to go; there are still a lot of almost uninsulated homes in the Maritimes; I'm speaking of the Maritimes, I can't be any more specific than that. These are homes that essentially have nothing but tar paper in the walls as a barrier to humidity, not as insulation. Everything we've looked at indicates that you can pack a house with insulation and still get your money back. We're not sure that we'll even up the economic optimum. I might add, by the way, our calculations are all based at today's energy prices; that is at $8 per barrel. We did not include any cost escalation factor; that was just so that we would be more conservative, we'd be on the safe side. But in any case, every place we've looked we've found more opportunities. Now there are people who have done a pretty good job. Once you've filled the wall up with insulation, you know there's no more you can do.
MR. MCINTYRE: That's my point; I wondered what you do beyond this.
DR. BROOKS: There are things you can put on the inside of the wall that will help a little bit. House operation can help- where you put

the thermostat, how well your furnace is maintained. We haven't included much of that here. This saving is independent of house operation, although the next slide is not. We do not recommend styrofoam panelling because of the fire hazard, but we promote things of that type. If you find areas that seem to be cold, just getting newspaper up against them will help. It's all of that sort of thing - anything to get some standing air will help.

PREMIER CAMPBELL: Do you recall what thickness of insulation was recommended for the new constructions against the 1973 standard?

DR. BROOKS: We wrote this assuming that we could not shake up the building industry too much, so we stuck with two-by-four construction but filled it completely up with insulation. We are quite sure we could go to two-by-six studs in the walls and fill it completely with insulation and be economically justified. But one of our ground rules was that we would not change technology. While two-by-sixes compared with two-by-fours doesn't seem like a change of technology, we felt that it was a change in building practice. We were writing the book for builders and we didn't want to urge that change all by ourselves; also CMHC wasn't quite sure that there would be enough two-by-sixes around Canada to do that.

HON. GEORGE A. PROUD: That would still add only $800 to $1,000 to the cost of the improvement?

DR. BROOKS: That's right, sticking with two-by-fours. If we go to two-by-sixes, I'm not sure what that will do to the price.

Now I'm switching from the residential structure to the commercial. Commercial - as you recall, are the buildings, the schools, the hospitals - consuming a very rapidly growing amount of energy. What we did here was first just re-design buildings. We asked - why do we build buildings the way we build them? and there was no good answer to that question. The most horrible examples of waste that I know of are commercial buildings. And so we decided to look at a much better designed building but one that's in operation, not one that's just on paper. We found a number of examples of cutting energy consumption in commercial buildings, not by 50%, but by 80%. So we were a little modest; we said 75%. And we assumed that from now on that commercial buildings will be 75% more efficient than they were. There were a number of other assumptions to get these figures; such as the rate of growth but effectively we took new buildings and said let's build them now to a new and better standard. By the way, we didn't touch hospitals and things like that. We just didn't have the information. I think everyone knows that hospitals can be built better than they are; you've already heard about schools this morning. But we just stuck with conventional large office buildings. But an office building is quite a different matter from a house where there are clear-cut structural improvements which can be made. In the case of an office building, one of these glass and aluminum structures at least, the answers are not very clear. We don't know what to do about them. Once that building is built, the costs of re-making the shell of the building better are pretty horrendous and we felt we could not justify that. But what you can do is improve the operation of the building and it has been shown over and over again that you can improve the operation of buildings by at least 25%. That is, you can improve the energy efficiency simply through better handling of the controls, controls that are already in most buildings. You don't have the air-conditioning and heating fighting each other as you do, reduce the lighting, things of this kind. Now as you see in Figure 21, we still have a fair rate of growth, but if we take the same sector, the same commercial sector and now improve existing buildings, not by changing the shell of the buildings but just by running them better, we're almost down to flat consumption over the next few years. We can really wipe out a lot of that growth just by running buildings in a better way than we have.

Well, let's turn now to something we all know about, and that's automobiles. Automobiles are perhaps the other main thing that we go after for energy consumption because they're pretty voracious consumers. Let's look first at our favorite graph (see Figure 22). This just shows you how your gasoline consumption is going to vary with the weight of your car. Anything you can do to get the weight of a car down is going to affect its gasoline consumption. I know there are a lot of other factors - the number of cylinders, the horsepower, the amount of equipment you have on it - but there's nothing that's as important as weight. You can almost predict with curve what the consumption is. So we've been doing what we can to get something to happen in that area. But you don't have to stop just by cutting the weight of the car. These next two diagrams (I apologize, they're a little bit complicated) show how you can go after the motor and improve the efficiency. Now this next one (see Figure 23) shows the potential for moving on both the front of technology and the front of lower weight. It shows what we've instructed automobile companies - to make automobiles that will do 24 miles per gallon on an average by 1980, and 33 by 1985; and in a combination of more efficient automobiles and lower weight, they can reach that easily without hitting any technological barriers. You have to do the combination. You can't do it all by weight; you can't do it all by efficiency. But why should we? We have both routes. There is no reason why the Big Four automobile companies can't do this.

PREMIER CAMPBELL: Are those standards now established and committed?
DR. BROOKS: Those standards are now established; 24 miles per gallon in 1980 and 33 miles per gallon by 1985. Now, those are the average of all cars sold by a manufacturer. We don't care if he sells a big clunker so long as he sells a lot of efficient ones at the same time.
MR. MCINTYRE: Is the average taken with the large and compact ones right across the board?
DR. BROOKS: That's right. It's the average of all cars sold by that manufacturer or importer in any one year.
PREMIER CAMPBELL: Oh, yes. So that one large firm may very well be selling cars that achieve 10 miles per gallon.

COMMERCIAL ENERGY CONSUMPTION

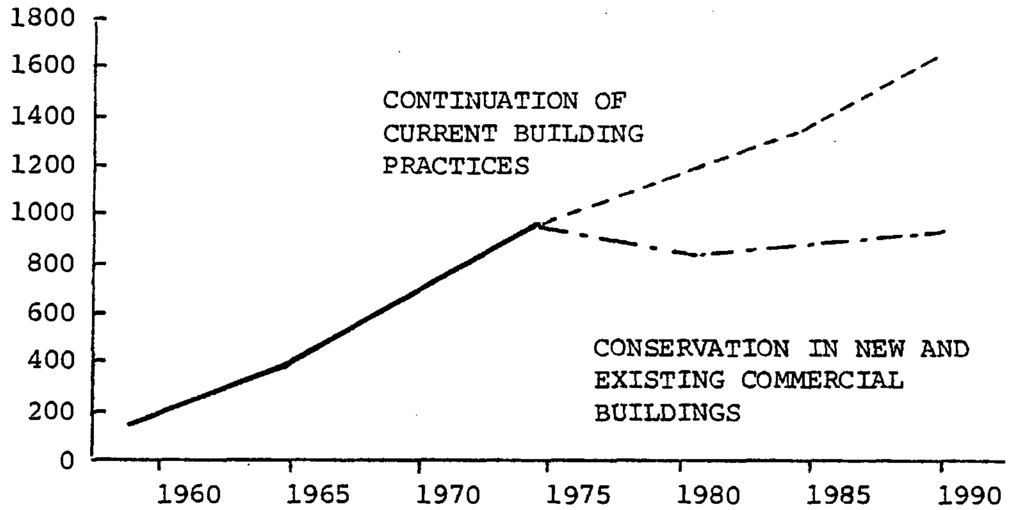


FIGURE 21

AUTO FUEL ECONOMY vs. WEIGHT

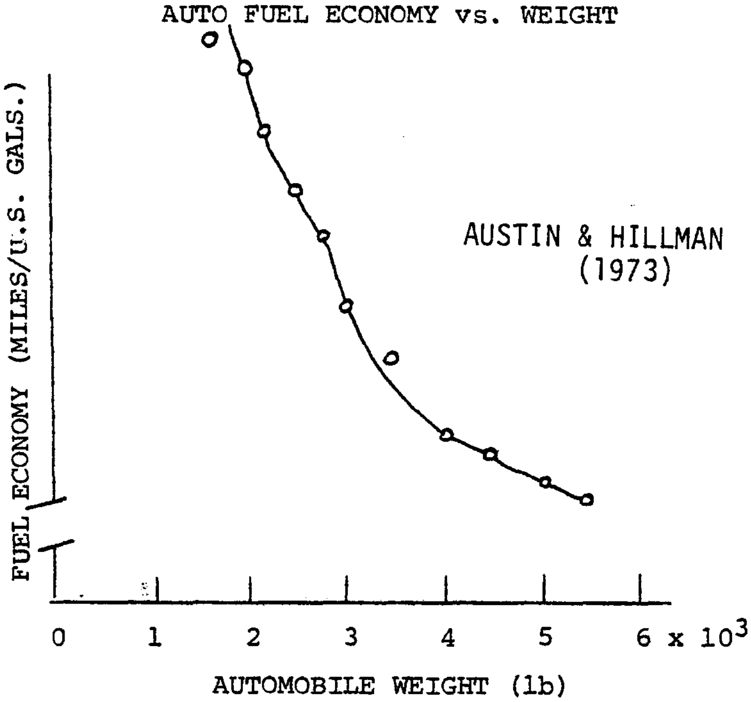


FIGURE 22

TECHNOLOGICAL POTENTIAL FOR FUEL ECONOMY 1975-1985

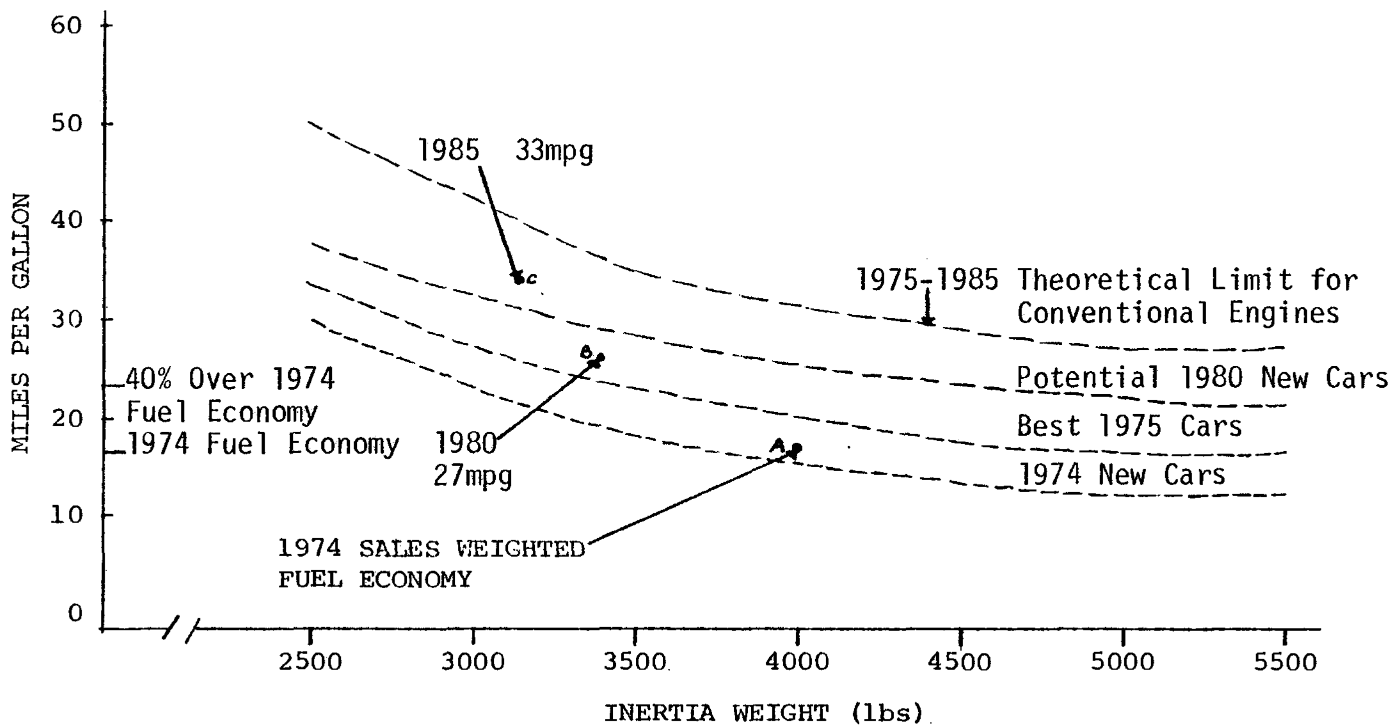
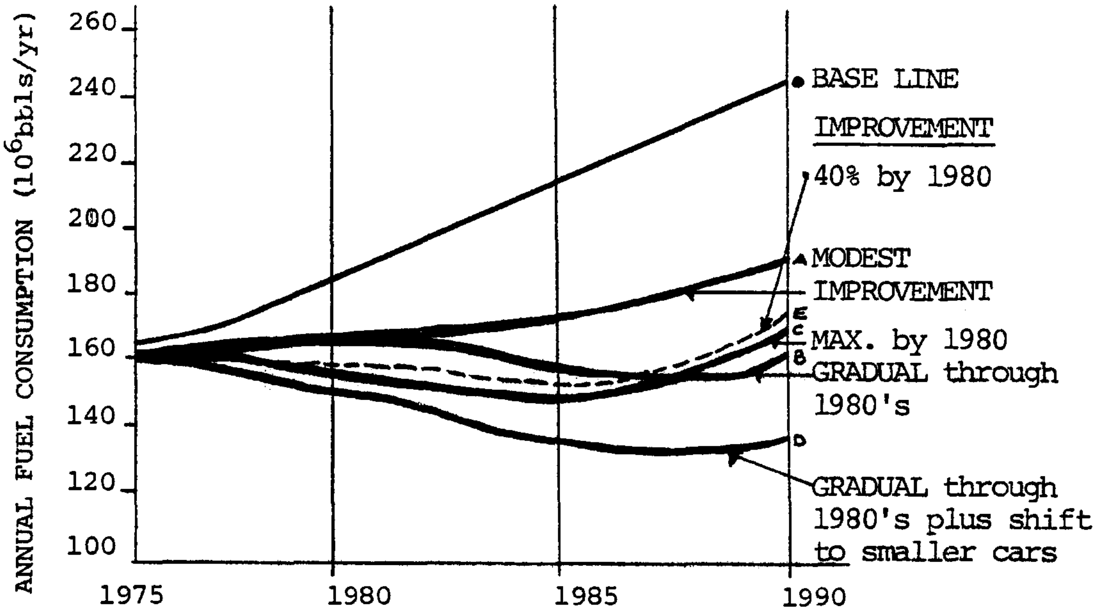


FIGURE 23

POTENTIAL FUEL SAVINGS BETWEEN NOW AND 1990,

CORRESPONDING TO FOUR DIFFERENT LEVELS OF PRIVATE-CAR IMPROVEMENT



- <u>The base line curve</u> represents a steady growth in vehicle miles of 2.6 per cent per year.

<u>Curve E</u> is based on announced industry goals (some engine changes, use of radial tires, slight weight and air-drag reduction) with no significant improvements beyond 1980.

<u>Curve C</u> is based on maximum improvements through 1980 with little change thereafter. Changes would include rapid weight and air-drag reduction, improved transmissions and optimization of conventional engines.

<u>Curve B</u> visualizes somewhat slower changes before 1980 but substantial improvements thereafter, including the phasing in of diesel engines for large cars between 1981 and 1989 and adoption of stratified-charge engines for smaller cars.

<u>Curve D</u> includes all the changes projected in curve B combined with a sales mix after 1980 consisting of 10 per cent large cars, 25 per cent intermediates, 25 per cent compacts and 40 per cent subcompacts, (present sales mix is 28 per cent large cars, 23 per cent intermediate, 24 per cent compact and 23 per cent subcompact).

<u>Curve A</u> represents a 28 per cent improvement in fuel economy over the period 1974-78.

FIGURE 24

DR. BROOKS: So long as he sells enough that make 40 at the same time. We have reason to think that those numbers will be pushed up. They aren't unlikely to come down but we think we can push them higher. We're talking with companies right now about going higher than that.
MR. MCINTYRE: Is there no regulation as such that a dealer must provide an automobile that will give 24 miles to the gallon?
DR. BROOKS: No. He's just going to have to provide some or we just won't make that standard. The words at present just say "or else". No one, neither we nor anyone else, knows what that "or else" stands for, but we hope it will be something significant.
MR. MCQUAID: Why did you give them until 1985 to get up to 33 miles per gallon?
DR. BROOKS: I think you'd have to talk to my minister. We didn't!
PREMIER CAMPBELL: Well, even worse still, they could be delivering cars of present-day efficiency and introduce a new four-wheel bicycle type which gives 65 miles to the gallon and meet the regulations.
DR. BROOKS: No, no. This has to be a sales average. It's a weighted average; that is, they'd have to sell an awful lot of bicycles to make up for that one clunker.
PREMIER CAMPBELL: They'd even give them away, I'm sure.
MR. MCINTYRE: I wonder at something else you mentioned there just a little bit earlier on the weight being such an assistance to conservation. I'd like to question that; unless you're stopping in city driving where you have to build your speed all the time, when you get your weight moving, I can't see that much difference between a reasonably heavy car and a lighter one. Am I right in assuming that?
DR. BROOKS: I don't think so. Would you hold the question for two slides?
LEONCE BERNARD, MLA: What's the average number of miles per gallon cars get now?
DR. BROOKS: The average is around 17 to 17-1/2.

O.K. This is a curve (see Figure 24) comparable to the first ones I've shown. What we're in effect doing is shifting (don't worry about all those intermediate lines) from the top line, that's the growth trend we were on with automobiles, to the bottom one. In other words, here again with this relatively simple change to more efficient automobiles, we will actually be consuming fewer gallons for automobiles, less energy for automobiles in Canada in 1990 than we're consuming today. We'll actually be at something under zero energy growth. Maybe we'll have a better 1990 standard. This doesn't include any 1990 standard; maybe we'll do better. This is the effect of what's in the law. The intermediate curves show the effects of different things separately. But we get all the way down there.

MR. STEWART: But then coming back to increasing the miles per gallon, can this be done without cutting back on horsepower?
DR. BROOKS: No. It means a decrease in horsepower. You've lost some performance, at least in the American sense of performance. I hesitate to mention it, but, of course, there are many European cars that deliver very fine performance at much lower horsepower and weight.

MR. STEWART: Is it not forecast that if you have a 300 horsepower motor now, that you can have a 300 horsepower in 1985 that will consume less energy?
DR. BROOKS: Sure. They can certainly engineer a 300 horsepower motor to do better than it does today, and we expect that they would. They're moving towards it. The first move is to cut the weight but they'll go on to engineering changes as well.
MR. MCINTYRE: Will this efficiency be cut at normal operating speeds?
DR. BROOKS: The figures I've given you are a mixture. I always forget whether it's 55% on the highway and 45% in the city or the other way around, but it's a combination of the efficiencies in the city and the efficiencies on the road. You combine those mathematically to come out with this average.

Well, the final slide in this group (see Figure 25) shows you the effect of speed. We've broken it down to just three types of automobiles: large, intermediate and compact. I think you can see the biggest effect of speed is on the larger automobile. Of course, all automobiles as you get way up there are pretty inefficient. But the speed falls off pretty rapidly, and the optimum point doesn't shift very much as you move toward the bigger automobile. So I think the answer is that even once you've got it moving, larger automobiles are pretty expensive to keep moving. I understand your point that once that inertia is going, it shouldn't take as much. Whether this is simply the effect of weight, or whether the particular kinds of weight we tend to have on automobiles, like power transmissions and things of this kind, maybe create more friction, I don't know, but these are the data we get from the companies.

MR. MCINTYRE: Is it fair to say that the driver controls a lot of this mileage?
DR. BROOKS: Yes. The driver can affect it. I wouldn't say these figures are driver-independent but they are averages that are over lots of different drivers. We hope to neutralize that factor if not completely taken into account.
PREMIER CAMPBELL: It seems as though the consumer - the automobile owner and operator - is being asked to take the bit by driving more slowly and getting into more efficient cars. The Leader of the Opposition has observed that the federal regulations seem to be running at a slow pace by requiring a doubling of efficiency over the next 10 years. I think most people believe that the auto makers have more efficient batteries and carburetors locked up in vaults and have for many years. Is the Federal Government conducting any research to determine whether or not the industry is performing quickly enough and well enough?
DR. BROOKS: I don't have a good answer for you. As I implied before, the Office of Energy Conservation is quite convinced that they could go considerably beyond where they've gone, particularly by 1980. I don't know of any research that is under way that specifically answers that question. So I guess the honest answer would be no, there is no research of which I am aware that specifically would answer that, but I think all the information we have suggests that with the lower emission standards

AUTO FUEL ECONOMY vs. SPEED

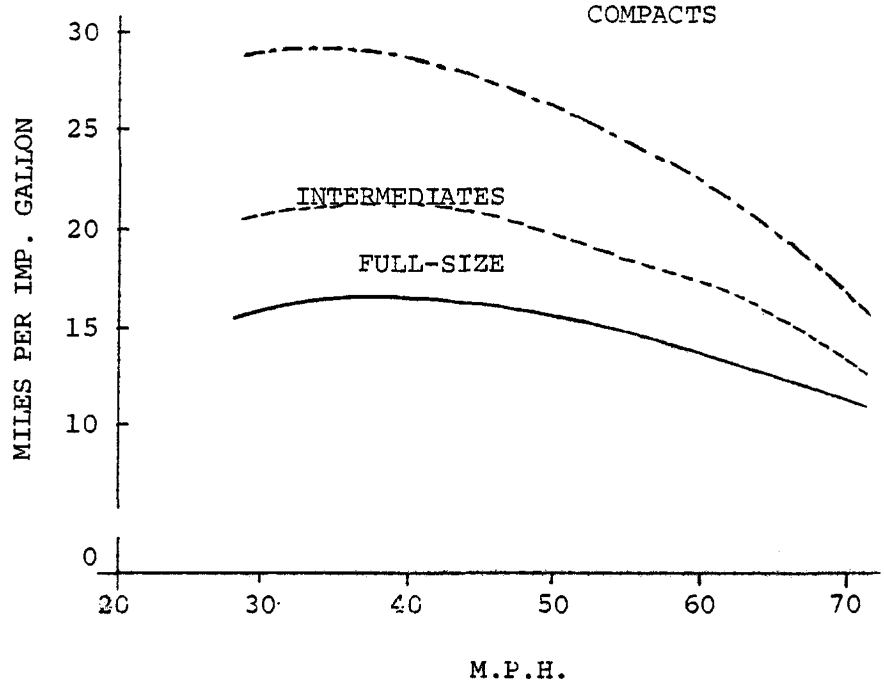


FIGURE 25

that we have in Canada compared with the United States, and other changes, they could certainly go higher by 1980 with no significant problem.

PREMIER CAMPBELL: I suspect the increasing costs of gasoline are going to force the auto makers, because the consumer is going to opt for the foreign cars if they can't get the efficiency in the North American cars.

DR. BROOKS: We would hope so, but the effect is not strong yet. Consumers are still buying large cars; now whether they're into one last fling, or what the psychology operating here is, I don't know. I'm just an economist, not a market analyst.

MR. BERNARD: This stage going to 1980, are the miles per gallon gradually supposed to go up or can they remain at 17.5 until 1980 and then go to 24?

DR. BROOKS: There are no formal standards between now and 1980, but the companies have been instructed by the three ministers involved that they had better move gradually. So I don't expect any games on that account.

MR. MCINTYRE: Do you see them forcing any restrictions to be put on in order to reserve gasoline?

DR. BROOKS: Do you mean driving restrictions? I don't see those at the moment, except possibly in the downtown areas of the largest cities. Even there I would be very cautious about suggesting that there'll be any driving restrictions. I can see reserved bus lanes and things of that kind, but not formal driving restrictions. I think that's the last thing that one would go to, it just isn't talked about very much.

MR. MCINTYRE: Is there a possibility of there not being any gas available in fifteen years from now to keep the cars on the highway that we have at the present time?

DR. BROOKS: That possibility exists. I think it is a fairly low probability, that would be the fair way to put it. I suspect if we come to that kind of a situation, we would go to some kind of a generalized rationing. We do have the whole apparatus of the Energy Supplies Allocation Board sitting there now ready to operate if ever we need it - once a national emergency is declared, all of their powers come into effect. We consider that if the national emergency comes about, that indicates failure of the Office of Energy Conservation.

MR. MCINTYRE: Are you suggesting rationing as a possibility?

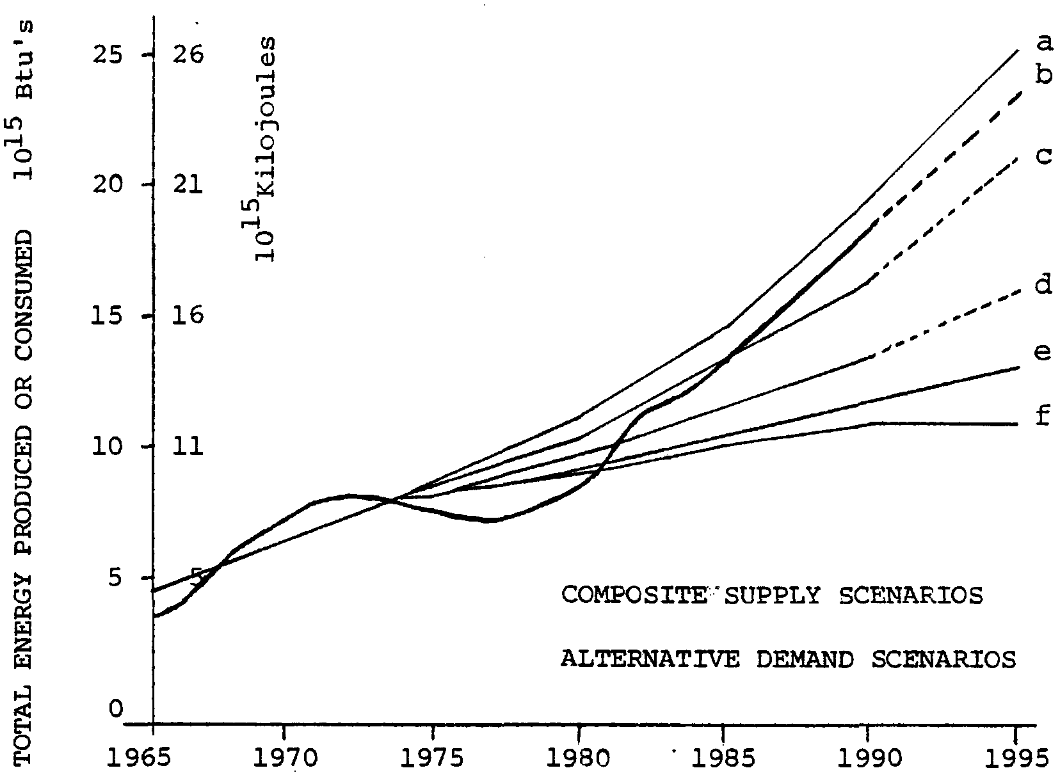
DR. BROOKS: Yes. I think that is what the Supplies Allocation Board is there to do. It is a rationing approach in the case of a national emergency, but rationing is always a choice that is open. In some ways it's an alternative to higher prices if you want to go at it but you've got to make sure it works. It's what we do in wartime. In wartime, instead of letting prices go up as they otherwise would, we were rationed because it seems more equitable. You certainly always have that option politically.

MR. MCINTYRE: But not in the foreseeable future?

DR. BROOKS: Certainly the Federal Government is not pushing it in any way.

O.K. This last and sort of capstone slide (see Figure 26) has lots of scenarios on it. Let me go through them, one after the other, so that we don't get confused. The very top line is just an historic growth line - just threw it on there again to give you something to measure up against. That's the continuation of the 1960s. Then there are a couple of demand lines, depending on prices. Now these are what's called now the EMR energy model - that's an economist's model of the economy in Canada and how it consumes energy at two different prices. You notice that I have a high price and a low price curve there. Obviously, the high price is world energy prices, the low price is existing energy prices. And you can see that has a pretty significant effect. Those are roughly the sorts of curves that you will see in a couple of weeks when the Energy Policy, Phase 2, is published. I'm not telling you anything new here; these have been published in a number of forms in other media. I've also drawn a supply line on there. That supply line is the sort of line I was talking about earlier in the day - the amount of production we could have if we make all of those investments, and if we build pipelines, and if we build tar sand plants, and so forth. It's sort of an ultimate technologically possible conventional supply curve. That doesn't include any solar, wind, or anything like that; it's just a what-is-technologically-possible-curve going up to the right. But, of course, the curves I really want to talk about are the two down near the bottom. Those are the ones that interest us, and they're quite different kinds of curves. One of them I have called "technical fix". Now that's a name we borrowed from the Ford Foundation. What that means is looking at all of the sorts of things that we just talked about. What are the things we could do with the existing system to make it more efficient? Let's look at everything; let's take account of what's technologically available and what pays off in economics. But in making a "technical fix", you don't really challenge what it is the economy is doing. You don't ask people to do much different. There are a few things - for example, there would be less commuting by automobile, more commuting in public transit. A lot fewer people would be flying from Ottawa to Montreal, or from Montreal to Toronto. We took out a lot of those flights - only those over land, by the way, we didn't take out any short-haul air flights over water, it'll relieve you perhaps to know! This is our own conception, I should add, too, just things we put together. But there are no basic changes in what is happening. For example, the curves we showed you on the automobiles in Canada at the historic rate; that is, 3% more automobiles every year than the previous year. We didn't change that, we just made them more efficient and smaller. So you put all of those things together and you add them up - I should say there's one element of naivete in this - in that we don't take much account of how rapidly all of these things could happen politically. For example, we were doing these curves in late 1975, assuming we got better buildings in 1976. Well, I think we're already lagging a few months in getting really good buildings in 1976; so there was a little bit of naivete saying that all of that sort of thing would happen quickly. But in any case, we do get that line after we've added all of our potential up, including industry now. I

ENERGY PRODUCTION AND CONSUMPTION SCENARIOS FOR CANADA



*All estimates refer to primary energy with electricity valued at 3.412 Btu/Kwh.

a Continuation of 1960's (5.6%)
b Composite Supply
c Base Case-Low Energy Prices (4.6%)
d Base Case-High Energy Prices (3.4%)
e Technical Fix (2.0%)
f Zero Energy Growth

Figure 26

Dr. Brooks (continued):

didn't show you the curves for industry and including transportation, including trucks, all of those things. We end up with a line that's around 2% per year. I think that line is really comparable with the supply line; they're both sort of technically based. In both cases, you sort of say, well, that's what we could do; it looks like that's economically feasible. It certainly makes a whopping big difference in what's happening in the future, but it requires a lot of things to happen. It requires that building codes be put in; it requires that automobile restrictions be levied and enforced; it requires that there be a lot of attention to how buildings are being operated; it requires that industry take its conservation targets seriously, all of those things. It requires a lot of investment, too, by the way. Again, it's not free; it requires less investment than in the case of other projects, but it does require investment.

I've also shown another curve on there. I always show it because there's another kind of choice. I've called it zero energy growth, and had it flatten out by about 1990. You can really draw the line anywhere you want, that bottom line. That's not a calculated curve as the others are; it's just a conceptual line that I drew to say that there's another kind of choice you can make, a kind of choice that interests us a great deal. That 2% curve shows what you could do if you are trying to do all of the things that our economy is doing right now - if you want to have more automobiles, as much transportation and so forth. There's another option and that's not to try and keep our economy doing all of the things it's doing. You could question whether we want to keep having 3% more automobiles every year: whether we want to keep air conditioning buildings in Canada; whether there are alternative ways of developing our economy. I think these are among the most interesting questions when you start questioning what it is you're going to do. This is a question of life styles or values. There's no way to get out of it in that lower curve. In the "technical fix" curve, we try to say we're really not touching values or life styles, although we are in a little bit (I mean a lower thermostat is a life style change - you've got to wear a sweater instead of going around with a bathing suit inside). But the bottom curve, there's no question, involves life style changes. Mr. Wells, this morning, mentioned a very careful matching of thermodynamics so that you don't mismatch energy source and use. It requires a whole approach to what has come to be called the "conserver society", and I suspect you'll hear something about that in Dr. Jackson's talk tomorrow. It's a society that is less dedicated to consumption and more to finding out what it is that really makes up a good life besides consumption.

Now, I think I ought to stop here again and ask if there are any questions. I'll come back to those curves at another point, but I think I can stop right here and let Mr. Hall talk about how this all fits into Prince Edward Island. Are there any other questions at this point?

MR. LEE: I'd like to go back to energy conservation in housing. You mentioned that you'd developed new standards at the federal level. Have these standards been published as yet, and are they out in the hands of the consumers and the construction trade so that they can put them to use?

DR. BROOKS: Unfortunately it's a very complex question, so let me go through it step by step. There are two building codes in Canada and then there's what the Office of Energy Conservation thinks should happen. Those are all at three different levels. The Office of Energy Conservation has published a builder's guide, that's been published actually by the Housing and Urban Development Association of Canada in cooperation with CMHC. That's the highest standard for houses right now. There is a code for CMHC which has been upgraded but not adequately. That is a required code and is operational now. There is also a National Building Code which has nothing in it about insulation right now. Now that the National Building Code is being studied, there will be new standards by the end of 1976. So there will be a model building code by 1976 for houses and probably a little bit later than the end of 1976 for large office buildings. The intention is to then start going to other buildings. We'll probably go next to schools and then to shopping plazas and to hospitals and other buildings. But we'll have, certainly, houses and large office buildings very quickly. However, on an interim basis, there's the new CMHC code, which isn't bad. It's a lot better than nothing.

MR. LEE: I think what I take from your remarks is that what you have come up with is much better than the CMHC code and the National Code. I wonder if you've given any consideration to publishing your findings.

DR. BROOKS: They are published; they're just not enforceable. In other words, that's the old problem of the Office of Energy Conservation; we can publish very easily, but we can't enforce anything.

MR. LEE: Have you distributed them in the provinces?

DR. BROOKS: Yes. It's published and can be obtained from my office. I think HUDAC wants to sell them but we're giving them away free. I don't know how that's going to work eventually; but I think if you write to us, we'll give you a free copy.

MR. MCINTYRE: Would you agree to give our Housing Minister in Prince Edward Island a sample copy?

DR. BROOKS: Tell you what - I'll submit a copy officially. How's that to get me off that hook?

PREMIER CAMPBELL: We ask you to do just that.

DR. BROOKS: Thank you.

MR. WELLS: I guess Mr. Hall doesn't need any further introduction.

Conservation in Prince Edward Island

MR. NORMAN HALL: You've heard Dr. Brooks explain in the national context of energy supply and demand why we must have a program of energy conservation. The numbers of barrels of oil, cubic feet of gas, gigawatts of electricity, and capital investment dollars are out of all proportion to the numbers we on Prince Edward Island are used to dealing with in our everyday lives. So much so that I'm sure that there are many who are shaking their heads and saying, "What on earth could we on Prince Edward Island do that would have any significant impact on the Canadian energy supply-demand situation?" Because when

PRINCE EDWARD ISLAND

ENERGY CONSERVATION PROGRAM

PHASE I

	1976 POTENTIAL IMPACT
EXEMPLARY ACTION	
Conservation in Public Buildings	$ 250,000[1]
PUBLIC EDUCATION	
Public Awareness Campaign:	
Residential	3,500,000[2]
Automotive	3,400,000[3]
HOME HEATING	
Sales Tax on Insulation	350,000[4]
TRANSPORTATION	
Reduction of Speed Limits	800,000[5]
Travel Pools	100,000[6]
TOTAL POTENTIAL IMPACT	$8,400,000

1. 15% saving by 100%
2. 10% saving by 100%
3. 10% saving by 100%
4. 25% saving by 10%
5. 2% saving by 100%
6. 50% saving by 25%

TABLE 27

IMPACT OF CONSERVATION ON ELECTRICAL DEMAND

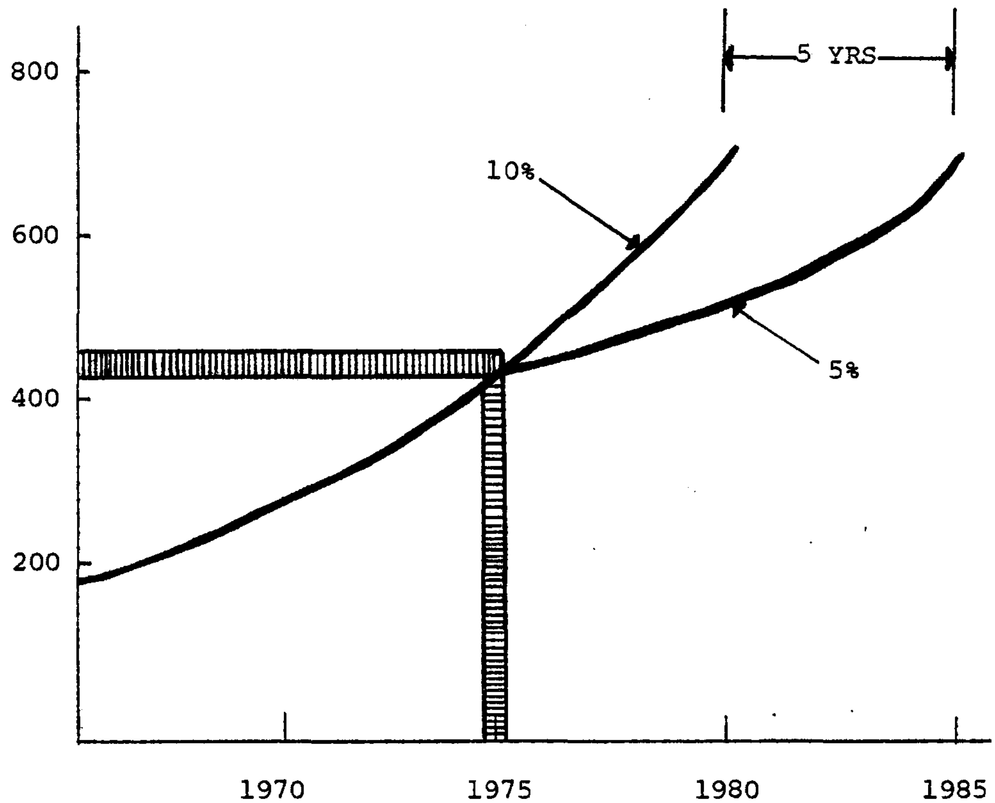


FIGURE 27

Mr. Hall (continued):

you really get down to it, our energy consumption in Prince Edward Island versus Canada and the world is a veritable drop in the bucket. Following along such an argument, there are those who say we don't need to promote energy conservation or encourage it: it will happen anyway when the price gets high enough. Such a position ignores three basic needs that we on Prince Edward Island must recognize. Firstly, the average person needs to know how to conserve. There must be an attempt to educate the public so they can determine the extent of their own energy needs and the best and most efficient way to fulfill them. Secondly, the people of Prince Edward Island have an opportunity to set a very much needed example for the rest of the country, by showing that regardless of size or impact, everyone has a part to play in a national conservation program. Thirdly, and from a purely selfish point of view, Prince Edward Island desperately needs a breathing space in which to fully evaluate the options. The events of the past few years since the Arab oil embargo have caught everyone off-guard and ill-prepared to cope. The alternative energy sources and uses we thought were futuristic are suddenly thrust upon us as needed, but essentially untried, options. To plan better for the long-term benefit of Islanders, we must be sure that the energy options we choose are both practical and affordable.

Figure 27, labeled "Impact of Conservation on Electrical Demand", shows that if we can cut the annual growth rate of 10 to 12% in electricity consumption in half, we can postpone for several necessary years the decision date on more electrical generating capacity, based on current technology. Here we see that if we continue our current growth rate of 10%, we will reach a consumption by 1980 of around seven million kilowatt hours annually. If we can reduce that growth rate to 5%, we won't reach that point until 1985. And that's the point at which we will have to decide to add to our capacity. Our interconnection with the mainland will be fully utilized; and we will have to look to add additional generating capacity. That five years can prove to be the most valuable five years that we could possibly have, because we have the opportunity in that five years to fully evaluate the alternatives to more of the same. In recognition of the three needs I've outlined and in view of the considerable financial impact energy conservation has on both government and the general public, an energy conservation committee has been formed within government and a conservation program initiated. Exemplary action within government has already been taken with the forming of a special energy conservation group within the Department of Public Works (see Table 27). The function of this group is to ensure that all public buildings under their authority will be operated with energy efficiency in mind. Another initiative that has been taken by the government is the reduction in speed limits and this will have an effect on the energy consumption in this province. In the past few weeks, the first phase of a public awareness campaign has been started with messages through the media. You are probably familiar with the 30 second film clips on television, hopefully bringing home to Islanders the need for energy conservation in various government departments to assess their value and

Mr. Hall (continued):

applicability to Prince Edward Island. It is hoped that a number of these will be brought forward in the coming years and that they will provide Islanders for the most part with practical ways of effecting savings in energy. Just as an example of the potential impact of the first phase of our energy conservation program - those things which are in place at the moment - let us look at the conservation effort in public buildings being conducted by Public Works. If Public Works can effect a 15% reduction in their energy use, which, as Dr. Brooks has said, is eminently achievable (in fact, 25% wouldn't be untoward), if they can effect a 15% saving in all of their public buildings, this amounts to $250,000 per year at current prices.

A public education campaign, some people say, is a waste of money. They say you're throwing money away, paying for advertising and so forth to tell people something that they already know. I'm not so sure that these types of awareness campaigns don't have their place; I think they do have an impact and just to try to get a handle on what that impact might be, let's assume that in the residential sector, for instance, if everyone on Prince Edward Island decided, just through an awareness for the need of energy conservation that they wanted to do something, such as controlling their usage of electricity, turning down their thermostats, and if they managed to do this to the extent of a 10% reduction in the use of energy in their home, that amounts to a saving in Prince Edward Island of $3-1/2 million. Again we can point to the numbers that Dr. Brooks has mentioned of 25% as reasonable to expect, just by changing the way you operate within a house. A 10% saving gives you $3-1/2 million; imagine what 25% reduction in cost is. If you apply a similar standard to the use of petroleum products in transportation, if all of the people in Prince Edward Island wanted to conserve the amount of gasoline that they use and just drove a little slower, used more conservative driving habits, opted for smaller cars, and effected a 10% saving of gasoline (and remember the average usage was in the order of 800 gallons per year), you're talking about almost another $3-1/2 million.

The government proposes to remove the sales tax on insulation and insulation materials and related energy-saving devices. If 10% of the population of Prince Edward Island opts to take advantage of that reduction in cost, to reinsulate their houses to a certain extent and effect this 25% reduction in heating costs(and again Dr. Brooks has indicated that it could be as much as 50%) then we have an annual saving of $350,000. In transportation again the reduction in speed limits (if everyone obeys the speed limit) amounts to about a 2% reduction in gasoline consumption, and a 2% reduction in gasoline consumption by 100% of the population amounts to another $800,000 a year. The bottom item on travel pools is something we're working on internally within government, to encourage civil servants to get together coming to work. It's a minor portion of cost; but it's still a potential benefit, another $100,000. You total all these up and you have in excess of $8 million as a kind of minimum potential for the first phase of our energy conservation campaign. Now we haven't really addressed ourselves

Mr. Hall (continued):

in this first phase to the major problems of retrofitting houses, assuring that standards for new houses are adequate for insulation, the areas in which the real big savings are possible; hopefully we will be able to do so in the coming months and come out with something that everybody can take advantage of. The total financial impact of around $8 million is more than likely understated because it represents less than 10% of our annual energy costs, direct energy costs, on Prince Edward Island. It's widely accepted that savings in excess of 25% could readily be effective without any undue hardship or reduction in living standards.

The last slide that I have is a repeat of one that Dr. Brooks has already shown you and it's the relationship between car weight and miles per gallon (see Figure 2). It's something that I mentioned this morning as being the most significant factor in gasoline consumption in the automobile. There are a couple of examples highlighted: a car that weighs in the order of 4,000 pounds will average about 15 to 16 miles per gallon; a car that weighs in the order of 2,000 pounds will average 33 or better. Now I'm sure each one of you are aware of what your car weighs and you know what kind of gasoline mileage you're getting. You can look at this curve and check it out for yourself and I'm sure there are very, very few people looking at that curve who can dispute that that relationship is a good one.

In closing, let me repeat that it's to our distinct advantage as individuals, as Islanders, and as Canadians, to practise energy conservation. It's been very well summed up in the phrase, "if you're not part of the solution, then you're part of the problem". Has anybody any questions on the material to date?

MR. MCQUAID: Does your experience so far in reference to conservation in public buildings give you a pretty clear indication that during this present year, this coming year, you're actually going to save $250,000?

MR. HALL: No. That number refers to application of the guidelines that have been established by Public Works to all government buildings. Now it's physically impossible to get around to them all within a year. We hope that by the time they get to them all, based on current energy prices, that that will be the order of magnitude of the annual saving. This year, I believe, the estimate was in the order of $100,000 for this coming year.

MR. MCQUAID: Well, you say 'getting around to them all'; what is this going to involve? Is it just a matter of issuing instructions to turn off your lights at night and turn your thermostat down?

MR. HALL: No, not necessarily. That is a part of it; the procedures, the operating procedures, are a part of it but I think the main thrust of the program is to go around to the buildings and do an audit of the facilities, the type of equipment that's in place, see just where the problems are as far as energy waste or energy uses are concerned, and physically correct the systems as best as possible. One of the ways an immediate saving can be effective is the reduction in lighting levels. It is, I think, apparent to everyone who has gone through an office building that there are too many lights on. You don't need that level of lighting down hallways and in areas where work is not actually being done. If you have enough light to navigate by, then it's sufficient. The lighting level should relate to the need for such lighting. Aerial lighting or task lighting is the way that office buildings should go; you don't need to have a uniform lighting level throughout an office. It's very, very wasteful.

MR. MCQUAID: What measure of success have you had so far with reference to your suggestion that there should be travel pools? Are you meeting with any measure of success there?

MR. HALL: That is very much in the formative stage. We have had declared support from the PSA that they will survey the membership through their bulletin to assess the need for and the interest in travel pools; and depending on the response, we shall coordinate the getting together of the various people who have indicated that they would like to join the travel pool, or they would like to look into the possibilities of a bus pool, say for a dozen people who travel back and forward from Montague to Charlottetown daily. It's entirely possible that they could group together and lease one of these ten or twelve passenger bus type vans and effect a real saving on their transportation costs back and forward. This sort of thing is entirely possible but you have to get these people together and provide the catalyst for this.

MR. MCQUAID: Well, it certainly would be a saving in gas but I wonder in the long run by the time you buy this bus and keep it in operation, keep it in repair and so on, would there be very much of a saving effective then?

MR. HALL: That would depend on the number of people involved, the distance travelled. Each case, again, would have to be evaluated on its own economics.

MR. BERNARD: On this survey you're doing of the provincial buildings, is there anything that's going to be done on the commercial buildings as well to eliminate some of this lighting, especially in parking lots and things like that?

MR. HALL: This is a real concern of our committee that the commercial sector should attempt to follow the same kind of guidelines. We don't know how you enforce this sort of thing other than trying to talk the people involved into reducing their energy requirements. You can go past any of the shopping malls in the evening and see them lit up like Christmas trees all night and nobody in them. The reason they're lit up, they say, is for protection purposes. Now I can't see that they need all those lights on for protection purposes. Surely, 10% of that lighting would be all that would be required. And let's not kid ourselves - the cost of that lighting, although it may be a business cost to the retailer, is passed along to the consumer one way or another. He has to get it back; it's his cost of operation, it's in his prices. So really large shopping centres are using this energy at our expense not at their expense.

MR. WELLS: It also has an affect on the number of times that the Borden generator must cut in to meet peak demand at very inefficient rates, which affects us all as consumers paying electric bills. I think this is an area that the Institute of Man and Resources must take a very serious look at, the commercial area.

MR. BERNARD: Do you foresee that you're going to be able to control them in reducing their lighting?

MR. WELLS: Well, like Dr. Brooks, we don't have any control apparatus, but it's possible that after working at it we might make recommendations to government in respect to controls.

MR. MCINTYRE: I'm wondering about your statement earlier on practical ways of saving energy which I agree almost totally with, except from a home heating standpoint, you might have a hot water system in your home and the boiler must run up to a certain temperature of 180° F or whatever it is. You don't have much control by a thermostat over that particular problem. How can you reduce the costs of heating in this type of home?

MR. HALL: The thermostatic control can be adjusted both in the temperature to which the water is heated and also the temperature at which the house is kept which is really the ultimate control of how much heat is used. There are losses in the heating system from the tanks and the pipes and so forth but the big potential as far as reducing energy use in the house is through control of the temperature and control of the loss to the outside air. And believe me the potential is significant. Now, let me illustrate it with my own home. Take my home, for instance, as the comedian says, "please". My heating costs this past calendar year were $750 for oil. I'm not proud of that; that's something I inherited when I bought the house. I have gone through the calculations to determine what that heating cost should be providing the house was at an acceptable standard of insulation.

MR. MCINTYRE: Could I ask what type of heating system you have in this house?

MR. HALL: I have a hot water, oil-fired system, radiators, and so forth, baseboard radiators.

MR. MCINTYRE: What is the water temperature of your boiler?

MR. HALL: I haven't got the foggiest idea what it heats to.

MR. WELLS: There are, I think, other possibilities. If I understand Mr. McIntyre's question correctly, hot water heaters for domestic use are set at 180°F and there's not much anybody can do about that. I think there are several things. One is that you may not need as much hot water as you're using on a daily basis, but that's a personal thing. The second thing is that 180°F is what they're normally set at; but do you realize that if you stepped into a hot bath at 110°F, you'd jump right out again because it would be really too hot for you. Now, there seems to be a great deal of excess heating in much of our hot water systems. There are other possibilities though that are a little further down the line. You could get a larger hot water storage tank and insulate it better than it's currently being insulated. Then you could heat that water during the off-peak hours;

that is, after everyone's gone to bed, and get a special rate because this is when the electric companies are running at a very low load, with excess capacity that they really don't need. You could heat most or much of your hot water that way.

MR. MCINTYRE: I can agree with that argument all right. The other thing is if your boiler is at 180°F and you reduce it to 160°F, and if you've got 200 feet of piping going through your home, by the time it gets to your living room or wherever it happens to be, your water temperature is probably 140°F.

MR. WELLS: I'm sorry. I was talking about domestic hot water; that is, the water you use to wash your dishes and take your bath. The water you pump through the heating system, you have to look at it a little differently.

MR. MCINTYRE: The other question I had was on the public awareness campaign: I think that you mentioned that we on Prince Edward Island could save \$3-1/2 million or something in that area. I'm wondering what this public awareness campaign, just a ballpark figure, is going to cost us.

MR. HALL: The first stage of our public awareness campaign is budgeted at \$10,000.

MR. MCINTYRE: What's the first stage? Is that one year or a portion of a year?

MR. HALL: This is for the initial presentation of the energy conservation effort to the public. On an on-going basis, it will probably be less than that annually. This was a budgeted amount to carry us through this first two or three months of fairly intensive effort. I think it's a pretty good return on the taxpayers' investment, that we should spend \$10,000 to encourage a potential saving of the taxpayers' money in the order of \$3-1/2 million - well, it's more than that.

MR. MCINTYRE: I wasn't being critical. I just questioned the value of it.

MR. HALL: In fact, I would be prepared to spend more money but in this age of restraint, it's a saw-off. Let me get back to my house, for instance.

MR. WELLS: Yes, why don't you? (Laughter)

MR. HALL: Are you ready to go home? I don't know if that's the final word. Is that the final word?

MR. WELLS: I couldn't resist it.

MR. HALL: Too many comedians around here.

I've gone through the calculations for my house just to determine what the heating requirement would be on that house if it was brought up to the proper standard. And I was quite shocked to find that I should be heating that house for somewhere between \$400 and \$500. Now that's a pretty substantial reduction from \$750 to maybe \$450. I don't think I'm the only one in this situation. I think there are many, many people in Prince Edward Island who are in the same situation. I think anybody, who by a rough rule, is paying more than 25¢ a square foot of house per year heating cost is probably paying too much. Now this is a very general number but I think as a rule of thumb if anyone wants to apply it to his residence, it'll stand up. Obviously, when you get to bungalows, that number is perhaps a little high, perhaps it's closer to 30¢. As you get to two-storey houses or two-and-a-half storeys, the number comes down because you're building vertically. And when you go to the duplexes of course, it perhaps drops again on a per square footage basis. But for the kind of houses we have on Prince Edward Island, that's probably a pretty good rule of thumb.

LLOYD G. MACPHAIL, MLA: Since you brought up the matter of your house, perhaps it would be logical to ask what you personally plan to do about your house for energy conservation?

MR. HALL: Well, I've looked at my particular problem and I've gone up in the attic and I've found that the insulation in my attic consists of about one and a half inches of loose fill fibre material. Now in order to bring it up to standard, I need probably another six inches of insulation in those joists. Probably the biggest loss of heat is through the roof because heat rises. And just by spending somewhere in the order of $200 to put in the required insulation, I could save a goodly portion of the heat that I'm losing. I don't think there's any way I can get my house up to 90% or 85% efficiency; but if I can just cut that loss down by a couple of hundred a year, I'd be well satisfied. I think it will certainly pay off within the five year period that Dr. Brooks sets as kind of a guideline for these sorts of projects. And there are other things that I can do, such as insulating the pipes in my hot water system, insulating a portion of my basement which isn't insulated at the moment. They recommend that all basements should be insulated to three feet below the ground level. Now, how many basements in Prince Edward Island are insulated? Very, very few. Perhaps some of the newer ones, the ones with rumpus rooms and so forth in their basements; but then given the water problems we have here in the spring, there aren't too many people who would dare that. I certainly can't, not with mine. That's another problem I've got.

MR. MCINTYRE: I don't mean to prolong the questioning on this, but I have one more question, and that is: how do you reinsulate a house that's already insulated?

MR. HALL: There are a number of ways. The major consideration is the insulation in the roof and you put it at the upper level - the attic, the attic roof. It's horizontal; it's easy to do. In my case it's a little tougher because I'm boarded over in the attic and I've got to rip the boards up. But once those are up, it's easy to lay the insulation. In fact, the insulation could be blown in place. Perhaps it's possible to blow that insulation in there with the boards still in place. I don't know; I'll have to ask the contractor.

MR. MCINTYRE: What about your walls?

MR. HALL: The walls? If it's conventional two-by-four construction with an air space in between, insulation material can be blown in. It can be either of this fibre material or the foam, which is somewhat controversial, but it loses its problems once you put it into an enclosed situation. Foam in an exposed situation is a definite fire problem; but when it's fully enclosed, it's actually much, much more efficient than materials such as blown in fibreglass and so forth.

MR. MCINTYRE: I'm wondering, are we saying here that if a house was insulated, say ten years ago, by a blown method, and that is settling, then it should be redone?

MR. HALL: Yes. That's entirely possible. There are a lot of houses with no insulation in the walls, none at all. And some of them that have a certain amount but as you say, it's settled down and there are gaps; it could be redone. We estimate that for the average house on Prince Edward Island it would take about $500 to get you to the point where you have increased your efficiency such that it will pay off within five years at current rates. When you start looking at further improvements, then you're getting into money. You're changing heating systems and putting in new types of furnaces and closing off fireplaces and that sort of thing. It all adds up to much more expense, but the basic requirements to get a house up to a reasonable standard of efficiency as far as heat is concerned would probably constitute about $500. That's our estimate for Prince Edward Island.

MR. COMPTON: Isn't that house of yours costing now about $700, you said?

MR. HALL: Yes, $750. Now I have a fairly large house. It's a two-storey with five bedrooms.

MR. COMPTON: About three years ago that wouldn't have cost much over $400, with the increase that's gone on in the price of oil.

MR. HALL: Yes. That's where the problem lies; there's just such a rapid increase. Now it begins to look as though it's worthwhile to insulate. Two years ago it wasn't.

MR. COMPTON: Our own home went from $435, I think about three years ago, to very close to $800.

MR. HALL: Yes, I think that's very common.

MR. DINGWELL: Did you ever have any research done on the fact that too much insulation is a deterrent to the life of a wooden structure; that a house has to breathe, and when there's a certain condensation of moisture that is not allowed to find its proper outlet, it has an effect on the deterioration of that house over a period of years?

MR. HALL: I think that you'll find that most insulating materials will allow the passage of moisture and air to a certain extent. They're not absolutely air-tight and moisture-tight, and they don't have to be in order to be insulating.

MR. DINGWELL: There have been insulating materials on the market over the years - to some extent I was familiar with them - and they did have a very detrimental effect to the life of that house.

MR. HALL: That's true. In selecting insulating materials you should be very careful that you get the best advice available.

MR. DINGWELL: I think perhaps we should recognize the fact that we shouldn't suggest just insulation per se without recommending perhaps the proper types of insulation.

MR. HALL: Yes.

MR. WELLS: I think the major point here, though, is the question of a vapor barrier. If you're building a new house, it's now mandatory to put up a plastic vapor barrier to stop the vapor movement and it does, virtually 100%. It's when you blow insulation into old homes, at which time you cannot add a vapor barrier, that you may run into some problems such as you described, Mr. Dingwell.

MR. DINGWELL: I think there is some question as to their effectiveness.

MR. WELLS: I think the problem would be one of installation rather than the barrier itself. Often the barriers are not put up as well as they might be and gaps are left. If you've got 100% coverage with a vapor barrier of polyethelene, no moisture is going to move through it.

MR. DINGWELL: Do you think it's better than birch bark anyway?

MR. WELLS: Yes.

PREMIER CAMPBELL: I think the point here is that in every single home in Prince Edward Island there is energy to be saved; and consequently, there are dollars to be saved by every family. To follow through on the program that Mr. Hall has discussed conserving energy in the home, I think we'll have to come forward with an energy audit program so that people who are knowledgeable are available to go to every single home in the province and pinpoint problem areas, areas where we're wasting energy needlessly and opportunities for saving on it. So we'll have to be considering ways and means of doing it without necessarily adding to the Civil Service numbers in the province. Perhaps there is a role for many Islanders to become involved in the energy audit program.

MR. BERNARD: Mr. Hall, this morning you said that it cost you $10.60 per thousand BTU to heat a home with electricity. In your campaign to save energy, are you going to discourage people from using electric heating?

MR. HALL: I don't think they need very much discouraging at this point. You can't turn around and say to somebody, "Take your electric heating out." We don't want to make any portion of this energy conservation program mandatory in any way. We would like to suggest and inform and hope that people will take the initiative and do things themselves. I think that to be effective, an energy conservation program, certainly at the stage we are in right now, has to be very, very much voluntary. And people who have a problem with electric heating or who take the time to apprise themselves of the problems now related to electric heating, I'm sure will make that decision on their own without us influencing them one way or the other. And I would hope that we will be able to give them the wherewithal, the information upon which to make that decision. That really has a lot to do with what we've been saying all day today and in the coming days we want to make people more aware of what the basis for their decision should be.

MR. BERNARD: More or less you're going to publicize that it's costing more energy by electric heat than it is by fuel heat.

MR. HALL: Yes, we'll make available information to the public as much as possible through Island Information Services or through our committee so that they can make those decisions.

If that's all the questions, I'll turn it back to Dr. Brooks. Thank you very much.

DR. BROOKS: Well, I hope this afternoon you won't decide that conservation is just a lot of talk. We've been doing quite a bit of talking at you. What I'm going to do in this final part and it shouldn't take too long, is to do something a little backwards - is to summarize first and then talk about the areas in which I think governments have to act. Mr. Hall has been talking about some of the things that have been going on in Prince Edward Island. I'm going to talk a bit more generally and somewhat more broadly about areas where you should be considering action.

By way of summary, I think everything we've talked about can be put down in relatively few sentences. Through 1974, energy demand in Canada was growing at 5% a year. I don't know of anybody - and I mean industrialists, legislators, academicians - I don't know of anybody who believes it would be in our interest to try to maintain that old rate of growth. To speak a little bit academically, continued increases of energy supply are: 1) certainly characterized by increasing costs in dollars, in energy, and in environmental terms. Further supply increases are also: 2) characterized, we think, or at least a lot of us think, by diminishing returns. It doesn't seem that we're getting as much out of continued additions of energy as we used to. The dollar returns seem to be lower. We are certainly not getting the employment out of increases in energy and maybe even the quality of life is declining. We've looked at a number of alternative scenarios for energy growth in Canada. There are those which depend just on price and get you about 3-1/2 to 4% rates of growth. There are those which involve just price plus doing some technical things using that five year rate of return; that brings it down to 2%. And there are those which involve an explicit choice to go lower. I don't mean to do the typical bureaucratic thing of saying there's a high rate and there's a low rate but right there in the middle there's a nice one; you ought to choose the one in the middle. I don't think I want to say that but I think I feel comfortable in saying you ought to go at least that far. Going to that 2% rate of growth seems like something that ought to be treated as a minimum. But I think there are a couple of things to notice about it. I think you ought to remember that potential savings are much greater than indicated by that 2% line. It could go much deeper than that. But more importantly for the present purposes actual savings will be less unless you do something about it. You've got to take certain kinds of actions. No one's suggesting that you can change anything overnight but there are a lot of areas in which you can act. So let me for the concluding five or ten minutes of presentation talk about those areas in which governments have to act because the fact of the matter is that energy consumption is just too important to be left alone.

For a long, long time governments have been involved in regulating the production of energy and it's hardly surprising now that there are going to have to be some steps by government in the consumption of energy. Now, let me go through a number of areas. The first has been talked about; number one is the provision of information and educational programs to the public. There's a lot that can be done here. There's the book, A Hundred Ways to Save Energy and Money in the Home, (I think that's the title). I understand that a copy will be in every family home in Prince Edward Island within a few days; probably for some of them at least it will be their second copy, but that's O.K. We have just received from the printer the millionth copy of A Hundred Ways which we intend to present to the Minister.

MR. WELLS: Can he follow it?

DR. BROOKS: He says he's taking showers now instead of baths if that's an indication! A million copies of any book are pretty good in Canada. There's a lot more though; we have a book on furnace servicing which everyone who has an oil furnace should be reading, about how to handle and service that oil burner and how to make sure the service man is doing a good job. We have movies coming out. There are a number of CBC productions. Some of you have probably seen our television commercials - CBC gives us some problems with our television commercials but they accept some of them. Some of them seem to be too controversial but that's the nature of energy conservation. You've heard our radio commercials - there's a lot of that. That's fairly expensive; it's more than $10,000 a year, sorry to say. Our information programs are costing around $2 million. A lot of that, however, is not visible. You see the tip of the iceberg. You see the books; a book just came out for industry. We have a book on recycling that's at the printer's. That's, well, a little more than the tip of the iceberg but there's a lot more. I think one of the things I'd like to mention is that we have a number of programs for schools. I hope your children will be coming home and badgering you and saying,"Look, this is what I learned in school, and this is what we ought to be doing." We are developing a whole curriculum for high schools - a curriculum that can be used by teachers to teach about energy and, by implication, about energy conservation. There are a lot of things like that. They're fairly expensive but we think they'll pay long-term dividends.

Now, information is inherently a voluntary thing. You hope it pays off in the long run; it's kind of the ideal thing. But the second thing is that there have to be mandatory restrictions. There are a lot of areas where real regulation is required. Building codes are a perfect example. You will simply not get good buildings without building codes. The problem is very clear. The person who builds the building is generally not going to pay for the energy costs of running it. It's very rare that one person builds a building, pays for it, and then ends up living in it or using it. Ordinarily, it's that the market is separated and the temptation is just too clear .. not a temptation, it's just the normal economics of the market which tell him to minimize the building cost. Whereas the poor guy who's got to live in it later on - he doesn't care how much it costs to build; he just doesn't want the energy cost to be very high. Well, the only way to bring these two together is a building code and a building code that covers all kinds of buildings, not just residences. The same thing is true, of course, about automobiles. We just haven't had very good choices in automobiles. Appliances - just try to go and

Dr. Brooks (continued):

find out when you go down to the store to buy a new refrigerator which one is energy-efficient. The guy probably can't tell you; maybe if he knew, he wouldn't tell you but the fact is he probably doesn't know. So again, part of our program that has been accepted by Cabinet, is a set of minimum efficiency standards and labels telling how much each new appliance will consume in energy and then we'll convert that to a dollar figure, too. It'll take us a while to get all these things; they're not going to happen overnight, but there are a lot of things that could be done in this area. You may want to consider various kinds of other limitations and regulations on energy consumption to make sure that your industries are more energy-efficient. You can think of certain kinds of plants operating under various sorts of restrictions to insure that they are more efficient than they are.

Now, we've talked about information and education and about regulation. Third, and an area that I think you should talk about very much tomorrow, are the financial incentives. Every government has taxes and every government has subsidies; they're all through the system. You certainly ought to review these to see which of them are supporting energy conservation and which are not. I'm not saying that's the only criterion - these things are decided on many issues - but it's very important to know which ones are helping and which ones are hurting. Mr. Hall mentioned the sales tax on insulation. That's a perfectly good example. If you want to support conservation, why not remove the sales tax? We have suggested at times that the personal income tax could be adjusted to help people pay for conservation for what they buy in insulating materials. A very important area to look at is the electrical rates. Electrical rates in Canada, in almost every province are an anachronism. They come from an era in which energy was getting cheaper and cheaper and so the rates get cheaper and cheaper the more you use. I just sit and look in amazement in an era in which we are urging people to conserve energy and yet tell them, of course, the more you buy the cheaper it's going to be. That certainly has to be looked at. You certainly have to review the rates to see if people are being charged in apartments. Is there one meter for the whole building or does everyone pay his own utilities? I, again, don't know the data for Prince Edward Island. I can tell you that the recent study of Ontario Hydro showed that in buildings for which there was one meter, that is the people didn't pay their own utilities or only paid an equal share, electrical energy consumption was 40% higher, with a bulk meter. Now, I frankly do not understand how someone can use 40% more energy in an apartment but they were doing it. I guess you just leave the heat on and the windows open and things of this kind, leave the lights on all the time. But that was the average in the Ontario Hydro study. Still talking about financial incentives, there's a very important area to look at in this instance of insulation, especially when you're talking about renewable energy, such as solar energy. We have a problem; not only do we have some incentives that go in the wrong direction, we have some that are just sort of not there. Let me give you an example: I think we could show, if we did a financial calculation, that it would probably be cheaper for Islanders as a group, to invest in insulating materials than to get electric heating for electrically heated homes. Let me restrict the example to just electric homes. It would be cheaper to buy insulating material than to build generating capacity.

Dr. Brooks (continued):

On the one hand we have a system, we have a utility, that can borrow large sums of money - almost any utility can borrow large sums of money through conventional channels but we don't have a common pot, an easy access for people to borrow money for insulating materials. CMHC is just getting into this but in a small way. Maybe we ought to develop special funds to help people over this gap, or alternatively for installing solar hot water heaters or other techniques of this kind. It's worth looking at; it may be cheaper to subsidize at the consumption end than at the production end.

Well, we've talked so far about information, about regulations, and about this whole big area of financial incentives. Fourth, I think governments have to start looking at the energy implications of some of their non-energy decisions. This is another big area. We've been talking about housing, which is another good example. All governments have housing policies; these ought to be looked at to see what their implications are for energy consumption. I don't know what the results would be in specific cases. All I am saying is that it's worthy of analysis. If energy is as important as we are saying it is and housing is such an important part of our energy consumption, it deserves to be looked at. The same thing is true of transportation policy: we ought to look at transportation. It might be cheaper to subsidize a public transit system or a public commuting bus system or whatever, rather than to subsidize the import of petroleum. I'm sure that's true in central Canada; I would guess that it's also true in eastern Canada as well, in the Maritimes. It simply is cheaper to buy buses than it is to buy the petroleum for people to come in private automobiles. It's worth looking at these things. And by the way, please don't ask me to defend the Federal Government's transportation policy, because I will not do it.

The last area I want to talk about is that area of zero growth. I don't know what you should do about this. I've come back to it a couple of times because it intrigues me. I think the question you'd have to ask here is, "What are lots of additions of energy doing for or to Prince Edward Island?" I think there are lots of reasons to go to the "technical fix" down to 2%. I think we can justify that on grounds of saving money for everybody, for Canada, for Prince Edward Island. I think when you then ask whether you want to go below that, whether you want to go to this area called zero energy growth, (let's call it to the conserver society) you've really got to ask what is it you want for Prince Edward Island. If you go to a conserver society kind of concept, it's because that's what you want for Prince Edward Island. I think it's worth looking at what more and more energy has done for you. What are you getting for it? Has it produced more employment or has it not produced much employment? I think as we look across Canada we're increasingly skeptical of the employment returns of slogging lots and lots of energy to an economy. I don't know of any evidence that suggests that more and more energy is getting us a better distribution of income. What we seem to be finding is that lots of energy simply means warmer

Dr. Brooks (continued):

buildings and faster transportation and higher incomes for that part of the population whose buildings are already warm, whose transportation is already fast and whose incomes are already high. It doesn't seem to be getting down very far at all. So I'd like to leave with that thought: that really, if you want to look at that conserver society, the zero energy growth option, the ultimate question is, "What do you want for Prince Edward Island?"

Thank you very much. I've enjoyed this a lot. By the way, I'll answer any questions if they come up.

PREMIER CAMPBELL: Dr. Brooks, before you leave, certainly we want to thank you for your contribution to this discussion. I think that you've left with us a good deal of material and constructive comment. I might say about zero growth: we tried it here on Prince Edward Island for 65 years and didn't like it; but we are practicing some form of limited growth and all of us may very well have something to do with the nature of the new society.

DR. BROOKS: May I respond, sir? I think there's a great difference between a zero energy growth that you plan for and deliberately search for and one that happens as the result of an unfortunate set of circumstances.

PREMIER CAMPBELL: Thank you. I may not have a better opportunity to ask this question and perhaps you don't have the answer, but can you tell us roughly how much the Federal Government is investing in nuclear research and subsidization of the national nuclear program as against federal investment in research in all other forms of energy creation?

DR. BROOKS: I don't think I can recall the absolute amounts, but I can recall the percentages fairly well. As I recall, we have been putting about 80¢ of every dollar into nuclear. That'll probably drop to around 65 or 60¢ - these are very rough, they could be off by 10¢. Most of the rest has gone into conventional oil and gas. Broadly defined, conservation has got about 5% and renewable energy resources about 1 or 2%. That's about the breakdown.

PREMIER CAMPBELL: Well, about 80¢ on the research dollar for nuclear and 1 to 2¢ per dollar on the renewable resources like solar systems.

DR. BROOKS: That's correct.

PREMIER CAMPBELL: And that's likely the reason why there is not technology available at this moment in time which enables us to buy solar systems in the hardware stores for our homes, and first of all reduce consumption by 50% and then make up the balance from the renewable resources.

DR. BROOKS: It's a very significant part of the answer. We've had a tremendous bias in our research, not just toward nuclear but toward large scale. This isn't just Canada: the whole western world has been going toward larger and larger systems which has biased what's available. Small scale efficient systems are only now coming onto the market and there certainly has not been anywhere near adequate attention to renewable resources.

PREMIER CAMPBELL: Well, we can thank you for your personal support for the programs of the Institute of Man and Resources and I hope that your influence continues to brush off on your colleagues.

DR. BROOKS: Thank you.

MR. WELLS: Thank you, Dr. Brooks. Well, we've finished a little early. I don't have anything more to add at this moment other than to remind you that tomorrow when we get underway again, we will be inviting the Public Utilities Commission and the electric utility, Maritime Electric Company, to come before us. In the afternoon we will be examining the whole question of nuclear power. So if no one has anything else to raise, I'll call today's meeting adjourned.

March 31, 1976 A.M.

4. ROLE OF THE PUBLIC UTILITIES COMMISSION, MARITIME ELECTRIC AND THE PROVINCIAL GOVERNMENT

MR. ANDREW WELLS: Good morning. Mr. Speaker and Members of the Legislative Assembly, I would like to welcome you to our second day of energy sessions. On behalf of the Institute of Man and Resources I would like to express our appreciation to the Canadian Broadcasting Corporation for what I consider to be the most excellent coöperation in presenting this material that we've assembled for the Legislature to the general public. I think most of us recognize the significance of the issue and the need for close scrutiny and attention to it. In the same vein, I would like to express our appreciation to all other members of the media who have given us extraordinary coöperation.

The first item we will look at this morning is that of the Role and Responsibility of the Prince Edward Island Public Utilities Commission, and to lead us in that discussion I would now call upon Mr. Bill Brennan.

The Role and Responsibility of the Prince Edward Island Public Utilities Commission

MR. WILLIAM BRENNAN: Mr. Speaker, Members of the Legislature, it is a privilege to appear before the Legislative Assembly this morning and I might say that it's a long time since I last appeared here. To best carry out the delegated responsibilities which have been assigned to the Public Utilities Commission, I do feel that it is a good thing at times to have to give an accounting and therefore have some contact. I have been asked to give the background of the Public Utilities Commission and report on each of the areas in which we have various forms of control.

To cover approximately 50 years in a few words is not easy. Up until the late twenties, the control existed, and such rates as were set, were set by legislative authority. The first Act was passed in 1929. I might say, where rates are a matter of legislative authority, I think our legislators find themselves almost continually in one form or another of hot water, which the Commission presently finds itself in. The first Act was written by our present Chief Justice, C. St. Clair Trainor, who was then Clerk of the House, and it provided for the control of electric power and telephone only. It's interesting to note that in each of the areas that have been assigned to the Commission over the years, they almost invariably were assigned as a matter of getting out of a serious problem that had arisen at the time.

The present Commission was appointed in 1946 and the membership consisted of again our present Chief Justice, then Judge, C. St. Clair Trainor as Chairman, L. B. MacMillan, and myself. This was a product of the power situation in the province having got into a very critical situation during the period of the war, and there

Mr. Brennan (continued):

are certainly people here who are cognizant of the fact that in those days following the war our lights were going out, power was rationed on a regular basis in the evening, and no way could the plant even carry the small area of the province that it was supplying at that time.

When the Commission was appointed in October 1946, we took a very close assessment of ourselves and the responsibilities that we would have to fulfill, and we felt that certain things had to be taken into very careful consideration. One is that we are an area composed of 100,000 people plus, and therefore can only afford those services which basically a good sized town in any other area could afford. However, in serving those 100,000 people plus, our costs are considerably higher, because those 100,000 people are distributed throughout the length and breadth of the province and not in concentrated areas. Another matter we had to take into consideration was the fact that basically in this province we have three sources of income only: the money the farmer brings in, the money the fisherman brings in, and the money the tourist brings in; and somehow, gentlemen, I get the impression that unless we look out for the farmer, the fisherman and the tourist we are not going to have much to look out for, and I think that these are fundamental to our basic existence.

One of the first things that followed the appointment of the Commission in 1949 was a request by the Legislature that the legislation be redrafted. We had several meetings with the then Executive Council, and criteria were pointed out to us which they wanted to be covered. We made an analysis of the legislation across Canada and came up with certain recommendations. The recommendations were put into legislation in 1948, and you will note that, with particular regard to the electric energy segment, the legislation is very strong on non-discriminatory rates. As a result of this new legislation, we felt that it was time that the whole matter of power be looked into and we ordered a full evaluation of the physical assets of the Maritime Electric Company Limited. In 1951 we brought down a decision relative to this investigation which set the rates as of August, 1951. Having set these rates between the time of 1948, when the legislation was fixed, and our findings in 1951, several other things had come to light that required attention. One was that there were at that time approximately 15 separate power utilities with rates running as high as from 8¢ to 16¢ per kilowatt hour. Now these served very small areas, and the endeavour was, and was decreed to be, that these were to be all joined together in the best manner possible. Over the next number of years the Commission took on the job of amalgamating these various utilities, and, with the one exception of Maritime Electric Company Limited, the rates, of course, in every area did come down. Of course in the area served by the principal utility the rates went up because they were being compelled to take power from their highly concentrated population of Charlottetown - and Montague had been taken in ahead of that and so on - and distribute it through the rural areas.

Mr. Brennan (continued):

This was not progressing fast enough, and in the year 1954 the Provincial Government Rural Electrification Program was inaugurated. This immediately made money available for electrical lines, and, of course, in order to try to get some equity into the matter we had to decree fairly firm principles on which these extensions would be made. The two principal bases that were chosen were: one, the greatest density, in other words, the greatest good to the greatest number; and secondly, the date of filing of the application where this could be done, because lines had to exist to serve communities. We couldn't serve a community away off the beaten track if there were no lines in the area to get into it. This program was enormously successful, I might say. However, it did meet with one very, very grave setback. In January of 1956 we had an ice storm in this province that took down practically every single pole, certainly in the western part of the province. I think there was one pole left standing in the town of Summerside. Now all the money that had been poured into the Rural Electrification Program at that point, not quite all but most of it, was down the drain at that point, and we had to start from scratch again and put it up again. By the early seventies the program had been completed and, I think, was one of the most outstandingly successful programs that had been carried out in the province. Certainly, it has drastically changed the way of life of the rural population.

Insofar as telephone is concerned, the matter of the telephone utility in this province is another matter where considerable consolidation has taken place. When we took over control in 1946 we had, I forget now whether it was 68 or 72 small, independent telephone companies. Now these did an extremely excellent job at a time when no other type of service would have been available to the people who had this service. And over the years the work was carried out mostly by devoted people who worked for little or no pay and were just interested in community service. It was an adequate service for the time. However, there comes a time when people want improved services even at a sacrifice of more money. It was interesting to note in those days that there was an attitude that prevailed that telephone service should be given in rural areas at a fixed fee of $18 per year, and for years and years and years that attitude prevailed. It continued until the situation changed and people didn't want their party lines, and did want dial service. So, over the period of time this consolidation took place. We now have one telephone utility, certainly providing the level of service that is being required, with the people demanding dial service. A few years ago when the dial service was inaugurated, why, people were satisfied to have ten customers on a line. Today people are dissatisfied with four customers on a line, and, of course, every time that you demand more service and more lines, the costs go up. There's no way around it. I think I'll leave further discussion of that to the question period, because I have the other realms in which to speak.

Mr. Brennan (continued):

The next area that was assigned to us by the government of the day was the Petroleum Products Act. This was a result of the fact that in those days there were licensed in the province just short of 500 gasoline outlets, and yet people could not get service, could not buy gas. It was next to impossible to buy gas on the western roads. Outlets would open up, close down and so on. So the government of the day said they were going to hand two things to us; one was the work that was being carried out by the Milk Board and the other was the Petroleum Products angle. Well, in the abundance of our ignorance we went and pleaded very seriously with the government that although nobody knew any more, nor yet any less than we did in the realm of public utilities, certainly there were a lot of people in the province that knew a lot more about milk than we did, and therefore, we felt that this should be put in more competent hands than ours. However, in the matter of petroleum products, we felt that it was a matter that certainly related to public convenience and necessity, and thus fell within the normal realm of public utility control, and we took this one on. I might say, gentlemen, it turned out to be one of the worst headaches we have ever coped with. If we go back a few years, I can recall the time when the oil companies, due to transportation facilities and so on, almost declined to put any adequate oil storage facilities in the province. It was a matter of great, great negotiation and concern to induce them to put what could be called even semi-adequate storage facilities in the province; and of course at that time practically all of our oil came by rail. Having got into that area, we then asked that the distribution be removed a little bit from, shall we say, one central location, and that storage facilities be created in other areas. I might say from the time that point was made until now, we have had a great deal of coöperation in this regard and we have what we consider reasonably adequate oil storage in the province. I wish we could say the same thing about price.

The next matter that was put our way was a matter of motor carrier. Now motor carrier was put in the hands of the Public Utilities Commission as a result of the fact that the various principal truckers in the province made numerous representations to the Executive Council, and to every level of government, requesting that it be put there as it had been in other jurisdictions in Canada. Now in no way, shape or form am I going to say it was a right thing or a wrong thing, but I will say this, that I don't think the government of the day had any choice in the matter. We assumed the job for this reason; because every other jurisdiction by this time, except Newfoundland, had taken on the control of motor carrier, then every outsider would be able to come in and leave basically nothing for the local carrier.

I have a personal opinion here that has nothing to do with the Public Utilities Commission but I feel compelled to express it! That insofar as trucking is concerned, there has been such a tremendous proliferation of government control that in a few years' time we are going to find the truckers controlled right out of existence,

Mr. Brennan (continued):

in a manner very similar to which we found our North American railroads controlled right out of existence. This is not the place for it, but I think it would serve a good point if somebody could just look into the number of reports, returns, controls and authorities that a trucker has to go through to get into the trucking business, and once in it, to even continue for a month's period. They are so overburdening, (and I am sure the members of this Legislature are aware of the fact), that many of our principal truckers are selling out. Now I don't want to harp on that point, gentlemen, but I think it is one that is very salient and one that must be brought to the attention of our legislators at all levels. I'm sure that people who have their ears as close to the ground as you people have, are aware of the fact that the word is out that our truck subsidy is about to be dropped. Now there's no single doubt in the world that even at the time the subsidy was created, it was the intention that it should gradually be phased out. But right now, with the cost of fuel going the way it is, and the cost of transportation being of such a vital concern to the people of this province, if we lose both the truck subsidy and our rail service within a short time, I might say that we will be in a very bad position of certainly being a second-class province where transportation is concerned.

The next matter I will refer to is the matter of water and sewerage. For years in this province the only two municipalities which had water and/or sewerage services were Charlottetown and Summerside - Charlottetown from 1888, and Summerside from 1908. When we got into the post-war period, several municipalities became very progressive in their outlook and wanted water and sewage, rightfully and correctly. Some of the earlier ones were Parkdale, O'Leary, Kensington, and so on. At the time we asked the Executive Council whether they considered that this would be a matter that should fall within the jurisdiction of the Public Utilities Commission, because it was our attitude that if it were to fall within our domain, then it would be much easier to take control at the beginning. We were advised in clear terms that it was not the intention to put water and sewage under the control of the Public Utilities Commission, and I might say, we breathed a sigh of relief and said to ourselves, "Thank God for that". However, as time went on, the provincial government assumed the underwriting of all the debentures for these new water and sewage utilities, and this is a sufficiently new domain that I am sure many of you in this room are aware of it. When some of these communities began defaulting on their payments and the government had to pick them up, the matter was very quickly referred to the Public Utilities Commission and it became our, shall we say, "uncomfortable position" to impinge ourselves on each of these communities, many of whom had been running their business successfully for some period of time, and to try, in some reasonable manner, to take proper level of control and bring in rate structures which would, at least, make these utilities financially sound rather than operating in the red. I might say that we are satisfied in most cases; however, we still have two or three cases which are, you might say, "not too good", and we are somewhat confounded and confused in this, and this is one level where I

Mr. Brennan (continued):

think a small bit of coöperation in legislative change could bring about a vast improvement for the operation of these utilities.

Now gentlemen, this is what you might call a thumbnail sketch of the situation. I realize that you are to hear from others, and I understand there is to be a question period, and I feel to go into more detail than I have at this point would be impinging on others' time. So at this point I will try to answer such questions as might come forward, and if I can't offer you an off-the-cuff answer, I can assure you that I will get a written answer at a later point in time.

MELVIN J. MCQUAID, MLA: Mr. Brennan, does your Commission automatically review the rate structure of the various public utilities to determine the rates with respect to their earnings and so on, or is this only following an application for review?

MR. BRENNAN: They are constantly reviewed, and I would point out in this regard that from the period of August, 1951 to July, 1971, there were 28 rate decreases in electric energy in this province, and without one single increase in the same period, I might say. Those 28 rate decreases were a direct result of the very situation of which you speak. The balance sheets are reviewed.

MR. MCQUAID: Well, when you notice an increase in dividends being paid, for example, by any public utility, does that more or less automatically cause you to have an inquiry to see if rates can possibly be reduced, or does an application have to be made for that purpose?

MR. BRENNAN: That is a question which I can understand being asked. It does form a problem. Here's the problem. According to public utility legislation we are not actually concerned with dividends, for this reason - that the return that a utility is allowed is a given rate of return on earning space. Now 'earning space' is prudent original investment, less accrued depreciation. This 'less accrued depreciation' is very important because if you didn't take that into consideration, why, they could be earning on something in perpetuity, which they are not allowed to do. Therefore, we allow them a rate of return on the actual money that they have invested at the time. How they treat that with regard to where it goes, whether the company's books show it is in the red or in the black, or whether they are paying dividends with it or putting it to earn surplus or buying new equipment - this is a matter which we take an interest in, it's a matter which we stay posted on, but it's not a matter which we have legislative rights over, because the thing has been taken down to the utter basics, a return on the dollars you have invested and that's all.

MR. MCQUAID: Well, would it not be correct to say that the earning base of the particular utility should be a guiding factor as to their rate structure? If their earning base goes up and their profits go up, would that not be a guiding factor as far as you are concerned in fixing the rate that the utility is charging?

MR. BRENNAN: In this realm again, it is a guiding factor, but it's not the cogent one as far as we are concerned, because as you well understand, the Federal Government requires that their income tax be paid on a given basis. Now they have what is called a diminishing balance system of depreciation, which is far more generous in some ways to the companies than the one that we use; that is, the straight line method. Now a company, shall we say, can put in a large turbine - and these now cost up in the millions - and take out an extremely heavy amount of depreciation in the first few years of the life of that unit, and this money then can be available for such use as they see fit to make of it. Now we wouldn't allow it to get misused; but with our straight line method of depreciation, which keeps them much more strictly confined, why they would not be allowed to take that much money out. Now, this isn't a case of book juggling as some people might think, because it is what happens to a few figures at the bottom end of a whole lot of calculations, where the whole thing is made up. It's made up the same for both sides; only the amount of depreciation that's taken off the bottom is what varies. We are not nearly as generous, and therefore our rate of return, and so on, is, shall we say, much more factual than other matters in this regard.

ROBERT E. CAMPBELL, MLA: Mr. Brennan, in the last few days we have been hearing about all the money that Maritime Electric has made in the last few months and in the last year. Now I'll ask you two questions in one. Is there any way that Public Utilities can cut them back now, on the electricity rate, or if they came up in another month and asked for the raise, would you grant it?

MR. BRENNAN: Well, answering the last question first: There is no way that we would grant a raise, an increase in rates, if the company is making an amount of money equivalent to what we have allowed them. We have allowed them a 9-1/4 to 10% rate of return on their earning space. If they are operating within that range there's no way they would be allowed a rate increase. Now getting back to the first part of the question: As we are well aware, the provincial government and the utility at this time are going through an extremely costly interconnection with the mainland. The government is required to raise a certain amount of money for this. Now when you see the figures such as are out and indicated on the balance sheet of Maritime Electric Company Limited at this point, the crux of the thing is this: that they are purposely taking certain figures and using rates of depreciation allowed by the Federal Government to show the best possible balance sheet that they can to enable them to go to the public and get more money invested in their utility. Now, if you turned around and took those same figures that have been publicized for the issues of bonds, debentures, common shares, what have you, and applied them to the formula which we use as a consistent formula right straight across the board, this wouldn't look nearly so good.

MR. CAMPBELL: As you know, we are in inflation now, and prices are only supposed to go up 10 or 12%, but I understand in the last few months, and I can go by my own electric light bill, and those of the farmers and the fishermen through my district, who are all complaining to me, that there have been at least two jumps, and I would say that it's way over 10% or 12%. Now, is this supposed to be allowed or not?

MR. BRENNAN: Well, the answer to that is quite simple, you see. Where it is simply a matter of money going to retained earnings or profit, no, it's not allowed at all. But where it's a direct flow-through of costs, yes, it is allowed. And in every case in this utility business, both in Nova Scotia and Prince Edward Island, this is a direct flow-through of costs. It has nothing to do with the company making more money. On these increases that they get, there is not one jot nor tittle more money for the Company. That is simply to go to pay for oil.

MR. CAMPBELL: When we stop and think, and I have seen bills that have doubled, 50, 75 and 100%, there must be something wrong there, and I think this is the Public Utility's duty to look into this.

MR. BRENNAN: Now I would respectfully say that the matter is looked into very, very carefully. I would also point out that we are not alone in this realm, and I might say that we at the Commission do pay the same rates as everybody else. We are just as conscious of it, and I don't know in all sincerity any group who have paid more heed to the actual costs than we have over the years. There was a time, from 1951 to 1971, when we would review these things casually, and you'd get a review probably once every six months, and you'd have a rate decrease. Now that's one nice thing. With the situation the way it is now, and in the inflation period of costs, and signing wage agreements up to 31% and so on that all have to be taken in (and that went in just ahead of the controls, I might say, so the controls cannot be exerted on that one) - all these things ultimately hit one person, and that's the customer. Because if a utility had other sources of money it would be a completely delightful thing, and of course that's the situation that Nova Scotia finds itself in right now where they have been subsidizing their utility rates, and to very heavy degrees, as this province has here, with oil. Now these subsidies are rapidly coming to an end, and as they come to an end the person who is actually doing the consuming is the person who is actually going to have to pay the shot. None of us likes it, but I'm afraid that until somebody shows up with some extra money, it's not too good a picture. There's one thing that we will assure you, that the Company isn't going to get one shekel to which they are not entitled.

HON. T. EARLE HICKEY: Is it customary to set a rate that is in a range, like you said, between 9 and 10-1/4, and how do these rates compare with those of other utilities?

MR. BRENNAN: Very favourably, I might say, in answer to the second part of the question. With regard to the first part of the question, we in the last few years have gone to this range business because it's almost impossible to set a rate schedule that will provide an absolutely accurate rate of return, and we are most desirous of not having a company overearn; but likewise we don't want to have it so nearly on the head that as soon as they dropped below it, we would be confronted with another hearing, or as soon as it went over we would be confronted with trying to chop something off somewhere. Now this is not feasible in days of such tremendous costs.

MR. HICKEY: Well, do the hydro companies have to have an amount allowed there for profit as an ordinary company would?

MR. BRENNAN: Well, as you well know, sir, Ontario Hydro has actually recently been disallowed the right of setting its own rates, and a Commission similar to the Public Utilities Commission has been established in the Province of Ontario for the purpose of doing this for them.

MR. CAMPBELL: Mr. Brennan, how does Maritime Electric justify shares going from 87¢ to $1.40 - some cents? Now before you answer that question, I am going to ask you another one. I don't know whether it's the right place to ask you or not, but I have people coming to me everyday and saying that Public Utilities will not do anything to keep the price down on telephones and Maritime Electric because their committee members and their workers have shares in these two companies. Now I think this is a good place to clear this and to find out if this is right or wrong.

MR. BRENNAN: Well in the first place there's no one on the Public Utilities Commission who is allowed to have shares in these things at all. By legislation it is absolutely forbidden. The second thing is that in no way, shape or form am I before you to try to act as a financial expert, which I can assure you, my good sir,I am not. But I do know this, that when these shares of Maritime Electric came on the market, and I would like you to verify this with some of your later witnesses because they can give you the factual information, they came on at a price a way, way, way in excess of where they are now, and they have gone down very considerably. In fact, it is one of the very deplorable things facing the financing of a company like this, where the share value or the actual value of the shares issued are very substantially below the actual value of physical assets that are there. And this is one of the things which is really quite difficult. On the matter of how and why the price and the value of these shares is established, it's a realm that does not fall within our jurisdiction, and by the time we are done coping with the things that are within our jurisdiction, we don't have too much time to be looking into other matters. We do keep an extremely close eye on the rate of return, and the rate of return is to us a very accurate thing, whereas if you are going to start dealing in share value, return on shares, this can vary with the stock market from day to day, and we don't feel rates should be set on this basis.

HON. BRUCE STEWART: Mr. Brennan, the Bank of Canada rate at the present time, I believe, is 9-3/4%. It costs, I think, about 1/2% higher than that to get money which has been transferred to other banks, borrowed by the province. I am not justifying anything so far as rates are concerned for Maitime Electric, but I am wondering, even up to 9-1/4 to 10%, do you consider that attractive?

MR. BRENNAN: It is not attractive, and the only reason it's possible is because in reality if they go on the market today to sell shares or to sell bonds, they are going to have to pay what today's market requires, that is, something in excess of 11%. However, the fact that they have quite a lot of older capital in there at lesser rates is why we only consider the actual total cost of their total capital structure; that high cost of 11+% is diluted by the low cost of some of the debentures and issues that have gone out ahead of this.

MR. STEWART: The rate allowable as income by Maritime Electric is adjusted how often, and on what basis?

MR. BRENNAN: Well, it's adjusted now basically on a monthly basis and largely due to the cost of fuel. There has been a situation, as you are well aware, where we have three sources of energy in this province presently. One is the steam turbine plant here in Charlottetown which uses Bunker C oil; the other is the plant in Borden which uses diesel oil; and the third is the plant in Summerside from which energy is periodically purchased. Now, the lowest cost by far is the plant in Charlottetown. Then I'd say that the cost in Summerside is next, and then the cost in Borden; and although the question has not been asked, I think this is a proper place to perhaps give the answer. People have asked why a plant such as the one in Borden was allowed to be installed when the fuel costs for it are so high. And the reason for this was that at the time that the plant was designed, set up and constructed and for the first period of its use, it was used strictly as what's called a 'peaking plant'. That is, the plant in Charlottetown was used to supply the basic load, and when we hit our peak loads, which are between 4 o'clock in the afternoon and 8 o'clock in the evening for the months of December and January, then we needed a little shot in the arm to bring our energy requirement up to what was necessary. This was by far the most expedient way to get it at that time. I'd say it still is, for this reason: That if you put in a new turbine, a steam turbine down here you are going to pay in the vicinity of $6 to $7 million for it. And then you are going to have to pay interest so that investment for the rest of the time until it's paid out and fully depreciated. Whereas, by putting a gas turbine in up in Borden or such place as it might be located, why, you are putting in an investment that's basically less than a million dollars, which means a whole lot less money for financing, but you are paying more money for fuel.

MR. STEWART: That plant, as you say, is called a 'peaking plant', and that means that it cuts in when peak load is required?

MR. BRENNAN: Yes.

MR. STEWART: I suppose there are some figures as to what percentage of the amount of kilowatts used in the province are used in peak load situations. Is there some indication as to how many kilowatt hours we would need to cut back on Prince Edward Island in order to avoid this situation, as Mr. Wells was suggesting yesterday on radio. Do you have any idea, Mr. Brennan, as to how many dollars it took to supply peak load in Prince Edward Island last year?

MR. BRENNAN: Not off the cuff. This is a figure that would need a concentrated study, and if it's wanted, I would be delighted to supply it. I might say it's a figure that would not be able to be supplied too readily. It's a figure where a study is going to have to be made, and practically on a daily basis.

MR. WELLS: I might say that the figures that we have are that in 1974 in Borden the fuel costs alone were just under a million dollars.

MR. STEWART: That's at Borden Plant?

MR. WELLS: Yes. And the total was $6.4 million for all.

MR. HICKEY: You didn't say this, Mr. Brennan, but I presume that before Borden goes on to take care of the peak, both Charlottetown and Summerside are 100% utilized.

MR. BRENNAN: Not always, Mr. Hickey, for this reason. The plant in Summerside has to be manned, whereas the plant in Borden just takes the push of a button, so if you bring a man on then you have got to be prepared to keep him on for so long. If it's going to be a continuing thing, then it would be one way, if it's going to be an intermittent thing then it would be the other way.

MR. HICKEY: Well, in January and December is it intermittent?

MR. BRENNAN: No, particularly at this point in time where normally if the cable were not going in, the utility would have been in the process of installing another heavy steam turbine; but because the cable is going in, we are running ourselves down pretty close with regard to our capacity.

MR. HICKEY: My question is really, are they doing it the most economical way?

MR. BRENNAN: We know of no better way. In fact, it's both the most economical and the most extravagant, because it's the only way.

MR. WELLS: I would like to give you another angle on your question. In 1974, 5.7% of our electrical energy needs in the province were supplied from Borden.

HON. GILBERT R. CLEMENTS: Mr. Brennan, a suggestion was made yesterday that there would be some advantage in having off-peak hot water, domestic hot water heating, done; and my question is: with an oil fired operation such as we have in Prince Edward Island, would you see any advantage in having an off-peak special rate for the heating of domestic hot water or any of the other high consumptions of electricity?

MR. BRENNAN: I would like to reply to that question this way. That in the middle sixties we did a very intensive study on this, and we have worked on the basis here that, being the small group we are, we can't afford to experiment too much. It's too costly. And therefore we've made a very, very heavy endeavour to profit by other people's experience. We have checked this out with other utilities and I might say that in doing this study it was sufficiently complicated that we didn't feel we ever came up with a really yes or no answer. But in the meantime, along came this item called 'total electrical', and I need not tell you that in this province one of the things that causes the heaviest and the strongest part of our cost structure is the fact that we have such a terrible differential between our peak loads and our base loads. The base loads in this province are at a terribly low level, and yet insofar as time and money is concerned, the same number of dollars have to be paid for that equipment in your base load period as in your peak load period, as far as financing is concerned. The principal difference, of course, is the cost of fuel. When we got into that question, not of electric heat but total electrical, we actually took over from the study that we were doing on the electrical hot water heating rate. It resulted in the fact that, although the utility was in no way impressed with this deal, we did decide that it would be of considerable assistance to our base load. And we figured the base load was the thing that most needed attention. Therefore, a rate was put in to provide for this. I might say it's worked out better than any other single thing with regard to the base load aspect of our electrical load in the province.

MR. CLEMENTS: That's the reduction for 100% electric?

MR. BRENNAN: Yes. You see, we didn't give customers a reduction because they were using the power. We gave them a reduction because they were using the power when nobody else was using it to a very heavy extent, because your electric heat is on and off all night, which very few other things in this province are. We don't have night industry, we don't have anything like that, and therefore anything that ups your night load is of tremendous benefit.

MR. CLEMENTS: But it doesn't lower the daytime load because it's on and off in the daytime, as much as it is at night, and in fact if we go ahead with some of our suggestions you would be turning it up in the day and down at night. And my question once again: is there any advantage as far as the utility burning oil is concerned in having a high user on at night rather than on in the daytime?

MR. BRENNAN: Yes, but accepting the question as it is, if we could get them on at night, that would be ideal. But can you imagine the amount of water storage a person would have to have, because most electric tanks are called Cascade 40's. Now if a person is prepared to go to a heavy capital cost and go into this matter, - I think Sweden is the country where they have probably the best use of electric energy of any place I've seen. You don't pay for it on the kilowatt hour basis, you pay for it on a cut out relay. Let's say a person takes one kilowatt, he can pull a kilowatt continuously. Now certainly if you could get people to put in a facility where they could store enough hot water for the daytime and heat it at night, that would be ideal, and that would be a very definite benefit; but it would require the particular individual doing it to make quite a capital outlay because he would have to put in a large, well insulated storage tank - 40 gallons wouldn't take the average household very far.

MR. CLEMENTS: But I can't see yet what the advantage would be when the cost of oil is the same at night as it is in the daytime and your plant is not operating to full capacity during the daylight hours, so where's the saving by doing it at night over daylight?

MR. BRENNAN: Well, the answer to that I think is this: that insofar as the cost of oil is concerned, there's no difference, but insofar as the cost of your carrying your capital structure, there's a total difference, because you've got to carry the capital structure just as well as the oil.

MR. CLEMENTS: That's right, you are carrying it anyway whether you are using it or not.
MR. WELLS: But you are not cutting into the expensive Bordon plant.
MR. CLEMENTS: No, but I say if your plant is not running to full capacity.....
HON. JOHN H. MALONEY, MD: Well, you are flattening out your curve and you won't need as much capacity to get the same number of kilowatt hours in a year; that's what it comes to, isn't it?
MR. BRENNAN: Relative to that, too, another very interesting point comes up here that gets back to this matter of electric heat again. There's no doubt about it that insofar as the average individual who is paying for it is concerned, it's more costly than other forms of heat. But insofar as the province is concerned, I think there is a totally different aspect here. This is because when you are heating, as most of us do, with oil heat, you are buying a fairly high cost commodity; that is, furnace fuel oil; but when you are heating with electric heat the individual is paying more, but the money leaving the province is substantially less for the same number of BTU coming out of a gallon of Bunker C oil.
MR. WELLS: But Mr. Brennan, the efficiencies are quite different between Maritime Electric burning oil, and burning oil in your home, surely?
MR. BRENNAN: I was saying insofar as the economy of the province is concerned and ignoring that of the individual.
MR. WELLS: No, but you must look at the efficiencies too. There may be more BTU in the oil that Maritime Electric gets than the oil that we take in the home, but when you have efficiencies of 22% as compared to efficiencies of 70%, which are possible there's quite a difference.
MR. BRENNAN: Well, if you want to get the rating on these boilers you can get them from CSA and I can assure you that some of these figures I think need looking into, because we've had checks done on boilers by CSA, who I believe are about the outstanding people in Canada on this, and their ratings are extremely poor on some and extremely good on others, and I'd hesitate to get into trade names now.
MR. WELLS: Mr. Brennan, we are getting into areas more and more it seems that properly belong in the hands of Maritime Electric. We want to bring them on next, and we are running a little behind schedule now, so perhaps if there are any more questions relating specifically to Mr. Brennan's responsibility, he will be here, as well, all through the morning....
JAMES M. LEE: I would like to ask you a question about the trucking industry, which you mentioned earlier. You made reference to the fact that due to controls and regulations which the trucking industry now has to live with, they, you might as well say, are being controlled out of existence, and more and more truckers have been selling out year after year. I wonder if you can tell us what some of these controls are and where do you see the major problem with the trucking industry, in order for it to survive?

MR. BRENNAN: Well, sir, the manner in which I put it - I said that I thought that it should be a matter of investigation and I really do. I'll just name a few controls, starting at the federal level (practically all of our truckers are inter-provincial, and therefore have to operate under federal legislation). They are under all of these various things such as the Unemployment Insurance Commission, the Workmen's Compensation and umpteen things out of the federal Department of Transport. They are under the Public Utilities Commission; they are under the Registrar of Motor Vehicles. If you do a real examination, I think they are required to make more reports and returns than any other single group, both on a federal and provincial basis. And small operators just have not got, in some cases, the competency, and in other cases, the time, to do these things and still carry on business. You see they have to comply with requirements of each of the jurisdictions in which they travel. As so much of our trade is with the United States, they have to comply with the Interstate Commerce Commission and each of the motor carrier tribunals in each of the states through which they travel. We have yet to see one Island trucker get a license to travel into Quebec in less than 18 months to two years; and that, to my mind, is obstruction.

MR. LEE: What, Mr. Brennan, are you doing as Public Utilities Commission to assist the truckers of Prince Edward Island to lighten the burden of some of these regulations and controls?

MR. BRENNAN: Well, that's a good question. And I've got to say that in all honesty we do not have legislative authority to do it. However, I will say this, that in the past, yes, we've helped our truckers. We've helped our truckers by going and actually calling on the areas of trouble and in many cases resolving them; in some cases not. But one of our biggest problems years ago when we first took over the business was that some of our truckers were classified as bandits. Now, since control has been taken over we are having no more problem at all in that regard because in those days people who actually had problems with our truckers had to contact them directly. Now there's none of that. All of that is done directly through the Commission and we straighten it out for them when these people are committing minor offences in other areas. All they've got to do is either give us a phone call or drop us a letter and the matter is straightened out, and this has done more than any other thing to give our truckers a good name in other areas which they didn't have before. We had terrible time in years past getting fresh lobsters down to certain areas of the States. Now that problem no longer exists.

MR. VERNON MCINTYRE, MLA: I wonder, Mr. Brennan, if we could refer briefly to electricity just for a moment again. You mentioned earlier extensive storm damage back some years ago: Is this written off annually or are we still paying for this, and does this come under your jurisdiction at all?

MR. BRENNAN: The manner in which it is accounted for rests strictly with the Provincial Treasurer and the department under which that was carried out. Insofar as we were concerned, at no time did we have anything to do with the money in any way, shape or form. In fact, at the time we took it on we made that a requirement that we would not handle the money. We would handle every other phase of it, which we did. When the situation was over, at the end of the period of reconstruction after the storm, the books were all finished.

MR. MCINTYRE: How feasible is an electric power cable to the mainland, in your opinion, in this part of the country?

MR. BRENNAN: As the cable was originally conceived it would have been no problem at all. The cable was originally conceived as coming across the causeway. At the time the idea of a causeway was abandoned, Ernie Weeks of the Atlantic Development Board and some of us got together and went to work this out. We were very skeptical as to just how this should be done, so ultimately the study was done in Ottawa by the National Energy Board, which indicated that a cable was not the thing at that time, but that a cable would be the thing at just about this point in time. Now there were several conditions on laying the cable. One was that the cable must not take the shortest route, from Sea Cow Head to Cape Tormentine, because that's the area in which ships are very prone to drag their anchors in case of heavy blows and storms and when they get caught in ice fields. So that is why the cable was relocated quite a bit up above that area, and although it makes for a longer cable, it makes for a much more safe cable. The second precaution is to heavily trench the cable.

MR. WELLS: I hesitate to interrupt again, Mr. Brennan, but if you keep on, we won't need to call any other witness today.

MR. BRENNAN: I'll shut up anytime.

MR. CAMPBELL: Mr. Brennan, I think that you should get together with the Government. If you think it's not the right thing and the Government thinks it is ....

MR. BRENNAN: I said it wasn't in the past, I said it is now.

MR. CAMPBELL: It is now, but it shouldn't have gone the short way, and it has gone the short way.

MR. BRENNAN: No, it didn't. It's properly located.

MR. WELLS: If we have time this morning, we have appearing before us somebody who has been intimately involved with the cable. So if you have no more questions relating specifically .....

EDWARD CLARK, MLA: Now our rates encourage us to use more electricity, because the more you use the cheaper it is. Is this the same for industry, such as shopping malls, and is the Public Utilities Commission looking at this to change it?

MR. BRENNAN: I won't agree that that's quite so. There are two factors in a rate structure. One is the service charge, and theoretically if the service charge were properly set, (now this is theory, it doesn't work this way) then let's say you had a complete electric utility sitting there without one wheel turning or one bit of power coming out on the line, the service charge theoretically should be able to carry the complete structure of that thing and then when you start turning the wheels and putting the oil in and covering the operating costs, then that should be your energy charge. Now that would load the front end of that rate too heavily and not make it at all acceptable. So the theory is that you have a service charge at the top that is as near bearable as possible, you have an in-between rate where you get really some more service charge out of it, and then you have the bottom rate at which it actually is the cost of energy.

MR. CLARK: A householder will pay more and industry and shopping malls will pay less because they will be getting a cheaper rate.

MR. BRENNAN: Well, the answer to that, I think, is this that we have so very, very few large customers that if you increased their rate sufficiently to be worthwhile at all to the many, many small customers, the top rates would be prohibitive.

MR. CAMPBELL: Don't you think that the farmers and fishermen should be paying a lower rate?

MR. BRENNAN: They are quite a bit lower.

MR. CAMPBELL: Oh, come on now, come on now. A farmer paying $120 and $130 dollars a month is paying a lower rate.

MR. BRENNAN: Well, if you want the answer, I'll give it to you, sir.

MR. CAMPBELL: Well, you give me the answer, and give it to me straight.

MR. BRENNAN: All right. I'll tell you the answer very quickly. You can service people in town here for a whole lot less than you can service the people in the rural areas, since in town you can get up to 40 customers on one transformer, and therefore you are only having the loss of one transformer, and you are able to supply that energy at substantially less cost. In the rural areas you have to have a separate transformer practically for every individual customer. Now in the western part of the province the service charge used to be over twice as high as it was for the rest of the province. One of the rate decreases that I referred to earlier is that the service charge rate in the western part of the province was made the same as all the rest of the province. And that is why, if rates were put out on a real cost basis, the people in the rural areas would be paying very, very substantially more than the people in the city would.

MR. CAMPBELL: I have two more questions to ask you, Mr. Brennan, and then I'm going to leave you alone. What is the cable mileage?

MR. BRENNAN: That is not one of my questions, sir.

MR. CAMPBELL: It's not, OK; and how do you justify $70 million for the cable?

MR. BRENNAN: I don't. I have nothing to do with it.

DAVID FORD, MLA: Do you think the power cable will cut the rates to the consumer when it is hooked into the power grid?

MR. BRENNAN: I do not think that we will see any rate decreases as a result of the cable, but I do think that we will put a very substantial brake on any rate increases.
Thank you, gentlemen.

MR. WELLS: I would now like to call on representatives from Maritime Electric Company Limited to present to Members of the Legislature their role and responsibility in the generation of electricity. I believe Mr. Robert Smith, President of Maritime Electric, is going to lead off.

The Role of Maritime Electric

MR. ROBERT SMITH: Mr. Speaker, Members of the Legislature, I am very glad that Mr. Brennan answered all our questions. I will try to cover part of the generation situation, the operations of Maritime Electric,

Mr. Smith (continued):

and I will be followed by Mr. John Reynolds who is Assistant General Manager in charge of operations for Maritime Electric. He will deal with some of the more technical aspects of the problem.

Now what do you say in a few minutes on generation of electricity? First, a brief summary of Maritime Electric. It's a privately owned company, with its head office in Charlottetown. The Company started business in Prince Edward Island in 1918; it was privately owned at that time, by an American company, actually. In 1935, it became Canadian-owned. It went public about 1964 and now has some 745 shareholders, of which 234 are in Prince Edward Island, and 510 are in the Atlantic Provinces. The remaining shareholders are in other parts of Canada, with a few in the United States. I am going to take this opportunity to try to correct some misconceptions. We hear very often that our parent company is so and so. We have no parent company. Maritime Electric is not owned by any other company. Montreal Engineering is the company I am referring to as being accused of owning us. The Montreal Engineering Company does not own any common shares in Maritime Electric. We are not a subsidy of Montreal Engineering in any way. The relationship is one of client and consultant. This relationship has been going on for some 40 years, and it's a quite close relationship, but there is no ownership either way. Now, Maritime Electric supplies 100% of the elctricity in Prince Edward Island. The system is isolated. It has no interconnection with any other system at the present time, so it must provide all the generation required by customers. The Company operates under the Electric Power and Telephone Act and the Public Utilities Act, as referred to by Mr. Brennan. These Acts specify certain things the Company must do, and the Public Utilities Commission is responsible for seeing that they are done. We must make an Annual Report to the Commission every year of our financial picture. Since our latest rate change in September, 1975, we have to make a report monthly to them. I want to stress that the Company under the Electric Power and Telephone Act is required to supply electricity required by the residents of this province. The customers determine the demand, and the Company is responsible for supplying it. The Company personnel can and do make recommendations and advise customers that they shouldn't do this, shouldn't use electricity for such and such a thing, but the customers make the final decision. Some take our recommendations and some don't. Sometimes they say, "I am glad I took your recommendation", and sometimes they say, "I wish I had". One example: some farmers use electric heat in areas of the barn for young animals because they consider it safer - less of a fire hazard than oil. This is probably an inefficient way of using electricity, but the farmer feels it's safer, and he feels he has a valid reason for using it. Now, in addition to supplying the demand for electricity, Maritime Electric must have some reserve generating capacity. We must have Public Utilities Commission approval for capital expenditures and for any rate changes, both increases and decreases. They also approve our general regulations. The Company has worked on a policy for many years that there must be generating capacity available in the province to supply 90% of the peak

Mr. Smith (continued):

load if the largest generating unit is out of service. The total generating capacity in the province is about 115,000 kilowatts, including Charlottetown, Borden and Summerside. The maximum load in 1975 was 88,400 kilowatts. So we must be able to supply 90% of that, or about 80,000 kilowatts without our largest generating unit, which is 25,000 kilowatts. This results in approximately 30% reserve generating capacity that we have to carry in 1975. That's much higher than if we were interconnected with any other system. In fact, after the cable is installed this fall, the reserve can drop to 20%; this is by agreement with New Brunswick. And this will be a saving in capital in the future. We will not have to install additional generation as soon as we would otherwise. This is one of the benefits of interconnection and is called 'reserve sharing'. It's not a benefit that you achieve immediately; it develops and builds up over a period. Now we have some slides here.

The first slide shows the reserve carried in recent years (see Figure 28). You will see a sawtooth type of curve there and you will see that in some years we have carried a very high reserve. For instance, in 1963, it went as high as 100%, and that was used up and we went down to 1967, when it dropped to about 26, 27%. Then we have to add more generation and it goes up to 58%, then down, up and so on. Each of those peaks represents additional generation and it drops down in subsequent years to reach the point where our reserve is such that to maintain our criterion of 90% we have to add more generation. So we are never below 25% there, and most of the time well above that. Now with interconnection we can maintain this at around 20%, and if necessary, we can purchase reserve capacity from our interconnection partner. I think we can do this for a few years until it's economical to install a reasonable-sized generating unit on the Island, if this is to be done, and then part of that capacity can be sold, made available to the other partner. This is one of the ways that you can make use of your interconnections.

The next slide shows the average annual residential use (see Figure 29). The top curve shows the average of domestic, farm, and rural customer use in the whole of Canada. That figure actually ends in 1963 but it continues at about the same rate or a little bit lower into the next two years. The other two curves are Maritime Electric. Curve 2 is City Residential, and Curve 3, the dotted line, is our Rural Residential, which corresponds to Curve 1. Now if you look at 1974, you will see that the average farm use in Canada is about 8200 kilowatt hours per year. The Prince Edward Island farm average is 5200 kilowatt hours per year. There is a difference of some 3000 kilowatt hours, or an average of 250 kilowatt hours a month. Now we are supposed to be conserving here. We are asking our customers to conserve. I wonder what the difference is between our use and the average Canadian use. Is that necessary use? Should the other customers in Canada be conserving down to where we are or below? Is this a frivolous, wasteful use? I don't know what the answer is - maybe somebody does. But when we talk conservation here we are already starting way below the average in Canada. You will see that the rural use

PERCENT RESERVE CAPACITY

INSTALLED CAPACITY - PEAK
Annual Peak

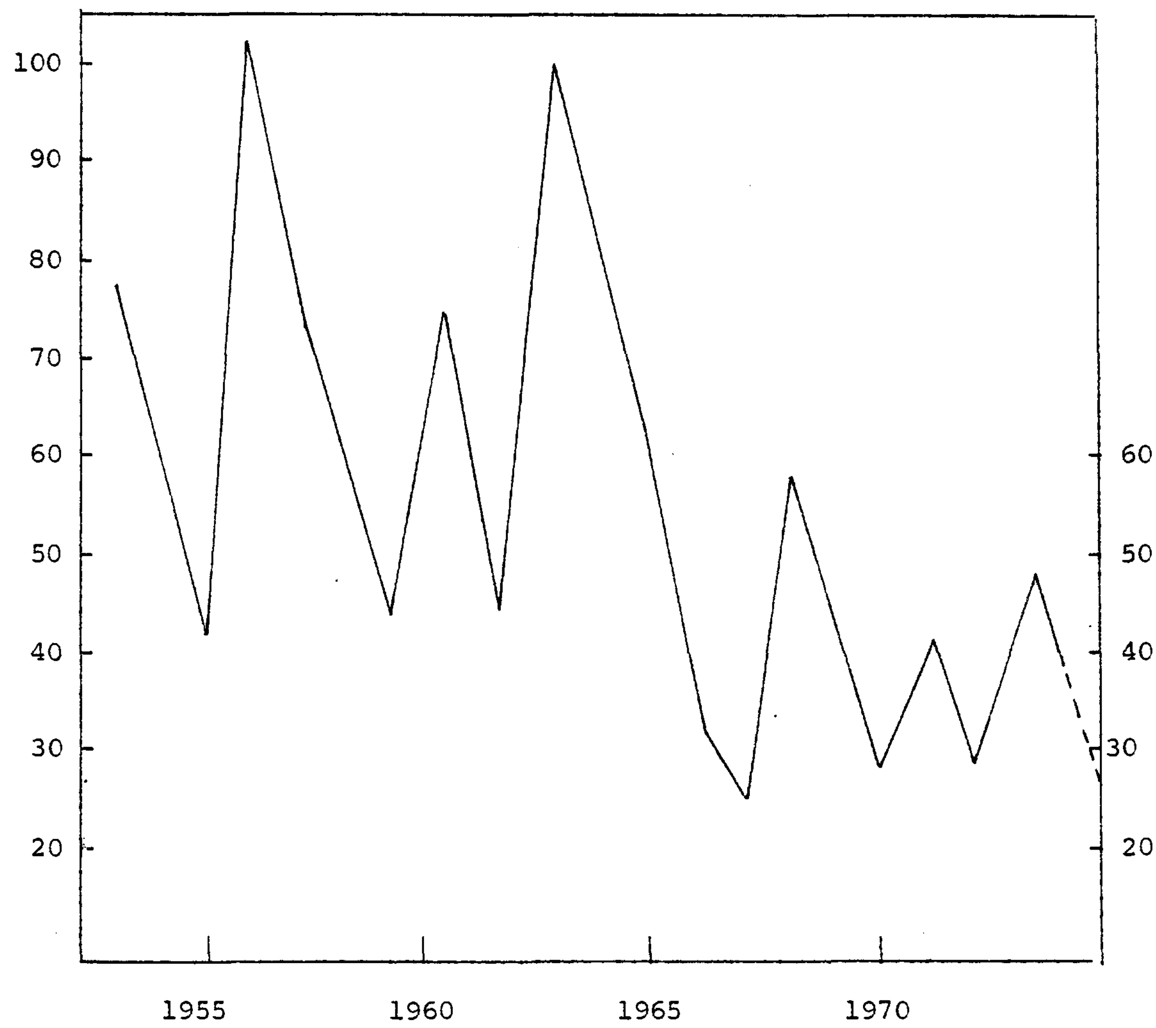
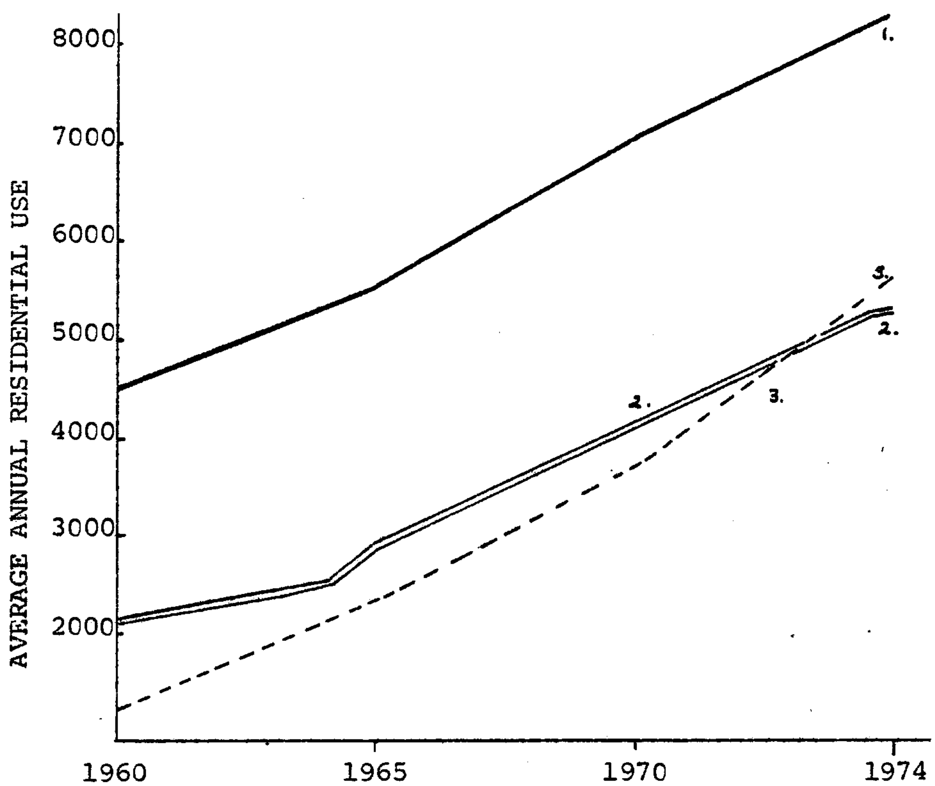


FIGURE 28

MARITIME ELECTRIC CO. LTD.

AVERAGE ANNUAL KILOWATT-HOUR CONSUMPTION PER CUSTOMER
DOMESTIC & FARM SERVICE



1. Domestic and Farm - Statistics Canada
2. City Residential - Maritime Electric
3. Rural Residential - Maritime Electric

FIGURE 29

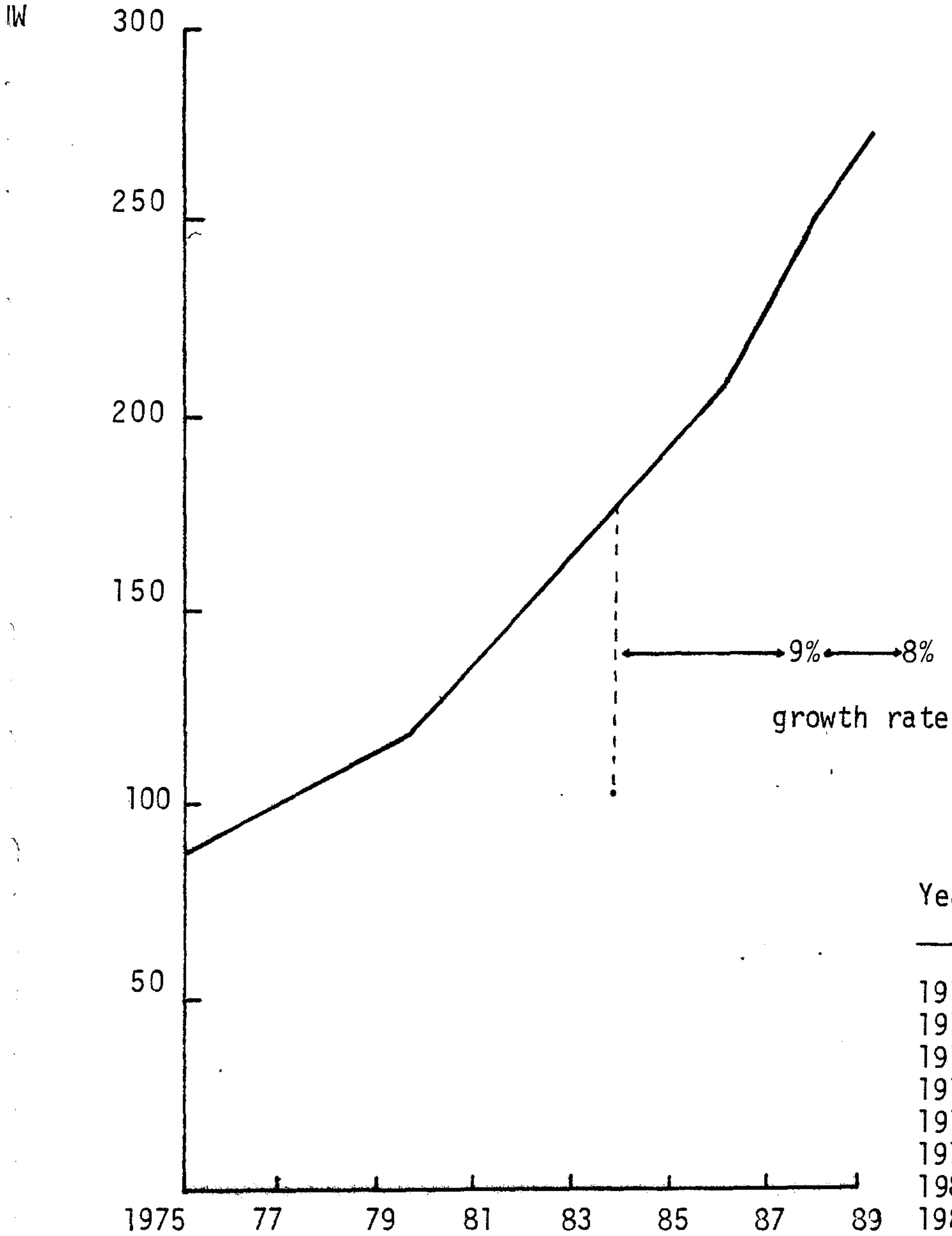
Mr. Smith (continued):

has increased more rapidly than the city residential use and this is continuing, as farmers use more and more electricity in their farm operations. The next slide shows a projected load schedule on a reduced growth rate (see Figure 30). The growth rate in Prince Edward Island for many years was 12, 14 as high as 17% a year in the late sixties and very early seventies. Now with the increased cost of oil and conservation, along with concerns over the availability of fuel, the growth rate has dropped so that now it's in the order of 10%. In 1974, it was actually 79,200 kilowatts. In 1975, we estimated it would be 86,700 kilowatts - 86.7 megawatts - actually it turned out to be 88.4. Last year we estimated in 1976 it would be 94,500 kilowatts, a growth of 9%; now what it is going to be we will have to wait to find out. But unless there is more conservation than there was last year, it is going to be more than the 94.5 megawatts and so on - you can look ahead there. This peak figure is usually the demand on the system some night the week before Christmas. That's the heaviest load period as a rule, and the demand is very sensitive to weather. If we get a cold, windy night in the week before Christmas or during Christmas and New Year's that will raise the peak between 1,000 and 2,000 kilowatts. The Island homes apparently are very sensitive to wind, and extra heating is required, whether it's supplementary heating, additional furnace use or whatever. If we have a very mild December, we will have a low peak which appears as a low growth rate. The next year we may have a very cold December and our growth rate is much higher. So the growth rate figures from year to year are presenting quite a variation. But last year we estimated that we would grow at the rate of 9% starting in 1976, and 8% in 1984. These were just estimates; they are revised each year. We now have a different figure starting with 1975 and an actual of 88.4 megawatts, but this is revised continually and always subject to change, and if our conservation efforts are successful, we may get back to the 94 megawatts this year, and subsequent years lower than that - time will tell.

PREMIER ALEX B. CAMPBELL: Mr. Smith, would you return to that chart for a moment, please? I think that one of the very fundamental and basic propositions has to do with the potential growth in demand for electricity in our province over the next little while, and this chart, if I have analyzed your figures correctly, indicates that if we continue in the present trend over the next eight years, we will have increased electrical use by as much as we have during the past 50 years. In other words, I see by your chart that from 1976 to 1984 we are up at the 186 megawatt value, so in the next eight years we will increase demand by some 94,000 kilowatts. We will double it.

MR. SMITH: That's what these indicate, and that's our prediction based on what we felt last year would be a reduced growth rate. If we had been doing this five years ago, we would have predicted a doubling in about six or seven years, so the growth rate has dropped from 12, 14% down to 9-10%, so we are going in the right direction.

PROJECTED LOAD SCHEDULE ON REDUCED GROWTH RATE



Year	Growth Rate %	Growth Generation peak MW (MVA)
1974	Actual	79.2 (90)
1975	9.5%	86.7 (98.5)
1976	9.0%	94.5 (107.4)
1977	9.0%	103.0 (117.0)
1978	9.0%	112.3 (127.6)
1979	9.0%	122.4 (139.1)
1980	9.0%	133.4 (151.6)
1981	9.0%	145.4 (165.2)
1982	9.0%	158.5 (180.1)
1983	9.0%	172.7 (196.3)
1984	8.0%	186.6 (212.0)
1985	8.0%	201.5 (229.0)
1986	8.0%	217.6 (247.3)
1987	8.0%	235.0 (267.0)
1988	8.0%	253.8 (288.4)
1989	8.0%	274.1 (311.5)

FIGURE 30

But there's a lot more that can be done and you are quite right there, sir, that based on these figures the demand will double in about eight years. Now, cut down use, that's what's going to happen; if we do, then those figures can be lowered. But the utility, in order to be able to supply the demand, has to look into the future and be prepared one way or another, through cable interconnections, negotiations with the interconnection partner, or in some other way, to meet the load that's expected.

PREMIER CAMPBELL: Now your basic mandate as a public utility is to answer the demand by the public for electricity, so that when they call for it in their appliances, in homes and industries, you have the power to deliver. Can you give us some estimate as to how much capital investment will be required by your utility to double your generating capacity in the next eight years?

MR. SMITH: Well, with the interconnection we probably won't double it - we'll make use of other ways of getting part of it. If we had to double it, if we had to add roughly 100,000 kilowatts, it would be done over a period in two or three steps but it might be ....

PREMIER CAMPBELL: I guess over a $150 million in the next eight years.

MR. SMITH: There wouldn't be much left of that, and in addition to generating capacity it goes all the way down to the customer. There's transmission, distribution, sub-transmission and so on, so that you are talking about a lot of money.

PREMIER CAMPBELL: Well, I think this is the whole proposition - that if nothing is done on the consumer's side, including government as a consumer, and if the demand continues to increase on your facility, somewhere in the eastern Canadian grid $150 million of capital must be invested to assure generating capability to meet the increasing demand. We are talking about alternatives such as shortening and lessening that demand. Now as a company, do you see other opportunities to decrease your business as the public utility, to encourage people to become less dependent on the public utility?

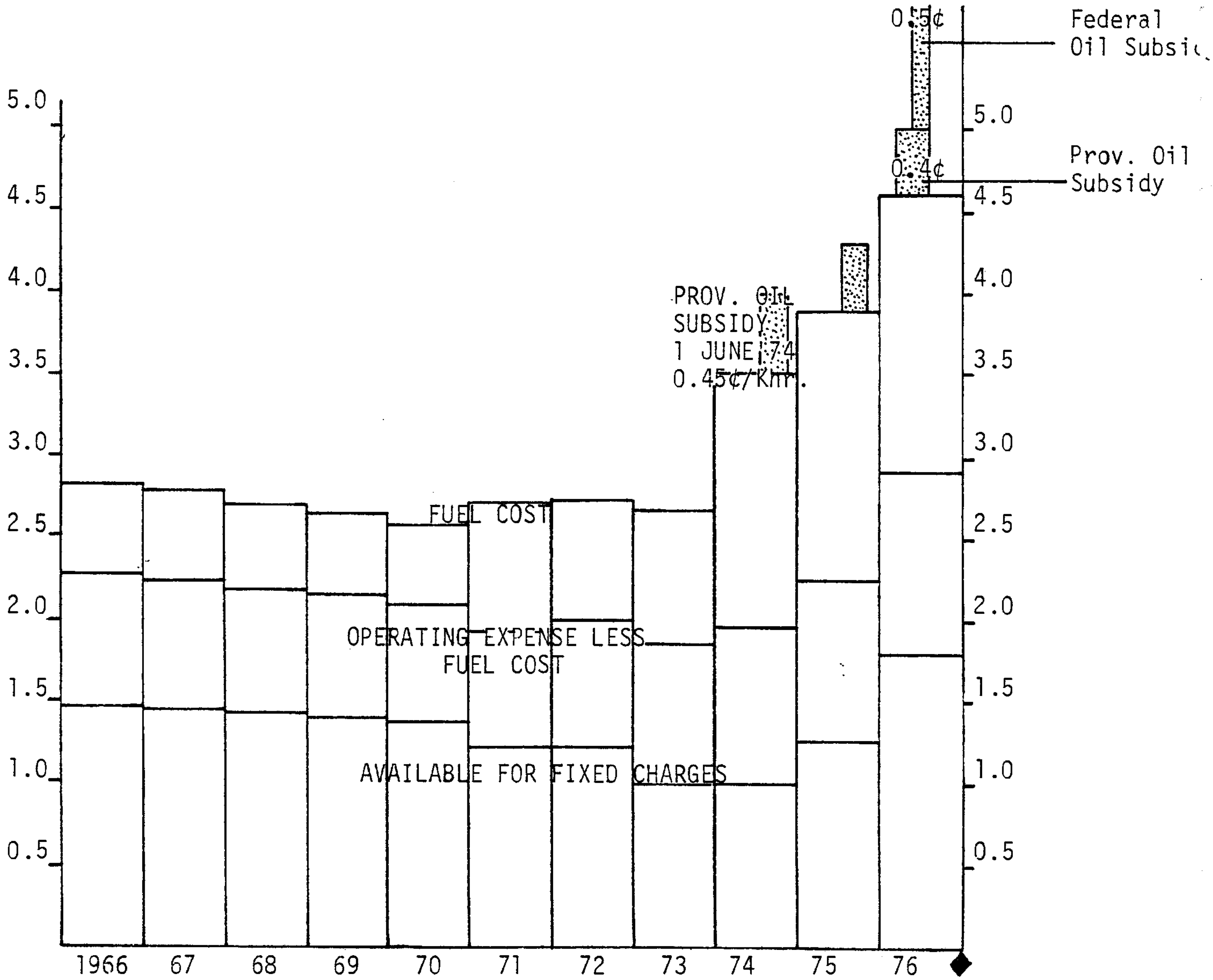
MR. SMITH: There are many things that can be done to become less dependent on a public utility. And there are many things that can be done in homes and in offices and so on to lessen the requirements on the public utility. There are alternate forms of energy, which, I believe, are going to be discussed here in the next couple of weeks. Some of these could lessen the requirements for the more or less conventional type of generation. The back page of the Guardian this morning had some excellent suggestions on conserving energy. If each householder examined his own use, talked to his wife very plainly, I'm sure that large reductions could be made in both demand and energy use. But this follows up what was said yesterday by one of the speakers, that in Canada if the demand for energy goes on the same as it is at the present time, the cost will be in the billions. Well, just reducing this down to electricity in Prince Edward Island, the cost is in the order of $150, $200 million.

MR. MCQUAID: That possible increase of doubling your demand, Mr. Smith, with a resultant capital expenditure of $150 million: if the demand doubled, does that mean that your operating profit doubles too?

MR. SMITH: No, not necessarily.
MR. MCQUAID: What prevents it?
MR. SMITH: Well, to go back to Mr. Brennan's discussion this morning on greater return on investment: If we had much higher investments, we would have to have more dollars as 'so-called' profit, but the percentage would be no higher, assuming the same 9-1/4 to 10% range that we're allowed to earn on our investment. The number of dollars would be much higher because our business would be greater, but the percentage would be the same.
MR. MCQUAID: Would it necessarily then involve an increase in rates if the demand went up like that?
MR. SMITH: Not necessarily. It would depend on the cost of fuel, the cost of capital to build these new facilities, and many things. We are a bit at cross purposes here. One of the reasons for the high cost here is low use. If we had a higher load factor, in other words more use at the off-peak periods, the capital cost could be spread over; on the other hand, increased use would undoubtedly result in increased demand so we would have to install more capacity. So you're fighting one against the other.
PREMIER CAMPBELL: What do you feel the practicality is in substantially increasing generating capacity within Prince Edward Island and using cable to sell your surplus capacity during our low demand periods through the night and so on?
MR. SMITH: There are possibilities of doing that. It will come a little later to possible bulk generation options open to us.
PREMIER CAMPBELL: I am sorry to have interrupted you but this seems to be quite central to the whole discussion.
MR. SMITH: It's quite all right, sir, but just along that point: In our discussion with New Brunswick in recent years since we have been talking about cable with them, which goes back maybe 20 years off and on, they have said they would be very pleased to have us build generation at the Island end of the cable, and they would buy power from us to supply southeastern New Brunswick where they do not have any great amount of generation. In fact, all they have there is a gas turbine in the Moncton area. So they have said repeatedly that they would be prepared to buy from the Island if we had generation in Borden with a surplus.

The next slide is a bar chart, and this is one we've used in some of our dealings with the Commission (see Figure 31). It shows three components of our costs. The top one is fuel cost, and this covers each year from 1966 to 1975, with 1976 as an estimate. You'll see that the fuel cost part of the kilowatt hour cost was about the same until the beginning of 1971. It started to rise when we had our first oil increase, and it stayed about the same for three years, and then in 1974, there was a dramatic rise, which has continued and is still continuing. The little cross-hatched part on the top of the bar in 1974, 1975, 1976 represents the provincial oil subsidy. If it had not been paid, that bar would have been raised to the top of the cross-hatched part. In the 1976 estimate, the provincial oil subsidy is shown there for six months, and the upper or narrower part is the expected reduction in the federal oil subsidy, this is assumed to be a $2 reduction, or a $2 increase in the cost of oil which

MARITIME ELECTRIC CO. LTD. AVERAGE PER. UNIT REVENUE AND COST
(cents per kilowatt-hour sold)



	1966	67	68	69	70	71	72	73	74	75	76
FUEL	0.597	0.598	0.598	0.569	0.553	0.813	0.790	0.810	1.573	1.59	1.73
OP.	0.838	0.812	0.797	0.808	0.730	0.743	0.774	0.738	0.836	1.04	1.16
FINAL Ch.	1.368	1.350	1.329	1.303	1.299	1.187	1.188	1.090	1.087	1.28	1.80
REVENUE	2.803	2.760	2.724	2.680	2.582	2.743	2.752	2.638	3.496	3.91	4.69

◆ ESTIMATE

FIGURE 31

then is added to the fuel cost. The middle part of the chart is the operating expense. This is labour, maintenance, mostly labour costs, replacement parts and so on. There was a question a little while ago that someone asked - the percentage labour costs represent, I believe. Our labour costs now are running in the order of $2-3/4 million with a gross revenue expected this year of something like $19 million.

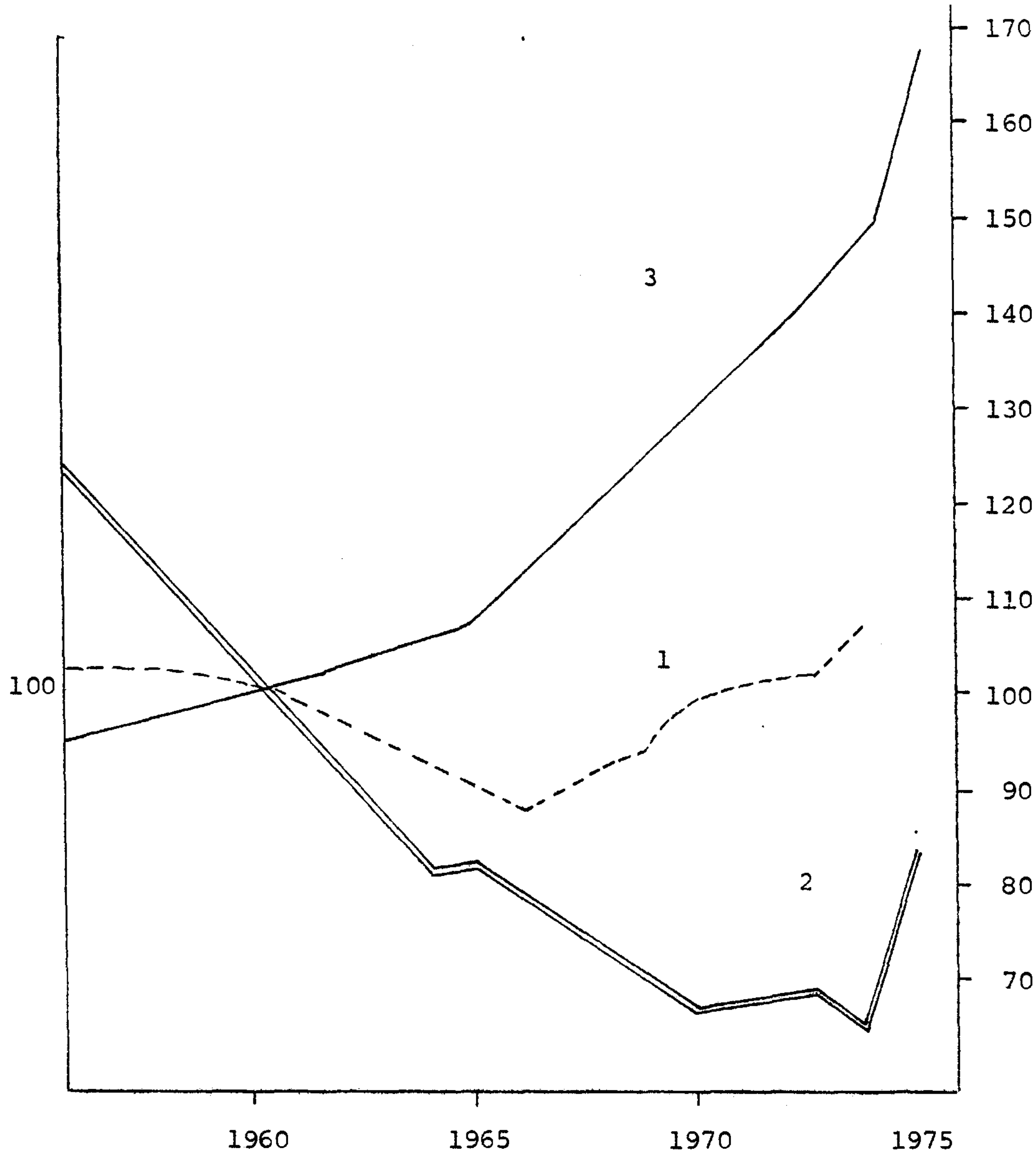
DR. MALONEY: What percentage is fuel of the total cost?

MR. SMITH: At the present time, assuming that the subsidies are still paid, fuel is about 37% of the total cost, and in 1966 it was 21%. The operating, that's the labour and maintenance and so on, in 1966, was 30%, and this year is estimated at 25%. Now the dollar amount of that has gone up, of course, but it is a lower percentage of the total cost. The bottom part is what's left over. It's referred to there as available for fixed charges, and it covers interest payments on bonds, payments to preferred shareholders, reinvested in the business, and federal income tax. That was 49% in 1966, and this year is estimated at 38%. You will see that was reasonably constant for three or four years, then it began dropping and got down to a low in 1973 and 1974. We were getting into a bad financial position then and were in danger of having our bond rating reduced; our rate increases in 1973 and 1974 were eaten up by inflation before they had any effect in giving relief. The increase in 1975 is evident there already, and we estimate further increases in this last part of the bar in 1976. In 1966, the prime bank interest rate was something like 7 or 8%; now it's over 10%, which partly accounts for the need for that increase. Bonds in 1966 were probably 7-3/4%; now they are over 11%.

The next slide is an index of revenue per kilowatt hour for domestic and farm service in Canada and in Prince Edward Island and also shows the consumer price index (see Figure 32). Curve 3, the consumer price index, is shown there at the top curve. These are all on the base of 1961 as 100, and remember they are indexes, and not actual rates - the consumer price index increased as we all know. The dotted line, Curve 1, is the revenue per kilowatt hour for domestic and farm service for Canada. That index decreased until 1966 and started an increase, and it is still increasing. The Curve 2, which is rural residential service, Prince Edward Island farm service, kept decreasing generally until 1973, and then started to increase and has continued to increase since that time. This Curve 2 bears up what Mr. Brennan mentioned - the decreases in rates that took effect in various times prior to the increase in the price of oil. The next curve is a typical daily load factor (see Figure 33). This is not Maritime Electric particularly. It was put in here to show a typical curve from any system. It starts off on the left hand side at midnight and load drops a little for an hour or two until everybody goes to bed. It reaches a minimum about two o'clock in the morning; it gradually increases about six o'clock in the morning, it's starting a more steep climb. During the morning, you see the peak climbing at a lower rate until noon. It drops off around 12 o'clock; we have an afternoon valley. It peaks again much more sharply at night, and then drops back again to the midnight, which corresponds to where we started.

MARITIME ELECTRIC COMPANY LIMITED

INDEX OF REVENUE PER KILOWATTHOUR DOMESTIC & FARM SERVICE
(1961 - 100)



1. Index of Revenue per Kwhr. - Domestic & Farm Service Canada
2. Index of Revenue per Kwhr. - Rural Residential Service P.E.I.
3. Consumer Price Index

Source: Statistics Canada, Electric Power Statistics, Vol. II, Table 8, 1939-1973.
Maritime Electric Co. Ltd. Statistics.

FIGURE 32

TYPICAL DAILY LOAD FACTOR

FIGURE 33

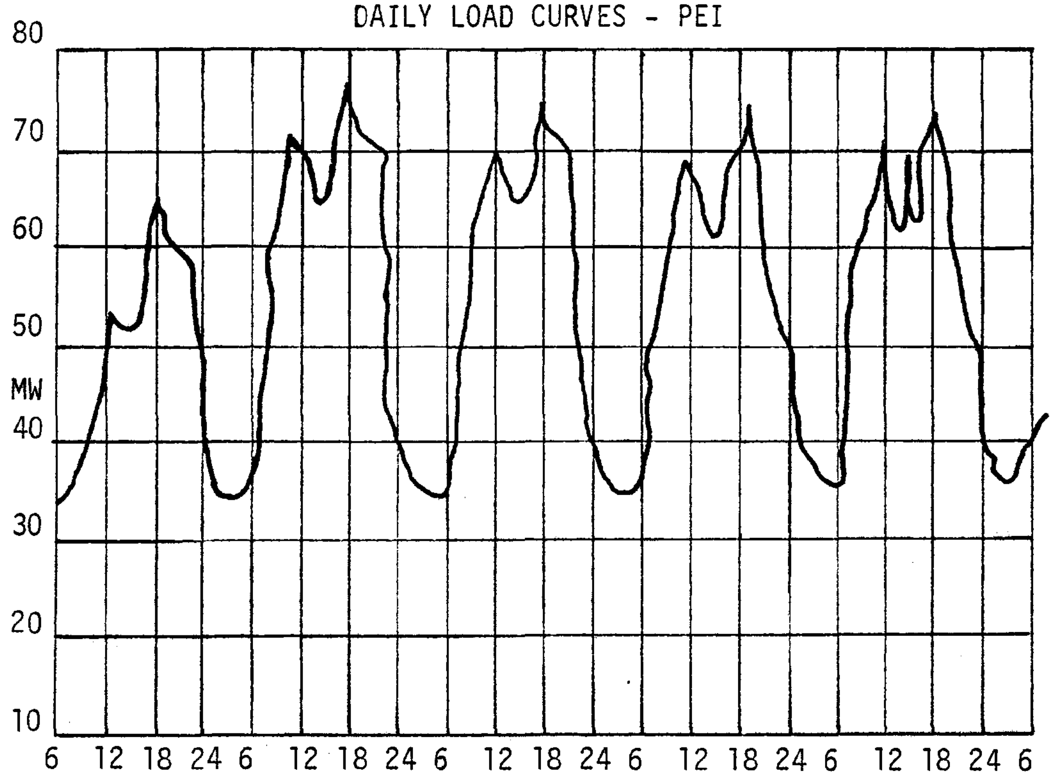
Mr. Smith (continued):

Now the next slide is typical daily load curves for Prince Edward Island (see Figure 34). The first one is a week in December, December 15-21, 1974, (and other years would be probably similar). Starting off at midnight the peak goes down until you reach something like five o'clock in the morning, then it starts to climb. We have a little peak at noon and a drop-off in the afternoon. The first day here is Sunday; it peaks again at about six o'clock and then drops off to the minimum again. The next day, Monday, we have a much sharper peak in the morning and at noon and a higher peak in the evening, and each day is roughly similar. Go down to the lower curves. This is a week in July, July 6-12, 1975. The pattern is similar for Sunday. The week days are different because the peak occurs at noon. Each of those days it occurs around 12 o'clock, so the situation changes - in the winter, we have a peak during the day. Those are fairly consistent throughout the different years for the different periods. If you took a curve sometime in the spring and the fall, you'd find that the winter and summer peaks were about the same. The next curve will show what happens to our demand requirements to meet some of these very sharp peaks in the winter, and what the effect is of the very low valleys occurring in the middle of the night. So if we could get rid of some of the peaks and fill up the valleys, we would have a better situation, making better use of our generating equipment. Those are what we call load duration curves, and the part of the curve that's solid represents the amount of time during the year that we have to supply a certain number of kilowatts. Our system is similar to the one on the left and we have to supply that sharp peak for only a very few hours in the year. Coming over to the right hand side at the top of the straight line, that is the number of kilowatt hours we have to supply every hour of the year, 8,760 hours. So that the higher we can get the right hand side and the lower we can get the left hand side, the better use we make of our capital investment. Now it's not quite as bad as that because we use that period towards the right hand side where the curve is low for maintenance of generating equipment, so that some of the equipment that is used for peaking may be run during those periods, and other base load equipment is serviced during that period. But the object of every utility is to get a load duration curve which has as low a peak on the left hand side and as high a line on the right hand side as practical. The last curve is really a repeat of the previous load growth (see Figure 30). This is on a logarithmic sheet and looks more like a straight line, but it's based on the same figures, and the same comments really apply as before.

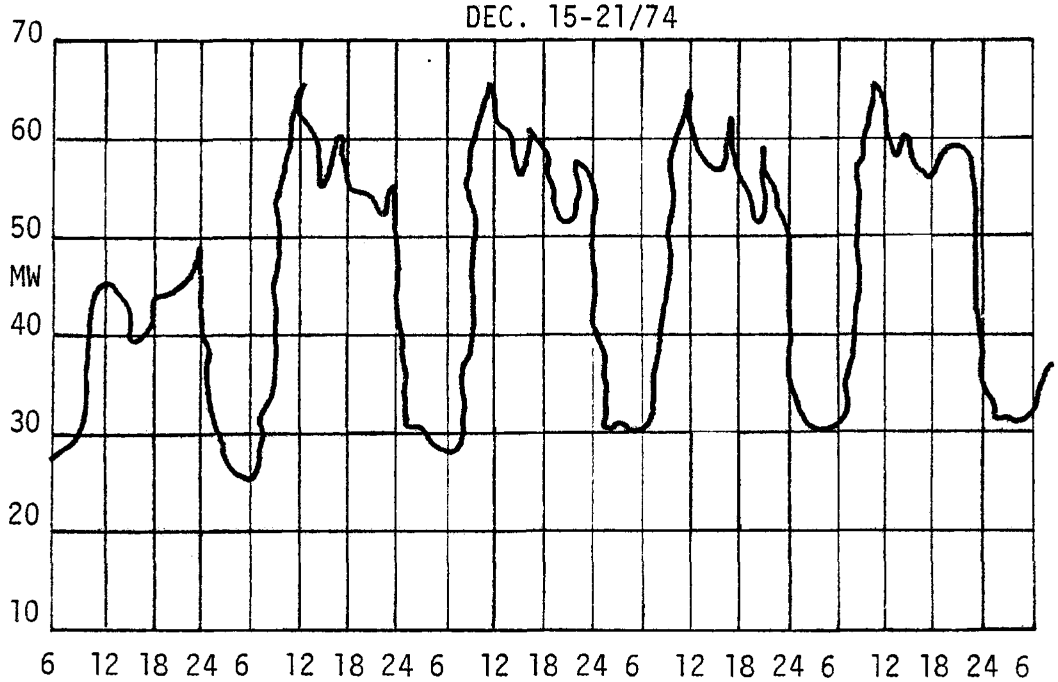
There are many things the customers can do to change their load patterns and change their lifestyle. People don't like to do this; they resist it. But when it comes down to their pocketbook, they are more inclined to look at it objectively. Some people in the province here are making a real effort to conserve electricity and to use it wisely. One man told me within the last two or three days that his light bill

MARITIME ELECTRIC COMPANY LIMITED

DAILY LOAD CURVES - PEI



DEC. 15-21/74



JULY 6-12/75

FIGURE 34

in the past 12 months was lower in dollars than in the previous 12 months because of conservation efforts, so his kilowatt hours must have been substantially fewer. This fellow had taken conservation seriously; he knew what he should be doing, and he went ahead and did it, and he saved himself some money and he saved some oil, too.

Other customers resist this - they just want to live the way they have always been living. You run into some very funny situations in this matter. One of the common ones is that the husband is complaining about the high bill, and "Will you go out to my house and see if something's wrong", so somebody goes out to his house to see what's wrong, and his wife says after he has gone to work, "There's nothing wrong - I know why the bill is high: because he has turned the thermostat down so low that I am cold, when he goes to work I plug in an electric heater, and I make sure it's unplugged when he comes back home, but don't you tell him. " I don't know how you get around that one.

Another situation: Somebody complains about a high bill, and he says, "No, I didn't do anything differently - I am living just the same as I was; I'm trying to conserve, trying to save energy. There must be something wrong; your meter must be wrong; there must be a leak or something wrong; you are not reading the meter right."...and so on and so on. So we check things and we spend a lot of time with him, and we finally say, "Well, you must be doing something different because we can't find anything wrong," and he said, "Well, yes, we do have a couple of heaters we put up in the bedroom upstairs, but they wouldn't use much. The fellow in the store said they wouldn't use much." And they go up and look at them and they find that they are both on, so this is 2,000 watts added to his load. And people use their ovens to heat their kitchens. I know one fellow had a fan set up in his oven to blow the heat out. This added to the efficiency - he was at least making an effort. But there are all kinds of things that people can do. Many people don't know what they can do; they need education; they need guidance; they need help; and I think there's a real opportunity here for someone to help these people just to live differently and to save some electricity and save some energy. This would apply to their heating as well as to their electrical use.

MR. STEWART: Mr. Smith, do you think that this sustained growth for a 15 year period might be optimistic?

MR. SMITH: I hope so.

MR. STEWART: Rural electrification has pretty well taken place now, and after that the growth factors would be based on the increase in population plus the added amount of energy that would be used by those of us who are presently here. Now one of the factors that caused the bulge, I believe, in the increase in demand was the rural electrification and the changing over to more demand in farming. Would it be reasonable to suspect that those things could be levelling off and the demand might not be that high?

MR. SMITH: Certainly rural electrification is practically levelled off to nothing. There is a little bit of rural electrification, but very little. We had something like 1,500 new customers last year which is an increase of some 4, 4-1/2%, which accounts for some of this increase.

MR. STEWART: Certainly the building of new homes will add to it.

MR. SMITH: That adds to it, and there have been a lot of new homes built in recent years.

MR. STEWART: And John Maloney's expansion of industry might be ....

MR. SMITH: When an industry turns up that adds 1,000 kilowatts to our load. This upsets a load curve right away but has other benefits. I hope this curve is optimistic, but looking at it realistically and planning for the future, I hope it's pessimistic, yes. What I mean is, I hope it's going to be lower than is actually shown, whichever way you want to use the words.

MR. CAMPBELL: Now, Mr. Smith, you were telling some stories about saving energy. I can tell you one if you will allow me - it will only take a minute. I know a couple that the lady went away for a month so he says, "I'm going to save all the electricity that I can." He sat in the dark, he shut everything and when he got his next bill, it was up $3.

MR. SMITH: Well, I can't give you the answer to that one. There are a lot of things here; you have to look at every case individually.

MR. CAMPBELL: Now I understand there's going to be a raise of 12% or so, and I'm quite concerned about it, because it means that the people are going to pay a lot more money; and now since this news came out yesterday and the day before on the shares going from $.87 to $1.42, can you see any reason to raise it 12% or whatever you plan on? Could you assure us today that you are not going to raise it any?

MR. SMITH: No, sir.

MR. CAMPBELL: You couldn't.

MR. SMITH: No, sir.

MR. CAMPBELL: Could you tell us how much you are going to raise it?

MR. SMITH: Mr. Brennan explained that we are allowed under the Public Utilities Commission to earn between 9-1/4 and 10% on our invested capital. I've forgotten the figure exactly, but at the end of the year...

MR. CAMPBELL: It's a good time to forget it, right now.

MR. SMITH: Well, all right, I can give it to you later, but I can give it to you now approximately. At the end of the year, our earning with that accounting change ordered by the auditors was about 8-1/2%, 8-3/4%, I'm not sure, but in that order; so we are still about 1% below our minimum allowed. And so until we reach that minimum allowed there's nothing we can do about it.

MR. CAMPBELL: Could you have raised them from $.87 to $1 and given the people of Prince Edward Island a cheaper rate?

MR. SMITH: Not while we are still under-earning, and we have under-earned for the last four years. We have never reached our allowed rate of return since about 1971, I believe.

MR. CAMPBELL: But you must realize that 710 of these shares are outside of the Province of Prince Edward Island. Am I right, sir?

MR. SMITH: Yes, that's correct.

MR. CAMPBELL: But don't you think it would have been better to give a lower ......

MR. SMITH: There are 234 shareholders in Prince Edward Island and there are 510 in the Atlantic Provinces, 745 in total.
MR. CAMPBELL: Yes, but wouldn't it have been better to cut these back and given the good people of Prince Edward Island a cheaper rate?
MR. SMITH: Well, the good people of Prince Edward Island have been getting a rate in the last few years that has not allowed Maritime Electric to earn what the Public Utilities Commission says it should earn. Now, Maritime Electric is a monopoly, and because it's a monopoly, the government protects its customers from its earning too much money, making too much profit. So that puts a top limit on what the Company is allowed to earn on its investment. At the same time the Company is protected by the Public Utilities Commission by having a minimum that it is allowed to earn, and it should earn that minimum in order to present a reasonable picture to the investors when it goes to raise money. Now the Company has not been reaching that minimum for four or five years, and until we do, if we are going to maintain our financial integrity in the financial markets and treat our stockholders properly, ones on the Island and other places, we have to try to get within this range allowed by Public Utilities.
MR. CAMPBELL: But still and all, you are now saying that it's the Public Utilities' fault.
MR. SMITH: No, I am not, sir.
MR. CAMPBELL: Well, you're saying that they allow you to make so much money. Well, you don't have to take that much money, do you?
MR. SMITH: We don't have to, but we're in danger, as I said before, if we don't show a reasonable earning picture, of having our bonds derated, which will cost us, then, more in interest in the future when we sell bonds or sell stock. This might cost us a 1/2% or a 1/4% more for a 20-year bond, which in the long run would cost the consumers a lot of money over that period.
MR. CAMPBELL: So, there's no problem there, and I might say, Mr. Smith, I've never met you, but I always heard you were a very smart man and a good man for the Company, and I see today that you are a smart man.
MR. CLEMENTS: Are you planning any increased generating capacity right now; is there anything on line?
MR. SMITH: No, we are not. Not at the present time.
MR. CLEMENTS: Do you have any thoughts in mind where it might go in the immediate future if you did come on with any increased capacity?
MR. SMITH: There are all kinds of possibilities. I am going to come a little later to some possible sites. Incidentally, the reduced growth rate we have already experienced has saved or deferred about $6 million in capital that we had expected to have to spend but we are not spending now because our growth rate is lower. We had planned for additional generation, even with the cable, in 1978, I think.
MR. CLEMENTS: Would that have been at Charlottetown?
MR. SMITH: That would probably have been a gas turbine at Borden, just for peaking, just to tide us over.

MR. STEWART: How long, Mr. Smith, would you have a guarantee of price for bunker? Is it on a 30-day basis?

MR. SMITH: Yes. Really there's no guarantee on a price for bunker these days. What we have is a price from our supplier until the end of May, 1977, subject to foreign government tax take; that is, taxes imposed by the producing country and any changes in federal subsidies - any taxes other than income tax that would affect them.

MR. STEWART: What I was wondering was, was it subject to change tomorrow or 30 days from tomorrow?

MR. SMITH: Well, let's say the federal subsidy of $2 is taken off and the price rises by $2; we get 30 days' notice of that and there's a further two months before it's felt by the customer. So three months, but I don't think you can get a contract anywhere now with a firm price for any longer than 30 days. We used to be able to do that. We used to write 10-year contracts and get a reduction nearly every year, but those days are gone. Nova Scotia has such a contract, but not for long. They are having their problems with it, too.

HON. GEORGE A. PROUD: Mr. Smith, did you say that due to the drop in the growth rate you are not planning to build another generator in 1978?

MR. SMITH: That's right. The concept of the cable was that it would be on a trial basis for five years, due to all the hazards of ice and fishing and so on, and we should be able to carry our own load, follow our basic criterion of 90% of the load with largest unit out for a five-year period after the cable is installed. Now with reduced load growth that five-year period is pretty well taken up without any additional generation. So that's how we are able to defer this; and the other deferment is a further transmission line from Charlottetown to Borden or Bedeque, actually.

MR. CAMPBELL: Mr. Smith, you mentioned that the fuel will be going up the first of May. How much oil will you have in storage at the first of May?

MR. SMITH: We will have not more than two weeks' supply. Our storage is 30,000 barrels, which is at that time of the year perhaps about two weeks' supply.

MR. CAMPBELL: Would it pay you to put in more storage?

MR. SMITH: We've looked at that, and we have decided that it would not, because storage is so expensive. Right now we have an arrangement with our supplier. The supplier owns the oil tanks here and we're buying the product from that supplier till the end of May, 1977. We have an arrangement with him whereby if we can get a better price for oil from some other supplier, we can rent the tanks from him at a rate that is worked out on a .....

MR. CAMPBELL: Could you rent more tanks from your company?

MR. SMITH: Well, there are only so many tanks here available now.

MR. CAMPBELL: Can you foresee anything that Maritime Electric could do in any way at all that would give us cheaper rates?

MR. SMITH: If we could, we'd do it. The cable is one of the best things I know of, the interconnection with the mainland. There will be a number of benefits which won't happen overnight like that, like the reserve sharing - it will take some time for them to work in but in a period of a year or two, we will have rates that would be lower than they would otherwise be. Now the amount that they will be lower by is hard to tell because it depends how much energy we can purchase from New Brunswick that is cheaper than we can generate here. It's looking more optimistic, because New Brunswick's growth rate has dropped a little bit and it appears that there will be available more economy energy, that is, kilowatt hours that you can buy on a daily basis as they are available, than we expected when we assessed the cable. So we are hopeful now that the cable will be more beneficial than we had really allowed for.

MR. CAMPBELL: I've read about the cable that it's not going to give us electricity much cheaper or probably no cheaper than it is right today, so to spend $17 million or that amount of money to put in a cable and the tax payers are paying for it, I can't see that it's any benefit. But if it's going to give the Island people a cheaper rate, well, then I'd say it's a wonderful thing, but I haven't really been told that yet.

MR. SMITH: Well, there were intensive studies done on this, and it was proven to be economically viable on the basis of the economy energy expected to be available about three years ago. Now we expect more economy energy available so the economics should be better than we expected. Now it's not going to be a great bonanza and immediately drop rates, there's no way it is going to do that.

MR. CAMPBELL: Well, I think, Mr. Smith, that you realize that right now all I am concerned about is cheaper rates.

MR. SMITH: I think we all are. I pay the same rates as everyone else here.

MR. CAMPBELL: Well, I do too, and I know my people in ....

MR. SMITH: Well, the rates here are certainly a concern. The electric rates are high, they have always been high here, which accounts probably for the graph you saw where our use per customer is much lower than the Canadian average.

PREMIER CAMPBELL: I think everyone believed you were a great guy, Mr. Smith, until the international price of oil went up and now all of a sudden we have to find the devils.

MR. SMITH: I'm not sure I should be here at all this morning, because after yesterday we are blamed for dumping all these millions of dollars in the Harbour; and in addition to that, I live in an electrically heated home so that makes me doubly a culprit.

PREMIER CAMPBELL: Do you buy your fuel by inviting tenders from the major oil companies and then selecting the lowest tender, and enter into a contract for one year or two years?

MR. SMITH: It was a one year contract, but this was negotiated last September, October. Oil had been fluctuating a bit last summer, and suppliers said, "OK, if you take our price, we will give you this price for the next eight months as well as the year June 1, 1976 to May 31, 1977." Now about February, 1977, we will again go out for tender, and based on the replies we receive we will either continue with the present supplier or we will take a different supplier and we will rent the tanks from the present supplier, which is in the agreement.

PREMIER CAMPBELL: I understand that at the present time there is loose oil in the international market that can be bought on the spot for let's say $2 a barrel less than the going market rate. Does your contract with the major oil supplier allow you to buy on the side, to do a little speculating?
MR. SMITH: No, it doesn't. They expect to supply our complete requirements. When we negotiated that contract last year, there wasn't nearly as much bunker available as there is now. There is a lot of bunker floating around loose now that you can pick up in spot cargoes, but according to our contract we can't buy it; and if we did, we would have no place to put it, because while we are buying from his supplier he has the use of the tanks, of course. But after May next year we could, because we would have the storage tanks then, if we are buying from a different supplier.
PREMIER CAMPBELL: And you will be looking at that clause in the contract which may leave that option open.
MR. SMITH: Yes, because there is a lot of bunker available, and some companies are, as you say, offering it at a lower price from spot cargoes.
MR. CLARK: You mentioned Montreal Engineering two or three times. Are any of their members on the Maritime Electric Board of Directors, and if so, how many?
MR. SMITH: I believe it's three; there were four. One of them has left Montreal Engineering and is now in Alberta. He is still on our Board. As far as I know, he is not now a Montreal Engineering employee.
MR. CLARK: How many Islanders are on the Board?
MR. SMITH: Two. One from New Brunswick.
MR. CAMPBELL: Mr. Smith, just one more thing and I am going to leave you alone. Now I hope there's not a raise, but if there is a raise, I don't want you to blame it on me because I broke two of your poles off.
MR. SMITH: No, that's a separate matter altogether. We'll deal with that one separately. (laughter).
PREMIER CAMPBELL: There are two things that I think we want to discuss: the attitude of Maritime Electric with respect to allowing people to hook into their system: and I think we want to discuss the rate structure and possible future subsidies or preferences or night-time options for industry.
MR. SMITH: I think Mr. Brennan explained our rate structure, which includes a demand component and an energy component, and in the residential rates the service charge covers part of the demand component. The first block is designed to include the remainder of the demand component and the second block, which runs out to the end, is theoretically designed for energy only. In fact, in actual practice here it does include some of the capital, the demand part. So I'll skip over present rates. Now quite a bit of work is being done, particularly in the United States, on rate research and design, new types of rates. The United States Federal Energy Administration announced the funding of $1.2 million last year, which has been given to various

Mr. Smith (continued):

utilities to conduct different types of rate research to determine future rate-making policies. In addition to the current programs underway, various groups and consultants have suggested others, and quite a few of these are under study on a test basis. Most of the work so far on rate research is restricted to the residential customer. One rate that has been suggested and is being tested is an off-peak rate, also called time-of-day pricing. The customer has a special meter designed to record off-peak consumption with one dail and on-peak consumption on the other dial, and the meter is switched by the time switch. This is intended to induce customers to use more kilowatt hours in the night-time; for example, on-peak hours 7 a.m. to 9 p.m.; off-peak hours 9 p.m. to 7 a.m. They have lower rates during these night hours than they have during the day. This is under experiment or research by the Green Mountain Power Corporation in Vermont. The advantages: it shifts some of the day-time peak to night-time peak; the customers find it reasonably acceptable; it can be used to considerable advantage with an off-peak heat storage system; and it has been used in other countries, particularly England, for some time. Its disadvantages: it requires additional metering and expense. The special meter in Canada costs about $135 now, although with more requirements it could probably come lower than that, but that's the cost now of a special meter in addition to the time clock and the wiring, so you are looking at $200 plus per customer to set this up. Another disadvantage: the utility may experience sharp increases or decreases in load at the time between off-peak and on-peak, which could present some problems in our generating plant. And the system peak may be reduced, but the area peak may be increased. It may affect distribution pattern. This is being tested in three states, three companies in the United States. Another one is a three part rate, where you have a customer charge, an energy charge and a demand charge. The demand charge increases with increased demand. For example, the first so many kilowatt hours might be $1.40; the next so many, $2.50; and anything in excess, $4, to try to hold down demand. This rate does not require any additional metering; it encourages on-peak energy conservation. There are a number of disadvantages: that you may still get the peaks in all of these because people may say at Christmas, "Well, I'm going to light up my house for Christmas and to heck with the cost." Or they are finding in the States that during a very hot period in the summer, they are going to turn their air conditioning on anyway. So it is sort of self-defeating. It's also being tried in Vermont. There's a contract demand rate that's under test. This is a rate where there's a customer charge of so much and a demand charge of so much which is quite high, but no energy charge. Now, this is not a very good rate because while it limits the demand, it doesn't limit energy, and the disadvantages are that customers don't like it, it doesn't encourage energy conservation, and you do need additional metering. It again is being tested in Vermont, but not very successfully. There's the inverted energy rate, which we hear quite a lot about. You start out with the

Mr. Smith (continued):

service charge and the first block of kilowatt hours at a nominal rate, say as ours is, and the next few hundred at a slightly higher rate, and all in excess at a much higher rate. This has the advantage of tending to slow people down because it costs them more to use electricity anytime over and above their basic amount. The problem as I see it is where do you set the levels, how do you set fair levels for different customers whose requirements are different? This has resulted in many problems, but some work is being done on it. Lifeline rate has a lot of appeal from groups. It's referred to as 'social rate-making'. The lifeline rate is one that has a service charge; the first block of energy at a nominal rate, the next block might be at a higher rate, everything in excess at a much lower rate. This is a rate that is designed and supposed to benefit the elderly, those on very low incomes, pensioners, and so on. It does provide financial assistance to these people, it's an easy rate to implement, and easy to explain. It is not cost based, it needs to be subsidized by other customers, but it tends to stimulate consumption among low users. Whether this is poor management, I don't know. It may be that, or that their homes are rather poorly insulated and they supplement their heating with electric heaters - there are a number of reasons. But this type of rate with its low last block does not encourage conservation, and it's been found that people take advantage of it and increase their use considerably because they are on a low last block. So it's not really achieving what it's cut out to do to some extent, and the benefits don't reach the needy if their utility bills are included in their rent. This has been tried in a number of areas, and the comments are just about those that I have mentioned here - that it does not encourage low use.

Of all these rates, I think the one perhaps most acceptable all around would be the one that requires the special two dial meter. Now this costs, as I said, probably a couple of hundred dollars, maybe more, to install, and it means that the customer has to change his pattern and do things differently. I don't like the inverted rate one particularly on the Island here because the difficulty in setting the proper levels to be equitable to all customers requires you to go and look at almost every individual customer's situation. We may have one farmer who is not using much electricity; he has several sons that he uses. The next fellow is trying to use electricity to avoid using labour; his use is much higher and I don't think it's being wasted. So what level do you put that is fair to both these people? There is some research work being done on these rates, I believe in Ontario and possibly some of the other larger utilities. We have not done anything on them here and have no plans to get involved in research because of our size and the cost of doing it; but after a reasonable period of tests, these utilities are preparing reports, which will be available to us through the Canadian Electrical Association or the Edison Electrical Institute in the States, or in some cases, directly from the utilities.

Now very quickly - future sources of generation for Prince Edward Island. This would be what you might call bulk generation, and

Mr. Smith (continued):

I'm not talking of alternative sources like wind or solar or this sort of thing, because I believe this comes up a little later. You have a sheet there which gives estimated cost per kilowatt hour for energy produced (see Table 28). The submarine cable is the most immediate source available. It should be in operation by the end of this year, and we are very optimistic that it will be of considerable benefit. Not immediately, but over a few years we should benefit substantially from the interconnection with New Brunswick. New Brunswick has been very cooperative in this and has spent a lot of time working out the agreement with us, and I think it will be very beneficial. It's expensive; we are taking a lot of precautions, a lot of care to get it protected adequately both from ice and from fishing vessels, but we hope that we are doing the best we can, looking literally all over the world for knowledge and expertise in this regard. This is the reason I was along with Tom Richardson for the past several days meeting with the Japanese people and the Swedes, who are manufacturing cable. Now some of the sources that might be available: some of these are located on the mainland and would have to use the submarine cable or future cables to bring the power to the Island. The first one, which has been considered for a long time was the purchase of a 5% share of the LePreau Plant. It has been decided not to proceed with that. That was estimated to have cost about 2.45¢ a kilowatt hour landed at Borden, including capital cost, operating cost, transmission costs, and so on. Incidentially, a lot of fuss is being made these days over the escalating costs of LePreau. There was a figure of $460-some million used a couple of years ago, which was the 1974 cost, 1974 dollars, and New Brunswick had three escalation rates that they applied to the completion date: a high one, a medium and a low one. The one they thought most likely to be experienced was the middle one, which ended up with an installed price by 1980 of about $678 million, and this is the figure that we have been using when we were considering the purchase. I think the latest figure I saw in the Saint John paper was $684 million, so they are still in that ball park. But the figure $466 million was a 1974 figure with no escalation. Now the Province is presently in negotiation with New Brunswick for a long-term contract, the purchase of some 30 megawatts, and it is expected that this will cost about 2.6¢ to 2.7¢ in Borden. This is with losses and all costs. Now we might arrange with New Brunswick to buy firm power from one of their large thermal units, say Coleson Cove, and we estimate this would cost about 3¢ per kilowatt hour delivered to Borden, based on oil at $15 a barrel in 1980. Hydro from Quebec is another possibility. There have been meetings of the five eastern Canadian utilities during the past few months to study the possibility of getting surplus energy from Quebec into the Maritimes. This study is not yet complete and I haven't the answer to it. Some investigation has also been done on the possibility of purchasing Gull Island power in Labrador. It is estimated that this would cost by 1980, 3-1/2 ¢ per kilowatt hour landed at Borden. The Gull Island project is stalled; the starting date is indefinite and will no doubt cost more than the 3.5¢ at a later completion date. A large part of that cost is transmission. Another possibility is a thermal plant in New Brunswick using New Brunswick coal. This is estimated to cost 3.4¢ per kilowatt hour at Borden, plus some additional cost for environmental reasons. It could cost up to .5¢ more for environmental protection because this coal has a very high sulfur content, so that 3.4¢ might well be 3.9¢. Now coming to sources that might be located in Prince Edward Island: a thermal oil-fired unit might be built, say, at Borden near the end of the cable about 100,000 kilowatts, part of whose output would be sold to New Brunswick. This is estimated to cost about 3.7¢ a kilowatt hour in 1980, again with $15 oil. The reasons for the difference between 3.7¢ and 3¢ from the Coleson Cove: one in Coleson Cove is just about completed, and it is built for lower unit cost. A new plant started now would obviously cost more before it was completed. We might build a coal-fired plant on the Island, again using New Brunswick coal. This would be about 3.5¢ plus, the plus again being environmental considerations. We have examined the possibility of burning Island peat. This has been done in some places but we find that there isn't enough peat on the Island and the quality is not suitable for combustion, so that was ruled out. Nuclear, just to complete the story, is completely impractical in Prince Edward Island, because the economical size is 600,000 kilowatts and we would require several cables to sell the surplus output, and we couldn't raise the capital anyway, so that's not practical at all. Gas turbines: they are best suited for peaking where they are used very little, the less the better. The first couple of years we had gas turbines in, the first three years we were using for about 2% of our generation, and at this low use they were economical because they had a low first cost, low capital cost. The present cost at Borden including capital at the present time about 6¢ a kilowatt hour. A combined cycle unit is a gas turbine with the exhaust gases being used under water to run a more or less conventional turbine generator. This has not been practical for Prince Edward Island, because to get the full efficiencies, you have to use both units at the same time, and the size would be just too large to absorb here on the Island, as long as we are a separate system. There's a possibility of this type of generation with the submarine cable interconnection if we could get it to burn on a heavy fuel. The present type of fuel would be about 5¢ a kilowatt hour. Tidal power is a possibility sometime in the future; we have no idea of the cost. It would be a desirable one because it's a renewable resource. Another one is the Doxford Diesel. There's been a presentation here recently on this machine; it is available in reasonable sizes and has possibilities. The estimated cost would be about 3.5¢ a kilowatt hour. The unit being proposed, I understand, is a prototype, a higher speed one than the Doxford Diesels, which have been used in marine work for many, many years very successfully at a low speed. The unit they are proposing has really not been tested very much. This pretty well covers the possibilities that we've examined, and I think you will agree that the least expensive of all these is conservation.

MARITIME ELECTRIC COMPANY, LIMITED

POSSIBLE FUTURE GENERATION SOURCES FOR P.E.I.

ESTIMATES

1. LOCATED ON THE MAINLAND

Type		1980 CENTS/KWh IN P.E.I.	1980 FUEL COST
(a)	Nuclear - Purchase 5% Share	2.45	
(b)	30,000 KW Long Term Contract with N.B. Power	2.6 to 2.7	
(c)	Thermal - Oil fired 300,000 KW Coleson Cove	3.0	$15.00/bbl
(d)	Hydro from Quebec - wait for report		
(e)	Gull Island (Labrador) starting date indefinite	3.5	
(f)	Thermal - Coal fired (N.B. coal)	3.4+	

2. LOCATED IN P.E.I.

Type			
(a)	Thermal - Oil fired 100,000 KW	3.7	15.00
(b)	Thermal - Coal fired (N.B. coal)	3.5+	
(c)	Thermal - Peat fired - impractical		
(d)	Nuclear - impractical in P.E.I.		
(e)	Gas Turbines	6.0 up	
(f)	Combined Cycle (Gas and Steam Turbine)	5.0	
(g)	Tidal Power	?	
(h)	Doxford Diesel	3.7	
(i)	Windmills	?	

TABLE 28

Mr. Smith (continued):

Now I haven't mentioned the alternative sources, because they are being discussed at a later date; but I would like to mention that we are very much interested in these, and I think they have great possibilities for the customer, particularly in the smaller sizes, perhaps for certain areas, for towns, or some isolated groups of people. We have had some discussions with an official of the Government and have offered for Maritime Electric to work with the Government on the installation of a relatively large windmill that they are considering. That would supply a particular load with the output connected to our system so that the load could receive energy from our system in the event that the windmill wasn't performing, the wind wasn't blowing enough; or alternatively, our system could receive energy from the windmill in the event that the load didn't require it. Our role in this primarily would be to work on design, and provide the interconnection equipment, and this is quite considerable; because, in addition to the two-way metering, you need relaying and protective equipment. Protective equipment is needed in both directions because we sometimes, as you know, interrupt lines to work on them, and we normally go and open our switch and when the line is clear, our men can go and work on it. Now if these alternative sources, one or any number are connected into the line, then the line is not dead, and each one of these sources has to be eliminated before we can go and work on our line. Alternatively, if we have a power failure, as sometimes happens, and the windmill is still connected into the system, the windmill then sees all the load on that particular piece of line and tries to supply it, so it either burns itself out or blows itself up or needs some protective equipment to save it. So there is quite a bit of work to do in getting this equipment between the two systems and we are very much interested in this and we see definite possibilities. We also see problems, most of which can be overcome. They all cost some money. Somebody said yesterday that conservation costs money and I think this is very true. But we are certainly interested as a company in working with the Government or any group or individual along this line, and I have the approval in principal of our Board of Directors to proceed in this direction. Now, I have taken a lot of time here, and Mr. Reynolds was going to cover some of the aspects of generation, use of fuel and so on.

MR. JOHN REYNOLDS: Mr. Speaker, Honourable Members, ladies and gentlemen. Mr. Smith and Mr. Brennan discussed the technical aspects of rate structures, and the elements that go to make up the costs that must be covered from revenue to meet the various demands on the electrical system. I'm using "demand" there in the broader sense of the word. It has been suggested that it might be appropriate to explain briefly the energy conversion process and perhaps follow the path of a block of primary energy through that process. The diagram which you have before you (see Figure 36) shows the conversion process for bunker oil as converted to electrical energy. And if those people who have a technical

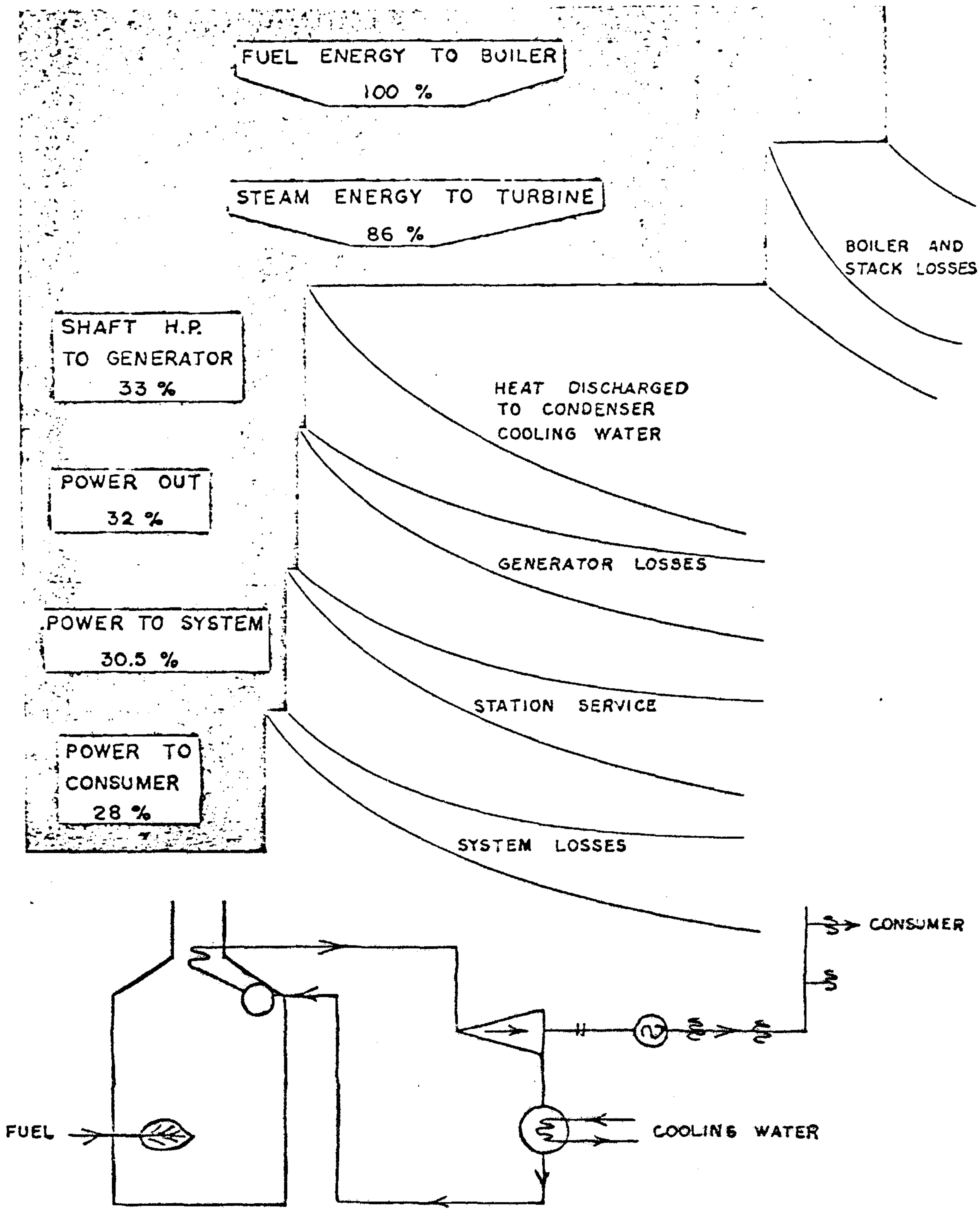

FUEL ENERGY TO BOILER
100 %
STEAM ENERGY TO TURBINE
86 %
BOILER AND
STACK LOSSES
SHAFT H.P.
TO GENERATOR
33 %
HEAT DISCHARGED
TO CONDENSER
COOLING WATER
POWER OUT
32 %
GENERATOR LOSSES
POWER TO SYSTEM
30.5 %
STATION SERVICE
POWER TO
CONSUMER
28 %
SYSTEM LOSSES
CONSUMER
FUEL
COOLING WATER

FIGURE 36

Mr. Reynolds (continued):

background will forgive me if I go well below their level of understanding, I'm just going to speak very briefly on how a central electric station performs.

The diagram shows 100% bunker oil being fed into the boiler. If you look at the lower part of your sketch, you see it being fired in the boiler where the furnace wall is being water cooled. Heated water is carried into the drum where the steam is released, passing in turn through the super heater where it picks up further heat, passing in turn to the throttle of the steam turbine. It expands through the steam turbine, converting the steam energy into mechanical energy and then into electrical energy in the generator when we rotate one field in relation to another. From the electrical generator, it passes through transformers down to a suitable level for distribution and use at the consumer's appliance level. The main portion of the diagram shows, for a typical installation, and I'm not suggesting for a moment that this is ours, the various losses as they occur from the 100% fuel energy feeding into the boiler. We can look for, in a utility boiler, efficiencies in the order of 85 to 89% if they are big enough, but in this instance I've indicated losses ranging from perhaps 13 to 15% of the primary energy. These go up the boiler stack as radiation losses in the boiler house. The steam energy passes into the turbine, which we are showing here at 86% of the original. It functions quite well in the turbine; the mechanical efficiency going through the turbine is quite high, possibly in the order of 75 to 78%, but at the extreme end we discharge a very large portion of our heat into the condensed cooling water. Through the generator we have further losses, bringing power out from the generator at about 32% of the original. We again in this instance take account of our station service requirement, which is the electrical energy which we use to run the pumps,auxiliaries, and the rest that go to make up the system. This drops us to about 30% of power onto the system, and then before we get the power to the consumer we have these various system losses, which can be as high as 9%. As I said, this is not necessarily typical of our system. We have quite a number of older units on our installation, and have a more than usual mix of gas turbine operation on our system so that our overall efficiency is less than the 28% that's indicated here. But it does or should serve to give you an idea of where the losses occur, so that when you are talking in terms of massive savings you can look and see where the potential for savings might lie. Other generation facilities that we have include the gas turbine, which has efficiencies from 18 to 25% depending on the type of loading we have on it. Bear in mind, of course, that it does use a more expensive fuel. The nuclear cycle will have a diagram of energy losses somewhat similar to what we've got here for the oil fuel steam electric station; however, the overall efficiency is lower due to the lower operating temperatures at which the Candu cycle functions, and the heat discharged to water is quite substantially higher, and this offsets the fact that there are no boiler stack losses. Diesel plants will function at efficiencies between 33 to 35%, so from

Mr. Reynolds (continued):

that little synopsis, you will see that these various processes have efficiency ranges that go from about 25 to 35%.

From yesterday's discussion, we know for a long time that possibilities exist to improve these efficiency levels up to 55 or perhaps 60%, depending on the effectiveness with which the so-called waste heat can be used (and I'm using the term 'so-called waste heat' very advisedly) and depending also on the availability of investment capital involved with the system. There are many examples in Canada, in the Maritimes, and in other parts of the world where electrical generation and process of district heat are provided quite economically. However, for such a system to work, the heat load must exist; and it should exist in reasonable proximity to the generation station. Maritime Electric Company will respond positively to any reasonable request to explore this as an energy conservation method.

In response to yesterday's general call for conservation, we will be continuing our analysis of the generation process that we have - we admit it's not as high as other utilities are - with a view to finding ways and means of improving our kilowatt hour output per barrel of fuel burned. And while we are waiting for the intertie as a further effort to improve our efficiency of operation, we are studying very closely to discover the best possible mix of imported energy and Island generation.

In pursuing that last objective that I mentioned of improving our efficiency, I'd like to refer back briefly to the question of 'peaking'. This was touched briefly by Mr. Brennan, and Mr. Smith discussed it, too. I will call your attention to two distinct areas where the consumer can help when staying off the peak period: the first is the obvious one that was covered earlier, associated with the kilowatt demand which is needed for only perhaps 400 hours of the year; in other words, that very peaked portion of the load duration curve. Associated with that is an energy that is very expensive in the capital sense, because the kilowatts to meet that demand plus a 20% reserve must be available for 100% of the year, while we are only using it 5% of the time. Now that's the obvious one. The second one is perhaps one in which in operations we are more interested again. In anticipation of that peak, either the noon-day peak or the evening peak down at the plant in Charlottetown, and we must ready ourselves at Borden besides, we must have units, maintain turbo generators, running at light load. When we maintain those units at light load, if we do it for a sufficient number of hours over the year, we are running them inefficiently over that period; but nevertheless, it must be there to meet the demand. If we can spread that energy need out over the longer period, we have our generation running longer at the higher, more efficient loads. And the consumer can help by making electricity demands before 10 a.m. in the morning, between 2:30 and 3:30 and after eight o'clock at night.

I would like to leave a thought as a result of some of the remarks that were made here yesterday in respect of waste heat. When

Mr. Reynolds (continued):

you look at Figure 36, you will be dismayed, I suggest, by the substantial heat discharges to the Hillsborough River. Now before you equate this heat loss to domestic or commercial heating fuel, please remember that the fuel we burned in the furnace is bunker oil, another name for which is residual oil, and that's just what it is. It is the residue from the refinery after they have taken what they can from it. Before decrying this as a system, remember also that those same types of utility boilers will burn low grade lignite from Western Canada, which if it weren't burned in that boiler would otherwise be so much Prairie acreage. Might it not be reasonable to consider that the heat which we cannot use and discharge to waste is the price we must pay to convert residual fuel oil or low grade coal into high grade electricity?

MR. WELLS: I now call on Mr. Tom Richardson to deal with the question of the Government's current role in supplying electricity in Prince Edward Island.

The Role of the Provincial Government

MR. TOM RICHARDSON: Mr. Chairman, Honourable Ministers, Assembly Members, Ladies and Gentlemen: My remarks today will begin with a general review of Provincial Government involvement in electric power matters. Then I will provide some detail on the submarine power cable interconnection project with New Brunswick, the electric power purchase contract currently being negotiated with New Brunswick, and finally I will conclude with comments on electric heating, electric rates and energy futures. In 1954, the Provincial Government began a Rural Electrification Program. This program involved the construction of rural distribution lines by Maritime Electric Co. Ltd., under the direction of the Public Utilities Commission. By 1970, some 1,400 miles of line had been built and the program was substantially complete, as you have heard from Mr. Brennan. In 1971, the Department of Industry and Commerce, together with Maritime Electric Co. Ltd., and the Federal Government, initiated a review of the economic and technical feasibility of installing a submarine power cable interconnection from Prince Edward Island to the mainland. This effort has culminated in the construction of the submarine cable interconnection scheduled for commissioning later this year.

The rapid escalation in crude oil prices commencing in late 1973, coupled with a forecast that the world is running out of oil, triggered what we now refer to as the "Energy Crisis". Prince Edward Island has been especially hard-hit by the increases in oil price, because we are completely dependent on oil for the generation of electricity. At the First Minister's Conference in January, 1974, Premier Campbell and the premiers of the other eastern provinces successfully pressed for a Canadian one-price for crude oil. The Federal Government imposed a tax on western crude oil exports, the revenues from which are used to

Mr. Richardson (continued):

subsidize the importation of crude oil into the Eastern Provinces from offshore suppliers. The amount of federal compensation is now approximately $4.50 per barrel, being the difference between a $12.50 world price and the present $8 Canadian one-price. To help cushion the effect on electric rates in mid-1974, the Provincial Government established a subsidy of $1.69 per barrel for bunker oil used to generate electricity, but financial constraints have made it necessary to remove this subsidy effective today. Beginning with the First Ministers' Energy Conference in January, 1974, and on several occasions since that time, this province has requested special federal consideration for our unique electric rate position, the highest in Canada by a long shot. So far, attempts to obtain a federal subsidy have been unsuccessful; but I understand this effort will be continued. Last year, the Institute of Man and Resources was established. Amongst other things, one of the tasks of the Institute will be to foster research into alternative energy sources, and of course, the Director of the Institute, Mr. Andy Wells, has organized these Energy Days sessions.

Another involvement of the Government in electric power matters is its active participation in the electric grid study initiated by the premiers of the five Eastern Provinces last September. While this study has not yet been completed, we do know now that Hydro Quebec has no firm hydro power available for sale. There is a possibility that the proposed Gull Island Hydro Project in Labrador might someday be jointly developed by the five Eastern Provinces. However, its remoteness from Prince Edward Island will result in energy costs considerably in excess of Point LePreau nuclear power, and its joint development has yet to be studied.

Finally, the Department of Industry and Commerce is currently negotiating a long-term power purchase arrangement on behalf of the Province from the New Brunswick Electric Power Commission. I will now take a few minutes to present some details of the Prince Edward Island-New Brunswick electric power interconnection project, and there are some slides.

The first slide is a photograph of the actual cable (not shown). It is being manufactured in Sweden by Dieverts Kableverk Company, the low bidder on the project. Two of these cables will be installed between Richmond Cove, Prince Edward Island and Murray Corner, New Brunswick, this summer.

The next slide shows the construction details of the cable (see Figure 37). You will note the overall diameter is slightly in excess of five inches. There are three copper conductors, each surrounded by paper insulation. The three insulators are in turn encased in a lead alloy sheath and the voids around and between the cables are filled with insulating oil. The lead sheath is covered with impregnated paper, and over that there are two tapes of stainless steel pressure armouring. Then there is a layer of round galvanized steel

SUBMARINE CABLE SECTION

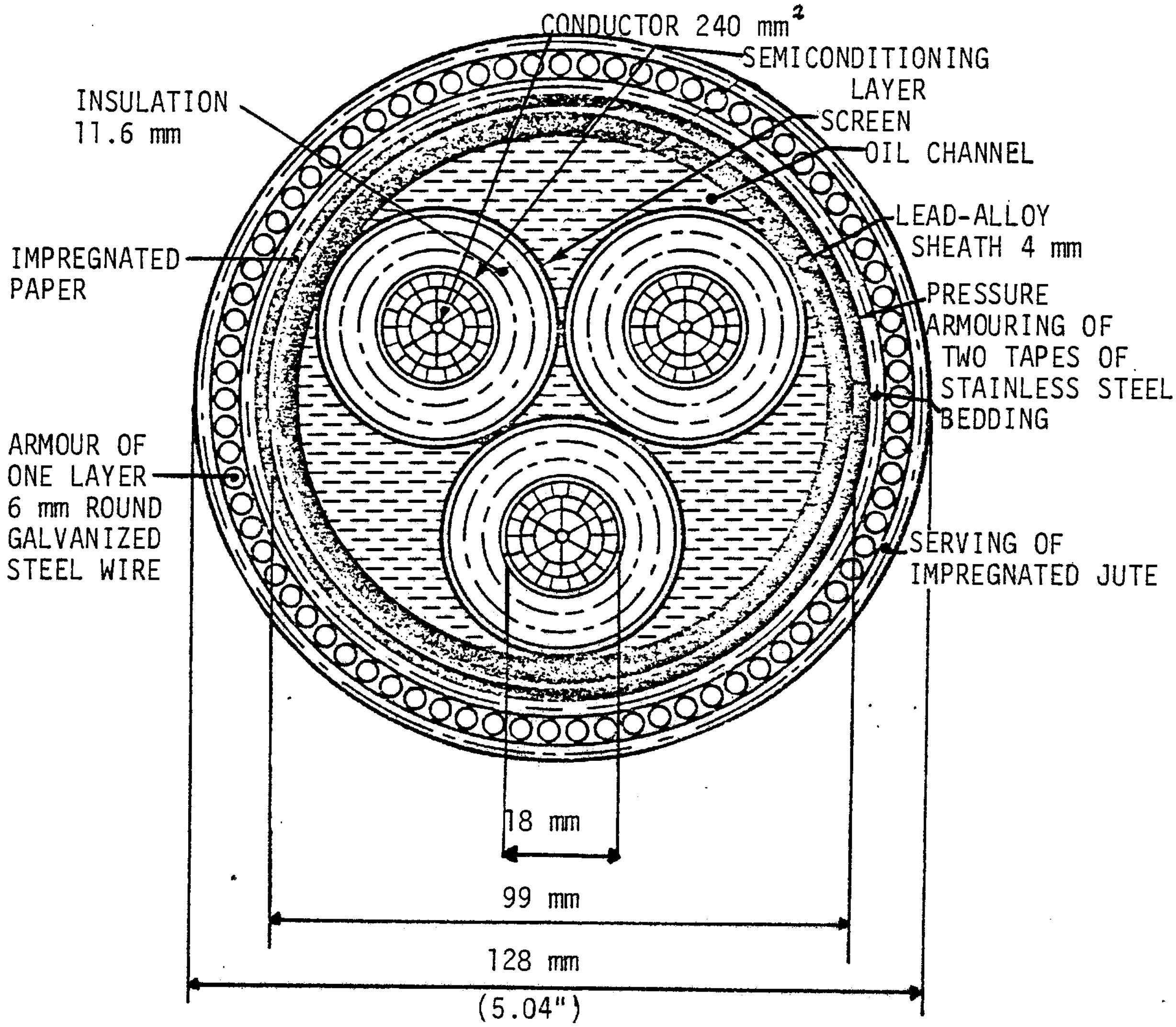


FIGURE 37

Mr. Richardson (continued):

wire and finally a jute exterior jacket. Each cable is spliced into a continuous length so that it can be laid directly from a sea-going barge without interruption.

This is a map showing the Island and the adjacent mainland with a cable interconnection running between Richmond Cove and Murray Corner (see Figure 38). Also shown are the connections into the Bedeque substation and to the Memramcook Switching Station in New Brunswick, which is on the New Brunswick-Nova Scotia interconnection line.

This slide is a plan view of the two cables (see Figure 39). You will note the cables diverge at the shore and cross the Strait with a separation of 160 meters or approximately 500 feet. The purpose of this separation is to lessen the probability of simultaneous damage to both cables. You will note that the total length of the submarine cable crossing is 22,700 meters, which works out to approximately 13.9 miles. The cable will be buried in 6-foot deep trenches out to a water depth of 40 feet, and will be plowed into the bottom of the Strait in the mid-Strait area. The burial in the trenches at the shore ends is to protect the cables from rafting ice in the springtime, while the plowing in the mid-Strait area is to protect the cables from scallop draggers.

This is a slide showing a section of Northumberland Strait (see Figure 40). It shows the cables trenched at the shore ends and plowed in the mid-Strait section as previously stated. Where mid-Strait plowing is not possible because of rock outcroppings, the cable will be protected with either cast-iron necklaces which clamp around the cable, or by means of concrete bags placed over the cable and hooked into the bottom.

The final slide shows the cable rising up in a terminal structure where the overhead transmission line commences (see Figure 41). You will note that there is a small building shown which contains the oil regulating equipment and spare oil supply. You will recall from an earlier slide that the cable is filled with oil. The oil ducts actually connect directly into the storage reservoirs at either end of the cable. The cable terminations are located approximately a quarter mile from the shore line to reduce the effect of salt spray on electrical equipment.

The cable interconnection project has a nominal cost of $36 million. It is being funded by an $18 million DREE Grant, a $9 million loan from the Federal Department of Energy, Mines and Resources, and $9 million by Provincial Government borrowings. The Province will lease the cable interconnection to Maritime Electric Company at a rate which will amortize the provincial loans.

What benefits can we expect from this project? First of all, the cable interconnection will mean that lower reserve generating capacity is required here on the Island. This amounts to the deferment of the installation of new equipment and thereby results in a financial saving. The second cable benefit is that it will permit the day-to-day and hour-to-hour transfer of so-called economy electrical energy from New Brunswick to Prince Edward Island. This means Maritime Electric will sometimes be able to shut down less efficient generating units and buy from

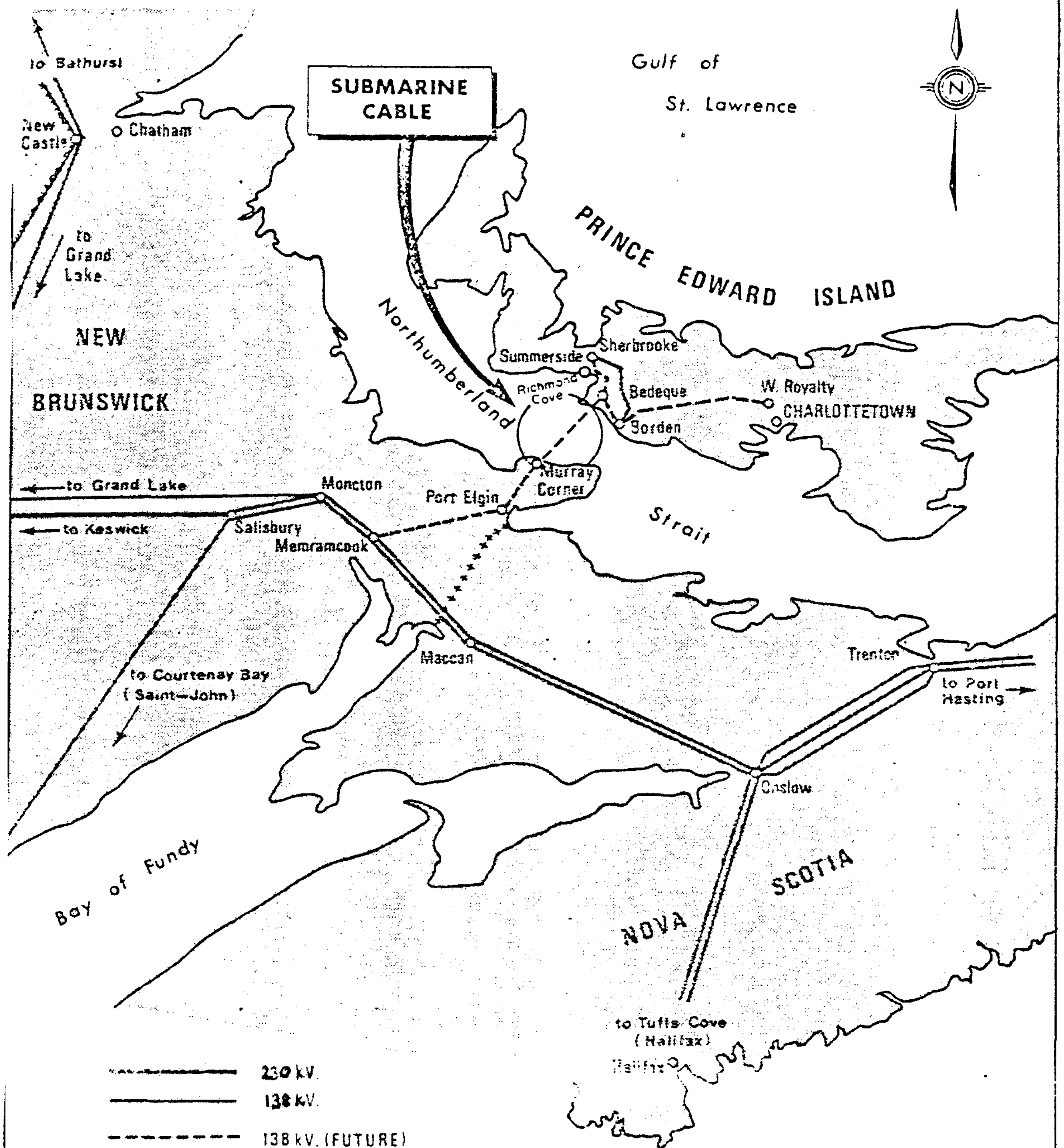


FIGURE
P.E.I. - NEW BRUNSWICK
POWER INTERCONNECTION

FIGURE 38

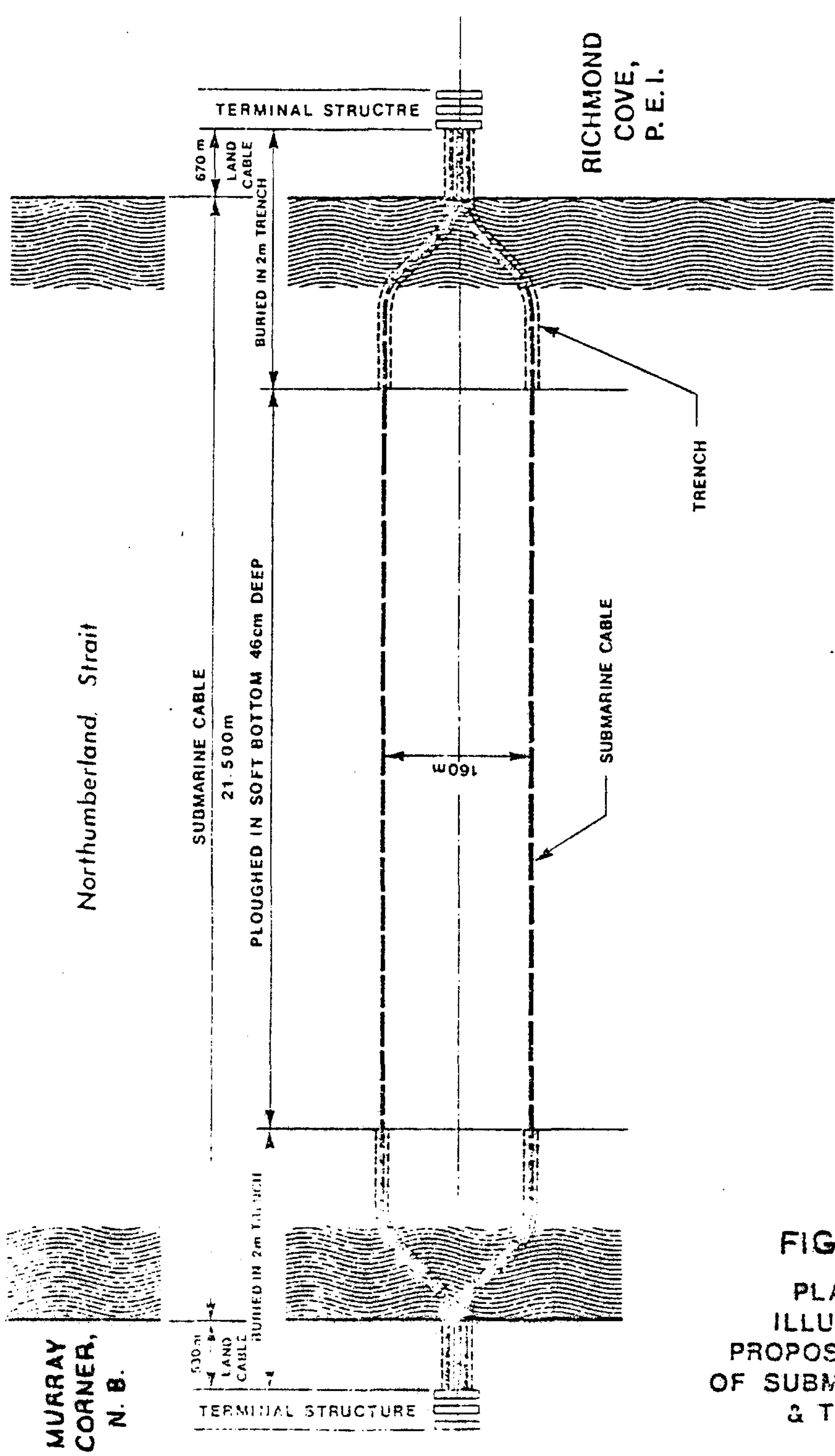
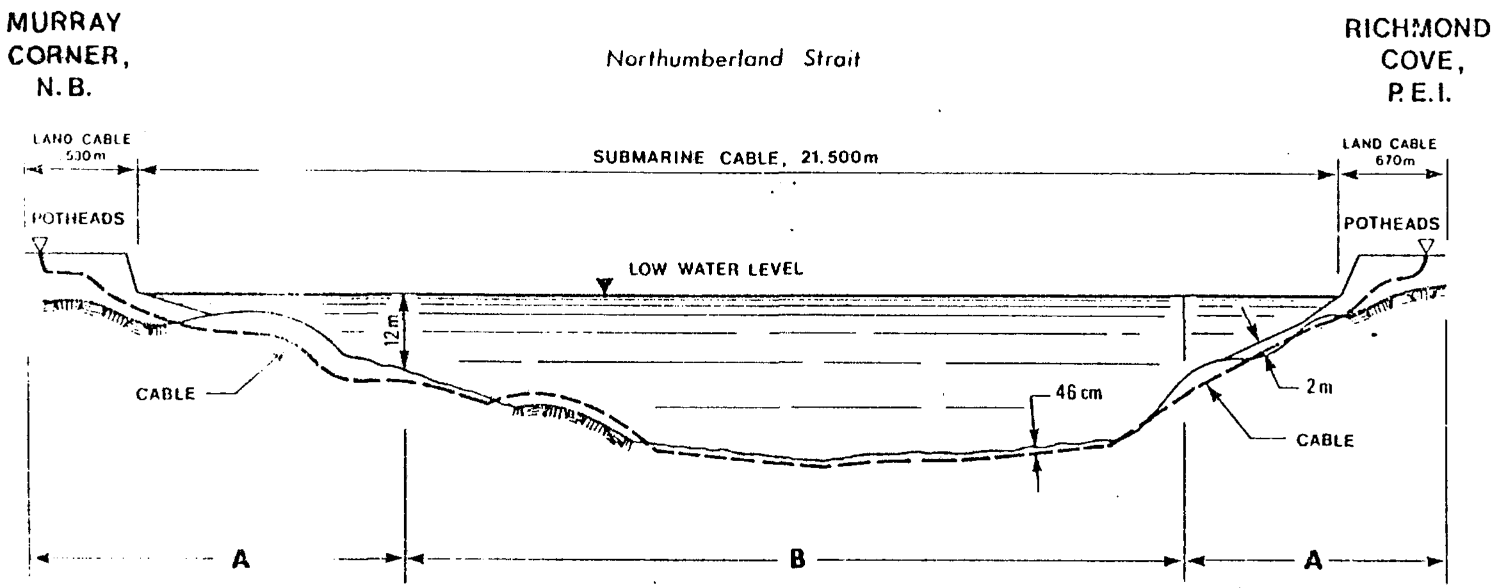


FIGURE 39

PLAN VIEW
ILLUSTRATING
PROPOSED SCHEME
OF SUBMARINE CABLE
& TRENCHES



A - BURIED IN 2m TRENCH

B - PLOUGHED IN SOFT BOTTOM 46cm DEEP. WHERE PLOUGHING IS NOT POSSIBLE, PROTECTION WILL BE WITH CAST IRON ARTICULATED PIPE

FIGURE 40

ELEVATION ILLUSTRATING PROPOSED SCHEME OF SUBMARINE CABLE AND TRENCHES

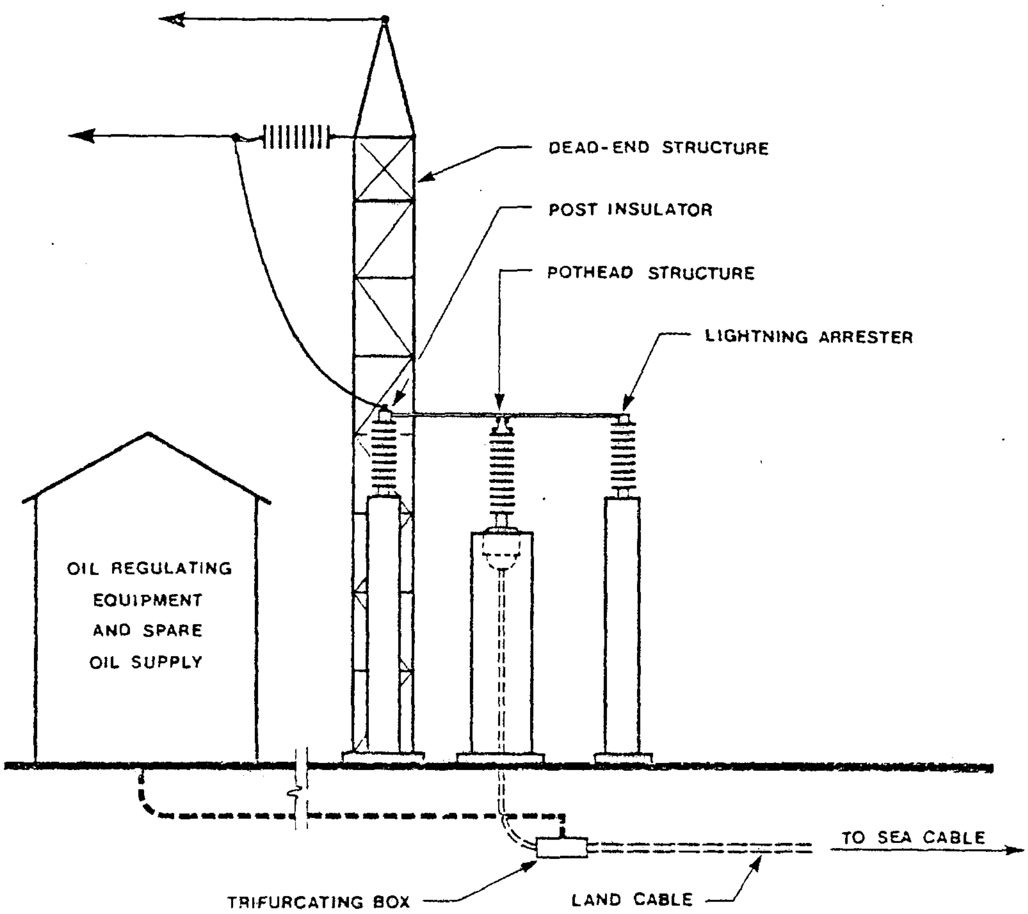


FIGURE 41

TYPICAL TERMINAL STRUCTURE

Mr. Richardson (continued):

more efficient units in New Brunswick, and the reverse might occur. The interconnection will permit the purchase of short-term firm capacity, such as later when Maritime Electric would have had to install another unit here on the Island if the cable interconnection had not been in place. Also the interconnection will improve the Island's security of energy supply. It can be considered to be an energy pipeline to the mainland. And, finally, the cable interconnection will permit Prince Edward Island to share in the purchase of larger and therefore more efficient generating units on the mainland. It will give us access to the economies of scale that are inherent in larger utilities and which we have not had to this point in time.

The concept of sharing in the purchase of larger generating units on the mainland brings me to my next topic, which is the power contract currently being negotiated with the New Brunswick Electric Power Commission. Prince Edward Island has requested a long-term power purchase arrangement from New Brunswick. The amount of power involved is 30 megawatts or 30,000 kilowatts. The New Brunswick Electric Power Commission has indicated its willingness to sell us 30 megawatts, and we are currently continuing with negotiations. While the power would be purchased from the New Brunswick system at Memramcook and delivered to the interconnection, the availability and price of the power would be directly linked to the Point LePreau nuclear plant. The agreement being negotiated could be considered as a lease or entitlement agreement. With the single exception of actually purchasing a share of Point LePreau, a power purchase agreement from New Brunswick based on the Point LePreau nuclear plant is the least costly of the alternatives available in the foreseeable future. Actual purchase of a share of LePreau is the rock-bottom minimum cost but financial constraints prevented our purchasing a share when we had the opportunity a few months ago. I would like to say a word on the capital cost of LePreau, because there has been a lot of comment in the media recently about those costs. The latest word we received last week on the capital cost of Point LePreau is $684 million. This total cost forecast has increased by only $5 million in the past two years; that is, it was $679 million when we were talking to them two years ago. And the $684 million figure includes a 13% per year escalation to 1980, and to quote an official of New Brunswick Power, "Given the Federal Anti-Inflation Board's effort, the final price could well be less than $684 million." There has been a considerable amount of alarmist propaganda recently about escalating costs of Point LePreau, which as far as we can determine, has absolutely no basis in fact.

I would like to say a few words in defence of electric space heating. The buildings being constructed today in Prince Edward Island have a probable life span of at least 50 years. As the central electricity supply is gradually changed from oil to nuclear, resistance electric space heating will make more and more sense as each year goes by. Surely one of mankind's major objectives must

Mr. Richardson (continued):

be to decrease the use of oil wherever possible so that remaining oil supplies are reserved for use where substitution is not possible; for example, in the petrochemical industry. Electric heating will no doubt be used to supplement solar heat derived from wind generators in rural areas. Also, the technology and hardware exists today for electric heat to be efficiently used for space heating when heat pumps are used as the conversion medium, so let's not write off electric heat too quickly. Certainly the generation of electricity from oil is now considered to be an inefficient use of a dwindling and expensive resource, but the answer to that problem is to stop using oil to generate electricity.

And finally, a word about electric rates. Well-meaning energy conservationists are calling for electricity rates which will penalize the heavy user of electricity. In my view, such a procedure might make sense in those provinces which have very low electric rates, but can anyone seriously suggest we penalize some of the present electric users on Prince Edward Island? Surely a better method to conserve electricity is to encourage conservation by educating industrial, commercial, and domestic users so that electricity waste can be minimized.

In closing, I would like to say a few words on energy futures for Prince Edward Island. I know that the two Energy Days' sessions in April will deal with this topic of Energy Futures. However, since I am not scheduled to speak on those days, I would like to put my two cents worth in right now. The entire purpose of the involvement of the Provincial Government in electric power matters through the Department of Industry and Commerce for the past five years has been to work towards the lowest possible electricity rates. You can say we haven't been very successful. However, as Mr. Smith, General Manager of Maritime Electric Company Limited, said in the lead article in yesterday's Guardian, "I don't see any alternative to PEI continuing to pay the highest electricity rates in Canada as long as we have to keep generating electricity from oil", and I agree with him completely in that statement. Yes, we must research and encourage the use of renewable energy sources in our homes and businesses; but if we are to have lower electricity rates, we must decrease and if possible eliminate the use of oil used to generate electricity. The successful conclusion of our present negotiations with New Brunswick for a long-term purchase of power will be a major step towards our goal of lower electricity rates. Thank you very much.

MR. WELLS: I would ask Mr. Smith and Mr. Reynolds to join Mr. Richardson so that the three of you may respond to questions. I might say while we are waiting for that to happen, Tom, that we may not have scheduled you as a speaker on the 12th and 13th, but certainly we would welcome your attendance because I think that we all have a lot to learn coming up on those two days. Now I'll return it to the floor for questions.

MR. CLARK: What percentage of shares of Maritime Electric are owned outside of the Maritime Provinces?

MR. SMITH: I'm not sure, but I think it's probably in the order of 80%.

MR. CLARK: And are these shares owned by the holding company of Monenco?

MR. SMITH: They are not. No shares are held by Monenco or Montreal Engineering. There's only one shareholder that owns more than 10% of the shares, one individual. Other holdings are all less than 10%.

MR. LEE: Mr. Smith, on the Monenco Company,Montreal Engineering and the Maritime Electric Board of Directors, there seems to be an overlapping of directorships there.

MR. SMITH: That's right.

MR. LEE: Would this have any bearing on your business relations for instance with Montreal Engineering when you are negotiating contracts with them?

MR. SMITH: As far as I can see, it doesn't. This is not an unusual thing, to have overlapping directors. I personally don't feel that there is any problem created that way, and on certain decisions involving Montreal Engineering, its directors abstain from voting at some of our meetings. This has happened a few times.

MR. MCINTYRE: Mr. Smith, you stated this morning, I believe, that your fuel costs had risen from 21% to 37%, which would be an increase of 16%. It appears that our electrical rates have escalated a lot more than that: are there other costs other than fuel here?

MR. SMITH: I am not sure I understand your question - that was the 21% of the total cost of kilowatt hours in 1966 to 37% at the present time. Isn't that more than 16%?

MR. MCINTYRE: 21 from 37 would be 16%, would it not?

MR. SMITH: Well, I don't know, it could be. Now in that time the cost of fuel has increased from $2.20 a barrel to a net price we are paying today of $6.04 roughly. That's almost three times. If you check the bar chart, I think you will find that the length of the bar devoted to fuel has also increased about three times. Now, remember these percentages are on different bases. The percentage in 1966 was on a base of 2-1/2¢ or something like that, and the percentage in the 1976 estimate was on a base of 4-1/2¢ - 4-3/4¢. I think the figures are right, but we are sort of comparing apples and oranges, I think.

MR. MCINTYRE: I believe you also mentioned, Mr. Smith, a 31% increase in wages.

MR. SMITH: No, I don't think I mentioned that. Not a 31% increase in wages, I don't recall that. Mr. Brennan may have mentioned that.

MR. MCINTYRE: Well, this 31% - is that a recent increase or are you talking about from 1966?

MR. SMITH: I don't know what he was basing this on. I didn't check with him beforehand, and I really can't answer that. The wage increase from 1966 to 1976 has been much more than 31%, obviously. I can't tell you offhand how much it has increased, but it probably more than doubled, I don't know.

DANIEL COMPTON, MLA: Mr. Smith, you mentioned the present price of oil was $6 per barrel.

MR. SMITH: $6.04, I believe, yes.

MR. COMPTON: Is there to be another advance in July on that oil?

MR. SMITH: I don't know; that July one depends on the Federal Government's subsidy. If they remove part of the subsidy, there will undoubtedly be an advance. If that is effective the first of July, then it will be noticed by customers billing starting the first of September, two months later. Now I don't know what the Federal Government is going to do. There is some talk it might be $2.00, it might be $2.50, it might be $1.50, I don't know.

MR. MCINTYRE: It was stated this morning that the average used in rural communities was 5,200 kilowatts per year in 1974, and I was wondering what the present average kilowatt hour rate is in rural areas?

MR. SMITH: I don't know, I haven't my budget here. I think it is very close to 5¢. I can find out and let you know just what it is.

MR. CLARK: Mr. Smith, what individuals within Monenco hold or have members of their family holding significant interest in Maritime Electric?

MR. SMITH: I wouldn't have the slightest idea, sir. I have no idea how many employees of Monenco or Montreal Engineering hold shares. The only thing that is published is the total shareholding of the directors. I believe that is published in our annual report and also any financial prospectuses that are issued. I just can't give you the answer to that now, but I think the directors hold something like 10% of the shares.

MR. CLARK: And members of their family could also hold shares?

MR. SMITH: Oh, I have no idea about members of the family. If this wording indicates directly or indirectly, then I presume it means members of the family, but whatever the wording is in the document, in the annual report it is about 10%. Somebody asked one time if that 10% of shares controlled the Company, and my answer to that was they do if the other 90% don't turn up or send in their proxies. The annual meeting is being held in Charlottetown on May 11, so any shareholders who are here are welcome to attend. I'm not sure where it will be held yet, we have always held our annual meetings at our office on Grafton Street here, but if more than half a dozen shareholders turn up, we won't have room for them, so we will probably move out to some other location which will give us more space this year.

MR. LEE: Mr. Smith, could you tell us who the Chairman of the Board is at the present time in Maritime Electric?

MR. SMITH: Yes, Mr. Mallory. He is one of the directors who is also a director of Montreal Engineering.

MR. LEE: He would also be Vice-President of Montreal Engineering and the Chairman of Monenco as well, wouldn't he?

MR. SMITH: He's a director, yes. Monenco is a holding company for Montreal Engineering and Monenco has a number of companies, and you can be a director of Montreal Engineering and/or Monenco, I think - I'm not sure.

MR. LEE: Would this individual abstain from voting, for instance?
MR. SMITH: In certain things, yes, he does. As Chairman of the Board, he doesn't vote anyway unless there's a tie.
MR. MCINTYRE: I am wondering, Mr. Smith, how much is it costing your company for the cable between Murray Corner and Prince Edward Island? Do you have a lease arrangement with the Government that your company pays so much a year?
MR. SMITH: That's right.
MR. MCINTYRE: Would it be fair to ask how much is involved?
MR. SMITH: It will depend what the interest rate is. But it's about $1.8 million a year, that's our estimate again based on two things. One is the Crown Corporation rate for the federal portion of roughly $9 million, the other is the provincial borrowing rate. Now we've estimated that these will amount to about $1.8 million a year.
MR. MCINTYRE: And for how many years?
MR. SMITH: For 30 years.
MR. MCINTYRE: It's a 30-year lease?
MR. SMITH: Yes, and this is designed to repay the Province for their costs.
MR. WILLIAM ZIMMERMAN: It's based on 400 kilowatt hours per month, which is very close to the average.
MR. SMITH: Which is lower than the average.
MR. ZIMMERMAN: It's 433.
MR. SMITH: The average is now over 500.
MR. ZIMMERMAN: Well, based on the 1974 figures.
MR. SMITH: You're using the present rates.
MR. ZIMMERMAN: I realize that but you only gave us consumption figures for 1974.
MR. SMITH: That's right, yes. I think the present ones would be a little lower than that, probably 5¢.
MR. ZIMMERMAN: For urban and then around 5.5¢ for rural.
MR. SMITH: I would think a little less than that, but I'm not sure.
J. WALTER DINGWELL, MLA: Mr. Smith, I don't know if you would perhaps wish to comment on this particular aspect of it, but both you and Mr. Brennan, in your excellent presentation, which we can't find too much quarrel with, emphasized something that is perhaps more peculiar to Prince Edward Island than any other part of Canada, and that is simply this: you have certain built-in protections that people in private industry don't, people who are responsible for the economy of the Island, to take care of your depreciations and increasing costs of labour. But we, the farmer-producers, with our dwindling returns from that area, don't have those protections, and have to live on depreciation to a great extent in times of problems such as now. Your protections come out of the same producer dollar as ours do, but we find ourselves in a not very competitive position as primary producers with the type of industries that we have here on Prince Edward Island.
MR. SMITH: This opens up a pretty large subject. I think I would answer it this way: I said this morning that we are a monopoly, there's no question about that; we are the only producer of electricity in

Prince Edward Island and as such have a monopoly and with no regulation, no controls. We could charge whatever we liked for electricity and make large profits, and if we were allowed to, things would be very difficult and we would be very unpopular. But what has happened in Canada in these cases, governments of the provinces have set up regulatory bodies, Public Utilities Commissions, to protect the consumer from our making excess profits; they also at the same time protect the utilities from earning too little. In other words, the Electric Power and Telephone Act says the utilities shall be entitled to earn a return that is just and reasonable, or words to that effect. Now a just and reasonable return on investment is, the Commission has decided, these days between 9-1/4% and 10%. Prior to 1970, it was 7%, and it has been allowed to rise in recent years so that it is now 9-1/4% - 10%; and that incidentally, I believe, is just about the average, or a little below average, that privately-owned utilities are allowed to earn in Canada these days. In our application last summer, we asked for a slightly higher rate and we were reduced to 9-1/4% to 10%. So the customer has the protection against our overcharging, we have the protection against underearning, and the Commission says we should earn this minimum - if we don't, we are jeopardizing our financial structure and creating problems in selling our bonds. On this same subject, I would like to, if I may, come back to a question that was raised this morning a bit, and one I tried to explain at our news conference on Monday afternoon, not as successfully as I'd hoped. It's my fault because it is a little bit complicated, and it relates to our earnings per share for 1975. This is not a share value as was suggested this morning. It's the amount of money that each share has earned in the year 1975. In 1974, it was 87¢, and in 1975 we will be reporting $1.42. Now the reason for that drastic increase is the fuel clause. As you know, the fuel clause now has a two-month lag, so that, for instance, the money we spend in November is not recovered until January. So if we just took the money we received in 1975, our earnings per share would have gone from 87¢ to 96¢ - 9¢ increase; however, the auditors insisted that we include in our 1975 revenue the amount of the deferred fuel, which is really a bookkeeping thing, because really there are 14 months of fuel revenue included in our 1975 figures. This is what I was trying to explain to the media and I wanted to try to explain it here. It's a one-time thing, and it does indicate, just looking at the two figures, that we have jumped from 87¢ last year (well, actually our third quarter report was about the same as the 87¢, not much different) to $1.42, or 60-some percent. Well, it is due to the fact that there are two extra months of fuel revenue included at the auditor's insistence - they said, "If you don't do this, you don't put your statements in this way, we must add a note to your financial statements that you should have done it!" So we did it.

MR. MCINTYRE: Did I understand you to say just a few minutes ago that we had a rate of 4-1/2¢ per kilowatt?

MR. SMITH: This is for the rural you are speaking of?

MR. MCINTYRE: Yes.

MR. SMITH: Again, I'm not sure; they did some little arithmetic here, but they used the average of 1974, which was the lower use, with 1976 rates, so you don't get the right answer.

MR. WELLS: Using those figures, they came in at 5.8¢. Now Mr. Smith points out that the average has risen since then, and it has come down to somewhere between 5¢ and 5.5¢.

MR. SMITH: Have you the rate there?

MR. ZIMMERMAN: I can calculate that again if you would like.

MR. SMITH: Work it on 6-1/4 kilowatt hours.

MR. ZIMMERMAN: No, that's way above, even giving a 12% increase over the 433 for 1974, that's much higher than you could possibly have for the average consumer, if your 1974 figures are right. The 1974 figures come out to 433, and 12% on top of that, assuming that every consumer grew at 12%, that's 484 per month, averaged over the year.

MR. SMITH: That's for one year?

MR. ZIMMERMAN: No, I just added 12%.

MR. SMITH: Oh, I see.

MR. ZIMMERMAN: I doubt that your growth per consumer is higher than 12%.

MR. SMITH: Well, some consumers grow more than others.

MR. ZIMMERMAN: Well, yes, but we are talking about the average.

MR. SMITH: Well, I think the average rural residential customer is now about 625 kilowatt hours a month. Again, I am talking from memory and I'm not sure.

MR. ZIMMERMAN: Well, unless your figures are wrong, it can't be right.

MR. STEWART: Well,if you took the total for 60 homes, it would come out to 36,400 kilowatt hours for a month, so it's 607.

MR. SMITH: I'm sure it's over 600, but just how much over I can't be sure.

MR. MCINTYRE: No, I was just basing it on a kilowatt hour at 4-1/2¢ per kilowatt: supposing we took our figure this morning at 5,200, it would work out to $234 per year, which would be $19.50 per month, and I find this a low figure. We as members of this Assembly, I know all of us are getting complaints, and the figures seem to be a lot more than this - I just wondered if this was a reasonable figure.

MR. COMPTON: Mr. Smith, has there been any problem in the past with meters giving a wrong reading?

MR. SMITH: There are more problems with meter readers reading the wrong figures than there are with meters giving the wrong reading. A meter, once it is set up, and properly calibrated by the Federal Government inspectors and sealed will invariably run correct or slow. In the past 13 or 15 or something years we have had a number of tests carried out on customer's requests. These tests were carried out by the Government inspectors, not be ourselves, and in that period two meters were found to be recording too high. One of those was creeping - that means that if all the load is turned off in the house, the dial turns very, very slowly, and it must turn a complete revolution before it starts to creep. This meant a rebate to the customer of a few cents for a long period. The other meter has been incorrectly installed; the register, the dials had been incorrectly installed and this had been missed in the tests and the meter was incorrect when it was originally installed and that customer got a rebate. But there's no way I know of that a meter will run fast once it is originally set up correctly.

MR. MCINTYRE: What is the procedure from a Company standpoint for someone who wants a meter checked or tested? Is there a financial burden on the user for this to be done?

MR. SMITH: The procedure is that the customer should contact the inspectors in the Government Office over in the Federal Building, Mr. Frank Strain, and say that he wants his meter tested. He pays I think 75¢. He or the inspector or somebody contacts the Company, and the customer pays a deposit of $5 to cover part of the cost of going out to get the meter and bringing it into our shop. It comes in with the seals intact. The inspector then comes into our meter shop and tests it with his standard, and he then reports to the customer. If the meter is reading outside the tolerance, they are allowed plus or minus 1%, say. If it is reading within that the meter is judged to be accurate and the customer's deposit remains with the Company and the 75¢ is charged by the inspector to the Company and that's it. The meter goes back. If the meter is reading fast, as I said there were only two of these in 15 years that I know of, then the meter is recalibrated, retested, and either put back or a new meter is put back, and an adjustment is made to the customer, based on the current regulations of the Department of Consumer and Corporate Affairs.

MR. MCINTYRE: That's an adjustment on the meter readings?

MR. SMITH: That's right, based on the time specified in the Act, and, I believe, it goes back to the time the meter was installed if this can be proven or shown; otherwise, it goes back three months - I'm not just sure. If the meter was correct, the customer pays the $5.35; if the meter was inaccurate, he gets his $5.35 back; and if the meter is reading fast, he gets a rebate; if the meter is reading slow, he should get a bill.

MR. MCINTYRE: Something else was mentioned earlier, a large windmill being considered for Maritime Electric, is this for a backup or emergency or is it to reduce the load either Borden or Charlottetown?

MR. SMITH: I mentioned that I had some discussions with government people on the possibility of working with them. I don't know where this is; the gentleman with whom I spoke said they were contemplating the installation of a relatively large windmill, and we discussed the possibility of the Company working with them. I don't know the details. I heard no more about it since our original discussions about a month ago.

MR. MCINTYRE: It was just a discussion up to this point?

MR. SMITH: As far as I'm concerned, it was just a discussion; now the Government may have some location in mind, I don't know.

LEONCE BERNARD, MLA: Mr. Smith, I was led to believe that when you are using electricity to heat a home, and you have houses built according to the standards, you get a reduced electric rate.

MR. SMITH: That's right.
MR. BERNARD: Now somebody was telling me that in order to get this reduced electric rate, you are not allowed to use any kind of other heating in the home. Is this policy of Maritime Electric?
MR. SMITH: This is the way the regulations were set up in 1968 when this rate was established, and the rate was established at that time to be roughly 10% below the normal residential rate. Now with increases in fuel costs, fuel adjustments, that is whittled down so that it is around 6% now, and the reason for the slightly reduced rate is not to give these people a bonanza or anything, but to give the Company some control over their insulation installation; because if we didn't do that, people would be putting electric heat in uninsulated houses or poorly insulated houses with resulting astronomical bills. Some people say they are astronomical enough anyway. Now these regulations have since been revised and are much more stringent now than they were then. We started out inspecting all the homes, and we found some rather horrifying results of insulation being installed. It was left out of places it should be put in; if insulation specification calls for 4 inches, they might put 2 inches in; and if certain specifications call for insulation between the first and second floor using ceiling cables, people left this out with the result that their upstairs was too hot, the downstairs was too cold and the bill was too high. Our inspector went into one house and the walls had all been stapled with the black rolls of insulation, you know, you are familiar with them, the black paper with the insulation inside, and it looked fine. For some reason he happened to touch one and it felt a little bit funny; he examined it and he found that there was nothing there but paper. The insulation had been scraped off and the bare paper stapled to the outside wall. This was obviously fraud of some kind, and, of course, it wasn't passed until it was fixed up. We had found, and I've found myself personally last year in building a home, that the builders do not appreciate the value of properly installed insulation. They think it's something that anybody can do and as long as it's stuffed in. You'll find spaces between the insulation and floor joists, and between the insulation and the wall studs. They'll think that wood is just as good insulation as fibre glass. And I had a lot of arguments with my builder over that point until I got a book and showed him that fibreglass was about four times the insulation value as wood. He was putting headers over the doors and windows with no insulation. And we finally got this straightened out and put some insulation in there as well, but it's not as much as it should be. But these fellows do not appreciate the value of insulation being properly installed. I pestered this fellow until he hated to see me coming around about insulation and other things, but even so, I know it's now installed the way it should be.
MR. BERNARD: My question is, when you are getting a subsidized rate, apparently you can't have a stove in the basement to assist your heating.
MR. SMITH: This is the way the regulations read. That it was supposed to be covering all the energy requirements in the home except

for a fireplace. Now most utilities in Canada have given up this preferred rate and electric heating just goes on like any other rate and the utility isn't concerned, apparently, with whether the insulation is in as it should be or not; that's left to the builder or the owner. We still retain this here, I'm not sure whether we should or not, but at least it does insure that the building is insulated to the required standards, and I don't think we are going to get very excited if there is a stove in the basement. The customer would be disqualified for failing to have insulation down to two or three feet below grade. If he has a cold basement or a crawl space and doesn't have insulation under his floor, under his first floor, he's disqualified.

MR. BERNARD: Another question. Is Maritime Electric doing anything to encourage the public to conserve energy?

MR. SMITH: We are trying to. We've sent out a number of bill stuffers, which have some effect, about the wise use of electricity, trying to suggest ways that customers could still use their appliances and facilities, but not waste. We have sent out, we have available, I'm not sure it's been sent out to all cusomters, pamphlets showing the average consumption per hour of various appliances: electric water heaters, mixmasters, so on and so on. We sent out a pamphlet on the care of appliances - how to look after your cooking utensils to get the best out of them and so on, and we've done a number of things like that. We haven't mounted any advertising campaign particularly. We don't advertise promoting electricity. We are not very popular with some of our salesmen in the news media because we don't advertise more. Any advertising we do is well, perhaps for safety week, fire prevention week, or something like that. But we have not any particular program budget for conservation, yet.

MR. MCINTYRE: Something that was said earlier today, Mr. Smith, was concerning Hydro Quebec having no power for sale or something to this effect.

MR. SMITH: That was Mr. Richardson's statement, I believe.

MR. MCINTYRE: Well, I'm not sure who, and Gull Island in Labrador because of costs would be a remote possibility; would it be fair to assume that any extra electricity that we must have would have to come from Point LePreau?

MR. SMITH: Not entirely, no. As Mr. Richardson said, the present negotiation with New Brunswick would pick up energy at the Memramcook interconnection, but the cost would be based on LePreau. Now where the energy comes from is hard to say, there is a saying that it's a very smart kilowatt hour that knows its own generator, so it might come from Nova Scotia; it might come from New Brunswick; it might come from probably the nearest or the least resistance route, but it would be based on LePreau costs, as if it were coming from LePreau as I understand it. Perhaps Mr. Richardson could amplify that.

MR. MCINTYRE: It would appear from project figures that people are going to use more, that we are going to have to depend on someone outside of the Province for our extra electricity, is that right?

MR. SMITH: Not entirely. The options I put to you this morning, including generation on the Island, and generation off the Island. They were all expensive, particularly the ones on the Island. The LePreau purchase was the least expensive, the next least expensive, I believe from memory, was the 30,000 kilowatt negotiation that is going on now. That's all I have to say about nuclear, pro or con. It appears to be the least expensive.

MR. WELLS: Mr. Smith, in your estimation of the Doxford Diesel, you came up with a figure of 3.7. Did you take the cost of money into that figuring, and if so, at what cost was the money?

MR. REYNOLDS: To answer your question related to the Doxford Diesel quoted at 3.7¢ per kilowatt hour: this is the relatively slow-speed diesel engine that formed the kernel of a presentation by a firm here in Charlottetown a few weeks ago. It's a marine diesel engine that has seen service for some 30-odd years, a marine propulsion service, and it is now in the process of being applied to land-based generation. We got information across the Telex, and we had some people work the numbers together including, I believe this is Mr. Wells' question, the consideration of the export terms that would be applied by a British firm supplying to Canada, and calculated, based on 1980 dollars, a size equivalent to the suggested 30 megawatts which might be an entitlement agreement from New Brunswick. It was all of these factors that were taken into account to make some kind of a reasonable comparison.

MR. WELLS: Well, I want to talk to you sometime, not now, further on it, because our figures even at $15 are 2.7, I think it was, and that's quite a considerable difference.

MR. REYNOLDS: The people who gave me that number said it certainly warrants a much harder look. It does look good, but they were unwilling to suggest any better number than that.

MR. WELLS: The figure you have for LePreau, 2.45: that is based on the current, most recent estimated price for the LePreau plant, and if - perhaps Mr. Richardson should respond to this - a long-term agreement is reached, the price is based on the actual cost of the LePreau plant when it starts generating power, is that correct?

MR. RICHARDSON: That's correct. The figure we are using that was used in that instance was 679 million, so you could add another...

PREMIER CAMPBELL: Were we not told this morning that the present estimate is 684?

MR. RICHARDSON: Yes, but that's less than 1% difference, so you can make it 2.46 instead of 2.45, and that 684 million does include 13% per year escalation every year from now until 1980.

PREMIER CAMPBELL: Does that include as well the cost of transmitting the power?

MR. RICHARDSON: Yes, it does.

PREMIER CAMPBELL: To Borden?

MR. RICHARDSON: To Borden, yes, sir.

MR. WELLS: But if in fact, the LePreau plant came in at a higher rate, then this figure would be adjusted accordingly.

MR. RICHARDSON: Yes, it would, it would be a higher figure.

MR. MCINTYRE: This $30 million cost of cable - I believe Mr. Smith mentioned that his Company was paying $1.8 million per year for 30 years for this cable. So what you are saying then is that Government is buying the cable, but your $1.8 million would replace this cost to government, is that right?
MR. SMITH: That's correct.
MR. LEE: Mr. Chairman, I would like for a moment to direct a question to Mr. Smith. A statement you made, sir, that Maritime Electric is enjoying a monopoly on producing electrical power here in the Province: I would say that it's the only privately-owned company in Canada that enjoys a monopoly like that in a province.
MR. SMITH: No, it isn't. Alberta has, as far as I know, two main utilities, which are privately owned - Alberta Power and Calgary Power.
MR. LEE: The balance, then, would be publicly owned, is that correct?
MR. SMITH: The other provinces' utilities, with the exception of Newfoundland's, are pretty well all government owned. Newfoundland is divided - the Government Commission there, I'm not sure of its present title, has taken on responsibility of generation and high voltage transmission and have left the sub-transmission, distribution, and dealing with the customers to the privately-owned Newfoundland Light and Power Company.
MR. LEE: My next question, Mr. Smith: do you feel that a provincial government could run a plant similar to Maritime Electric more cheaply and pass on the savings to the consumer by not having, for instance, the shares to worry about, and the profits...?
MR. SMITH: Well, I'm afraid I wouldn't know how the provincial government might operate the plant, so I don't think I'm competent to answer that question.
MR. LEE: From your experiences in other provinces? And no doubt you have studied these.
PREMIER CAMPBELL: Power is cheaper everywhere else.
MR. SMITH: There's your answer.
PREMIER CAMPBELL: And they are all run by governments.
MR. SMITH: Nova Scotia's catching up fast, though.
MR. LEE: But overall, could a provincial government operate it more cheaply not having the built-in shares to worry about?
MR. SMITH: I don't know. I guess they could because they wouldn't have the shares. They wouldn't have the income tax. Of course, we pay federal income tax, 95% of which is returned to the Province. Alberta has the same situation. Their income tax is returned to the Province and the Province passes it to the consumer through the utility. In Newfoundland, I don't know just what the situation is. I think when Brinco were operating, they received it, and the Newfoundland Light and Power did not receive it - I'm not too sure of their situation. In Nova Scotia, when the Nova Scotia Light and Power was operating, I think they received it, or a part of it, and passed it on to municipalities that they served who used it to keep their tax rate down.
MR. LEE: A take-over by the Province certainly is something that I don't imagine you spent too much time looking into, but ...

MR. SMITH: Well, it's certainly a possibility. It's been a possibility for years, and I don't know what will happen in the future.
MR. LEE: Maybe the Premier might have a comment on that if they've looked into that possibility.
MR. SMITH: Make an offer, it depends on who's complaining that day.
MR. COMPTON: Mr. Smith, you mentioned, if I understood you correctly, that you paid $1.8 million a year on that cable?
MR. SMITH: Of that order, I said it depends on the interest rate and it depends on the final cost too.
MR. COMPTON: That would be roughly $54 million in 30 years. Does the Federal Government not pay part of that?
MR. SMITH: The Federal Government pays 50% or up to $18 million as a direct grant, not repayable, that's from DREE. The Department of Energy, Mines and Resources provides a loan of up to $9 million or 25% at Crown Corporation rates. The Province is responsible for finding the rest. If the cost goes over the estimated 36 million, the excess is the Province's responsibility, and, of course, will add to the amount that has to be repaid. So this $1.8 million is an estimate; of course, there is an awful lot of interest in that.
MR. MCINTYRE: What was the reason for not taking the shortest distance - 13.9, I believe, was the mileage? Was there a reason from an engineering standpoint or electrical standpoint for not coming directly?
MR. SMITH: Not from an electrical standpoint. From, I suppose, a safety standpoint. The shortest route has the greatest build-up of ice because the ice is trying to pass through a restricted area, and it is more apt to raft and pile up, so we looked at three sites actually, the shortest site which was Germaine Island to just west of Borden, almost the old causeway route, the route we selected from Murray Corner to Sea Cow Head which is some five miles west, and the third route roughly Wood Islands to somewhere just west of Caribou, Nova Scotia. Now all three routes came out reasonably close. There were pluses and minuses and various things, but the total cost of them all came out approximately the same. At the time the decision was made, there appeared to be more opportunity to get power from New Brunswick than from Nova Scotia, New Brunswick being closer to Quebec. If there was anything from Quebec to Labrador that was closer, so the decision was made to go to New Brunswick rather than Nova Scotia. The decision was made to go to the longer route, Murray Corner to Sea Cow Head to avoid this ice damage. And one of our biggest concerns over this whole negotiation of cable safety is to protect it from ice.

March 31, 1976 P.M.

5. NUCLEAR POWER

MR. ANDREW WELLS: Good afternoon. This afternoon we are going to be examining nuclear energy, and the first area we want to look at is possibilities of nuclear power.

To lead off the presentation we have with us Mr. Ian MacKay who has extensive experience in the nuclear field. He's spent some time with the National Research Council on the Chalk River Project, and some time with Canadian General Electric Company,Limited as Manager, Engineering Nuclear Power. Since 1970 he has been with Atomic Energy of Canada Limited, Marketing Development, particularly involved with technical liaison with Australia (Mr. MacKay tells me that they didn't buy a Candu Reactor). He has also liaised with the Government of Argentina, and I think most of us know now that they did buy a Candu Reactor. Now, Mr. MacKay, you lose some and you win some, and depending on your point of view it's either a loss or a win. I would now ask Mr. MacKay to come forward.

The Possibilities of Nuclear Power

MR. IAN MACKAY: Thank you Mr. Chairman, gentlemen, its a real pleasure for me to be here for several reasons. One is that if I can, of course, do anything to enlighten people on the subject of nuclear power, I am happy to do that; another reason is that I spent many summers here as a boy, about 12 summers over on Holland Cove, and have returned a few times; but this is the first time that anybody's paid my way back here. Now, being here brings back many very happy memories. I can remember counting the sailing schooners as they left Charlottetown Harbour when there was a good wind, and we got up to 22 one afternoon, which was a very energy conserving operation. Remember the old paddle wheel steamer ferry that used to run to Rocky Point? I think it died just about the same time as its Chief Engineer, who, if I remember rightly, was Archie McGuigan. I may have the name wrong. And it also brings back memories of oil lamps and wood stoves and kerosene cook stoves with blue chimneys and that sort of thing. And it brings back the realization that we have come a long way in the use of energy. Whether that is an advancement or not in all details is debatable. And also I'm here with a certain amount of trepidation, representing, I suppose, the nuclear power industry, being paid by the Federal Government at the moment, and I suppose being branded as a merchant of death and all that sort of thing. And I definitely don't have all the answers; I am looking forward to questions but by no means do I kid myself that I can give all the right answers.

What I'd like to discuss first of all, briefly, is what nuclear power is. I would like to say what it can and cannot do, look into costs in very general terms (because to be specific in costs you have to refer to specific stations) and then if there's time go into safety aspects and some of the wastes and disposal of wastes of nuclear stations.

Mr. MacKay (continued):

Now, I've planned this talk on the assumption that there will not be, at least for a long time a nuclear power plant actually located on this Island. I see no way that it could be a viable economic proposition for a long time. If the Island goes up to a couple of million people that's something else again; I hope it doesn't. So I'm talking about it from the point of view that you might or might not at some time buy into a share of a nuclear plant on the mainland.

Now first of all, what is nuclear power? Well, it's just a method of generating electricity using uranium as fuel instead of oil. It has practically no technology in common with nuclear bombs. This, of course, is undramatic, and any possible relationship with bombs is much more news than claiming no relationship; so you can't blame the media for reporting on that sort of thing. But I think its reasonable to criticize a national magazine, as happened two or three years ago, when they wrote that feature article on nuclear power in Canada and illustrated it with only three pictures, all of them atomic bombs. I think this is dishonest.

Now I would like to show you a slide of a fuel bundle being held by a person before it's put into a reactor. It weighs about 52 pounds. It's fairly easy to lift. For the benefit of people who can't see it, it's 20 inches long, a half a meter these days. It will generate in the reactor about a million kilowatt hours,equivalent to, if my calculations are right, about 1700 barrels of oil. Well, it costs about $1,200, and that's equivalent to buying oil at 70¢ a barrel. So the fuel is not free, but it's very cheap. Canadian reactors use natural uranium, uranium that does not go through the process of being enriched. I won't describe that process, but it is expensive and it is energy intensive, so that the cost of enrichment will go up in the future as the cost of primarily electric energy goes up. In the United States particularly, in the rest of the world virtually, the reactors use enriched uranium, and the net cost of fuel is about three times the cost of fuel for a Canadian reactor.

Now the reactor: that's a general full diagram of a nuclear power plant, a Canadian nuclear power plant. All it says is that there is a tank, a reactor tank, which has actually several hundred tubes running through it horizontally. The tank is about 25 feet in diameter. It's not very heavy; it has half-inch to two inch walls, and it's about 20 feet long. Each of the several hundred tubes carries a dozen fuel bundles. There are several thousand fuel bundles in a reactor. Outside the tubes and inside the tank there is heavy water carried at room temperature and room pressure; it's not highly pressurized. Inside the tubes there's heavy water, but it is at a high temperature and a high pressure, 1,500 pounds per square inch or so, and it is pumped past the fuel, which gets hot, to carry the heat to generate steam in heat exchangers. The steam goes to more or less ordinary turbines.

Next, I want to show you a picture of a model of the reactor vessel which is a great deal more complicated than the diagram shown originally. However, it is the heart of the reactor.

This is a view of the end of an actual reactor. You can see the ends of the several hundred tubes and each tube has a pipe going from

Mr. MacKay (continued):

it, (to it at one end and from it at the other end) to carry the high pressure heavy water. The way that fits into a building can be seen in that diagram - down near the bottom in the centre is the reactor tank. The building is some hundred and, I think, 30-odd feet diameter and a little bit lower in height. It is about four feet thick of concrete, it is heavily reinforced.

Well then, the next step is a picture of the Pickering Nuclear Power Plant about which you have to have heard (there's no way you could avoid hearing about it). It has generated more kilowatt hours than any other nuclear plant in the world. Last year, one of the reactors, No. 4, the nearest one actually, was shut down most of the year because the treatment of the alloy in the pressure tubes was wrong, and they had to replace a number of tubes. However, the reactor was repaired and is now operating at full power. Running on three out of four reactors, most of the time, the average capacity factor of Pickering was considerably above the average for the rest of the world; and in the years up until last year, when it had all four reactors going, it was generally the most reliable nuclear plant in the world. The fuel is handled by hand - it will work a geiger counter, but it's not harmful to handle before it goes into the reactor. After it comes out of the reactor, it must be removed by remote handling equipment which is the only really complicated part of the reactor from a mechanical point of view; and these machines, worth between $1 and $2 million a piece, are completely computer-controlled and operate behind shielding. They have to be brought out away from the reactor if they require any servicing. This is a feature of the Canadian reactors which permits them to have high capacity factor because it is not necessary to shut down the reactor for loading fuel. United States reactors, light water reactors, all have to be shut down approximately once a year for usually a period of four to six weeks to re-load the fuel. Then if fuel fails during the following year, the cooling system activates and they carry on until it gets too active, but on the average the cooling systems produce a good deal more radiation than the cooling systems of the Canadian reactors. This affects only the operators. Used fuel that comes out of the reactor (and a 600 megawatt reactor I guess uses about 50 or 60 tons of fuel a year) is stored in a thing something like a rather deep Olympic swimming pool - it's about that size. The pool would be 20 or 30 feet deep, and this is enough to store fuel for ten years. Now the used fuel contains plutonium, which is about a quarter of one percent of the used fuel, and this is potentially useful in the future. Right now it is not useful. It is not useful for making bombs. I would like to emphasize that. It is about two-thirds the kind of plutonium that is useful for bombs and the other third is impurities which are very difficult to separate out - other isotopes of plutonium. However, within the ten-year life of the storage tanks of existing reactors we must decide, principally I guess the Federal Government must decide, whether to install equipment to re-process this fuel and extract the plutonium and then put what's left, which is virtually useless, into permanent storage. This

Mr. MacKay (continued):

would most likely be in tunnels dug in the rock of the Laurentian Shield, much north of Toronto, where nobody lives. It contains no useful minerals. The Department of Mines is looking over their records to find out where they have drilled holes that were total failures because that's the ideal place for storing the fuel. There's no ground water, virtually, because it's solid rock, and the rocks have been there undisturbed for about 400 million years and it looks like another half million years is a pretty good bet. The cost of storing 60 tons a year per reactor is a good many dollars, but very small compared to the cost of the energy generated.

Now, why worry about plutonium? Well, it can be mixed with natural uranium fuel and fed back into the same reactors that we have, with new uranium, and will about double the output of the fuel. Right now the cost of doing that is not economically attractive because the price of uranium is, well depends on who you buy it from, but say $30 a pound or something like that; but in the future if uranium becomes somewhat scarce and the price goes up, then it could become attractive. The other thing is that a long time from now we could run out of uranium, or run out of the cheaper supplies. It's almost inconceivable that we, in this country, can use all the uranium that exists here, but we have to export something, and exporting uranium right now is attractive.

Well, in this country there is about as much thorium or perhaps a good bit more thorium as there is uranium. And thorium can be mixed with plutonium and fed back into the existing Candu reactors without alteration, which then, due to the physics of the arrangement, can be used in its entirety. We actually only use the order of 1% of the uranium and throw the other almost 99% away. But by reprocessing the thorium and mixing it with plutonium to start with, stuff called uranium 233 is generated, which is somewhat similar to plutonium or uranium 235. It would be possible to go on for a tremendous number of years, decades and centuries, using this fuel cycle. It is going to be more expensive than the existing fuel cycle, but there's no chance really of running out of fuel for Candu reactors in this country before somebody thinks of a better idea of generating power.

So the point I am trying to make in this case is that, zero growth in the use of energy is fine; that's a commendable objective. It still means that you are merely putting off the time when you are going to run out of oil, or when oil is going to be very expensive; and it also means that, unless you also have zero population growth, after a little while you will, by definition practically, be lowering the standard of living. This may be necessary - maybe we are living, at the most, at the optimum time in the history of the human race. It's not a bad time. But eventually I can see no alternative but that most of Canada, not necessarily Prince Edward Island, will have to have nuclear power because there's no alternative.

Now, I would be glad to have interruptions and questions that I can answer any time, but I'll keep going.

What can you expect a nuclear plant to do? First of all, perhaps not obvious in the very rough pictures of the description of the reactor that I gave you, there are a great many portions of a nuclear power plant that have to be there whether the plant generates ten megawatts

Mr. MacKay (continued):

or 20 megawatts or 1000 or 1200 megawatts or what have you. So that if you reduce the power output of a nuclear power plant, of our type at any rate, the cost does not go down anything like in proportion. Sure, there's a 25 megawatt nuclear plant operating about 125 miles up the Ottawa River from Ottawa. That was a first demonstration nuclear power plant in this country. It is nowhere near economic to build, because the cost of its power, if you write off the capital expenditures, is much higher than alternatives. However, the cost of operating even this very small plant is such that every winter in the periods of peak power requirements of Ontario Hydro system, this little plant puts out its 25 megawatts with generally about a 95% capacity factor during December, January and February, and this is economic to do. However, nobody is offering in the world today, that I know of, nuclear plants smaller than the 600 megawatt size which we have adopted some years ago as a kind of a standard, and this is at least 10 times too big for Prince Edward Island, which is why I say there is no rationality in considering a plant to be built on this Island. Most new nuclear plants being built in the United States and also in Europe are 1100 to 1200 megawatts (a megawatt is a million kilowatts).

A nuclear plant can be run at any desired load. There's no restriction to the minimum load - there are some restrictions on the rate at which you can drop the load, but this is not a real limitation, because nuclear plants cost so much that it is highly economical to keep them loaded up and use them for the bottom part of the time-load curves mentioned by Mr. Smith, I think it was, this morning; in other words, keep the throttle wide open virtually all the time. And that's another reason why they don't fit in Prince Edward Island here. Like other plants they have to be shut down for maintenance periodically. Well, the average time for the Pickering reactors has been about 15% of the time per year, between 15 and 20%, including the almost one-year shutdown shared between two of the units (which used, I might say, a different material from previous reactors in their tubes). Also, a single generating unit should be less than 10 or 15% of the system capacity and also some percentage of the system capacity, you might say. The reactor that we sold to Pakistan several years ago was about 40% of their system capacity but they wanted it because a nuclear plant would be keeping up with India more or less, even though they don't have as advanced a technology as India has developed, and perhaps thank goodness. But when we said that if a nuclear unit, or any unit, of 40% of the capacity cut out, then most of the other units would cut out and there would be a blackout. They just said, 'So what else is new - it's better to have the lights on when it's running.' Ever since it started up, it has been available for full load, something like 75 or 80% of the time, but its actual output has been much lower. But with the rise in the price of oil it is now a highly economic unit, and they are using it instead of the oil-and-coal-fired plants, that were originally intended to be more economical.

Now to go into costs in a kind of a general way. A nuclear plant with its high capital costs and low fuel costs is much more like a hydro

Mr. MacKay (continued):

station, a hydro power development, than it is like conventionally-fueled power stations. A hydro plant, of course, you buy it once and operate it and the operation is cheap, relatively, and the fuel bill is essentially zero. Well a nuclear plant, once you have finished paying for it, has a fuel bill around 15% of the cost of power of that station. Now that's not on the same basis as the 37%, I think, fuel costs which was mentioned this morning as the contribution to the cost of power delivered to your homes here. The nuclear fuel for the Pickering station was about 1 mill per kilowatt hour last year. For a coal-fired plant in Ontario, the cost of coal is a little over 80% of the cost of power generated by the plant. Now for the Pickering Station, the first two units were paid for, partly by the Federal Government through Atomic Energy of Canada, the Ontario Hydro provincially owned utility (now it is a crown company), and the Ontario Government. And the agreement was that they should be repaid, based on the cost of power from a coal station that is built at just about the same time (the Lampton Coal Station); the Pickering Station is four units of 500 megawatts, the Lampton Station is the same. They are operated by the same utility, a utility which up until recently has saved money by putting high quality equipment in both stations. So there are three government outfits very interested in comparing the costs of these two stations accurately. The net result is that every year Ontario Hydro publishes the operating costs of the two stations. Last year for 1975 the costs of energy from Pickering was 7.03 mills per kilowatt hour and the cost of energy from the Lampton coal-buring station was 16.18 mills. That's about two and a half times the cost of nuclear power. The coal is purchased from the United States, but Ontario Hydro has in the past, and I think they still do, contracted for the whole output of a number of United States mines, and has managed to get pretty good prices for the coal. Now in actual fact the cost of power from the Lampton station was more than the 16 mills, because it was used as a peaking station and this 16 mills is calculated as if it were used to generate the same number of kilowatt hours as Pickering nuclear. Now the fact that the cost of fuel is very low, not negligible, but low, means that a doubling in the cost of uranium is very nice for anybody who holds stocks in Dennison Mines or anything like that, but it affects the cost of the nuclear power by a very small amount - about 1 mill if you doubled the average price of uranium which Ontario Hydro paid last year. This means that if the cost of nuclear power is the same now as an alternative, whatever the alternative is in the way of a conventional fuel plant, as escalation to something a lot lower than it is now, 10 years or 20 years from now the cost of nuclear power will be considerably less. When Pickering was built (it was committed about 12 years ago) estimates were that it would not be particularly cheaper than coal. That is, its costs would be, with luck, about the same but the effects of escalation were recognized quantitatively, even if nobody foresaw the amount. Now of course it's a tremendous investment for Ontario Hydro. Incidentally, Ontario Hydro is forecasting escalation rates for this year, 1976, of 13% and for 1980, 6% with a sort of a straight line relationship

Mr. MacKay (continued):

between. This is for capital projects that they buy. This means, roughly, that delays in deciding to build LePreau Station, for instance, have cost about a million dollars a week. Now that's a considerable figure, but it is the effect of inflation. This is, in a way, a large amount, but in another way it's largely due to devaluation of the dollar, and therefore it means that the more expensive stuff, that costs more money, in the years to come will be paid for by cheaper dollars. This doesn't go all the way. Doubling the cost for coal for Lampton would increase its cost by about 13 mills, incidentally, compared to 1 mill for Pickering ...... I want to divert for just one second and explain very clearly that I am, I hope, an engineer, but no politician and I look at things from the point of view of engineering and not from ever having to get elected, so some of the things I say may not appeal to members of any government. So I am saying now that in Ottawa, Ontario, the cost of electrical heat per BTU is just about the same as oil heating, and oil heating (I think I pay the same as you people do) is about 43 or 44¢ a gallon. Incidentally, my house cost 17¢ per square foot per year to heat compared to 25 that's been mentioned here. I don't think there's that difference in climate. So as far as electric heating goes now, is it a saw-off in Ontario. In the future Ontario Hydro will be increasing its generation capacity largely by nuclear. In the past it has largely used hydro, and in between it has put up some coal stations. Because of shortage of capital, it may be required to put up more coal stations in the next decade than would be considered the most economic route from a purely engineering point of view. However, this does mean that probably the cost of oil heating will increase more than the cost of electric heating, and therefore in Ontario, and Quebec also, electric heating could well be considerably more economic in the long run than oil. My house is heated by oil.

So much as far as general description of nuclear power plants and what's involved in them. I would like to talk a little bit about safety, although if you buy into a portion of a nuclear plant somewhere in New Brunswick the safety of the plant is only of secondary interest to you. It depends on your love for your fellow New Brunswickers, I guess, your fellow Canadians anyway. Of course safety, as I mentioned, is illustrated with pictures of atomic bombs and all that sort of thing, but I'd like to just take a few points rather than try to go into any kind of argument in absentia with Nader or anybody like that on overall safety. Nadar was in British Columbia last week and was reported in the paper I read as saying among other things that plutonium is the most toxic substance known to man. Well, it just isn't, and it's no secret. Plutonium is about nine times as toxic as caffein. In other words, if you substituted the amount of caffein in your coffee with 1/9th of the amount of plutonium you would have about the same net result, which is nothing - that is to ingest, to eat or drink. Mercury dichoride, which is one of the soluable forms of mercury is about twice as toxic as plutonium. You frequently read in the press that plutonium takes 24,000 years to decay - its half life that is. Well, of course, mercury doesn't decay at all; so you only have to look after plutonium for a quarter of a million years but you have to look after mercury forever. I haven't figured

Mr. MacKay (continued):

out the difference but anyhow that's the way it is. Now most, I believe, fluorescent lights contain selenium oxide - certainly they used to. There's a difference: if you breath plutonium dust as a smoke and selenium oxide as a smoke - a very, very finely divided dust - the ratios change. In that case plutonium is about five times as toxic as selenium oxide. However, radium, which we all know is toxic, because a lot of people died after licking their paint brushes in the days when radium was used for luminous watch dials, is about 8,000 times as toxic as plutonium. Its half life is very much shorter and that's largely why it's more toxic, because it gives its energy out much faster as its radiant energy. Botulism toxin, which I believe you can grow in your own backyard if you know how, and must be infinitely easier to produce than pure plutonium, is about three million times as toxic as plutonium. And anthrax spores, probably the most toxic substance, are about 30 million times as toxic as plutonium. So plutonium is simply not the most toxic substance known to man. It is toxic, sure. If you spread plutonium as a dust over a large city, somehow ran a crop spraying aircraft filled with plutonium dust over the city, you would expect to get - and this is based on quite accurate data - one death in the city within about 30 days (it wouldn't be immediate) for every 15 grams of plutonium, 1/2 ounce, if nobody knew it was being done. If there were a general warning so that people stayed inside and closed their windows and took no other precaution, it would take about 150 grams. But one of the United States speakers on the horrors of nuclear power, Gofman, who has talked in the west in Vancouver - I don't know if he has talked here, he charges quite a lot to make an appearance - he has claimed that one ounce of plutonium spread over a city or a country would kill 30 million people. Well this is a figment of his imagination and it's the kind of thing that makes news, and therefore of course is interesting for the news media to pick up.

No one has ever been killed by the nuclear part of a nuclear plant in the western world. I don't know about the Communist world. People sometimes say this is because nuclear energy is a new thing, but I think you should remember that the NRX reactor at Chalk River was started up just about 30 years ago and at that time there were no commercial jet aircraft in service. I don't think there were any television sets - it's not a particularly new thing. People have asked how we can calculate that a nuclear plant is safe. Well, no nuclear power plant has ever really blown up. You can say that it's dangerous to cross the street and you can estimate how dangerous. Well, I did it for Ottawa anyway: there are so many people in Ottawa, 300,000; there are so many cars in Ottawa; you know from insurance statistics roughly how many miles a car has driven a year - I don't remember, 15,000 miles and say 10,000 of that is in the city; therefore, a car on the average crosses so many crossings during the course of a year. You have to guess at how many pedestrians there are who walk to work or walk downtown or something like that. During the course of a year perhaps they cross a street an average of ten times a day. Well you can then, taking into account the effects of rush hours and so on, very approximately calculate the number of times the pedestrian and

Mr. MacKay (continued):

the car would be at the crossing together. There are traffic lights at some crossings, which reduce the probability of a pedestrian being hit - it doesn't eliminate it. If a pedestrian sees a car coming directly at him he is likely to take evasive action. Now I think the factor in Charlottetown here would be different from the factor in Toronto because of the number of pedestrians who have not taken evasive action in Toronto, a fair number of them have given up walking for one reason or other. A car driver, if he sees a pedestrian in front of him, will normally take evasive action. Well you can put down factors of ten, say you know that when a pedestrian sees a car coming right at him, he may not get out of the way every time, but if a car came right at him a hundred times he would probably be hit; so give it a factor of ten, it's between one and 100. Well you can add all this up and work it out for Ottawa that there should be between one and ten deaths in the way of pedestrians being hit by a car per year. The actual figure between one and ten statistically is three if you like, the actual figure for last year I think was six, and that's as close as you can be. How does that apply to a nuclear plant? Well, the first plant, the NPD of 25 megawatts, had a great deal of electronic equipment, thousands of relays, many hundreds of temperature censors and pressure transmittors, all that sort of thing. Every year a team analyzed every failure of every piece of equipment in that plant and translated it into the effects of failure of that kind of equipment in the larger plants. Well, it's the same procedure as trying to figure out how your chances are of crossing a street, and you can come up with a reasonably accurate figure. You could be out by a factor of 100 perhaps, but if the answer comes out that a nuclear plant is as likely to blow up as a city is to be wiped out by a large meteor, and that's about the same factor, you can figure that they are really pretty safe compared to a lot of other activities of man. So the numbers are not just picked out of the air. Just as an example: nuclear power does involve deaths in the uranium mining industry. To mine uranium to run the Pickering Plant for about five years would result, on the average, of a death of one uranium miner. Now that's a United States statistic. But coming also from the United States, the number of coal miners that would be killed from black lung disease, that sort of thing, in mining coal for the same size plant over five years would be 11, on the average, over the last good many years. Sounds awfully safe, but about on an average of every 12 years during this century, a dam has burst killing more than a hundred people, mostly drowning them, and the chances of people being killed by hydro power are considerably greater than the chances of nuclear power. I think I've laboured that subject enough.

Radiation also, because you can't see it or smell it, and have no way of detecting it except by instruments, creates fear. Minute amounts of radiation are detectable. It's common in medical and some chemical work to irradiate some element and mix it in an extremely small quantity with some other element or some ordinary non-irradiated

Mr. MacKay (continued):

element that you are trying to follow through a chemical reaction, perhaps; or irradiate piston rings of an engine when you are trying to measure the rate of wear of the piston rings. Then you measure the amount of radioactivity picked up by the lubricating oil and that's a measure of the amount of material worn off the piston rings. Because radiation is so readily detectable, we can detect radiation from stars millions of light years away. So in order to think about radiation it is necessary to think in terms of numbers - you can't just say there is radiation or there isn't radiation, that a nuclear plant must emit no radiation. Nobody ever worried about the amount of radiation emitted by a coal burning station until somebody figured out that it is probably more than came out of a nuclear plant; it doesn't affect anybody. And there are units, various other units such as millirems, which are handy to use if you are calculating or working with them. I am just going to try something on; I hope you don't kick me out. If you imagine the amount of radiation, ambient radiation, radiation here in this room if you like (I left the piece of uranium that I brought with me in my briefcase, I was going to pass it around) anyway, if you imagine that as being represented by a scale one foot long, it happens to be about 100 millirems. One foot of radiation is everywhere. The average number of X-rays that the people in this country have would add about eight inches to the total amount of radiation that the average person gets; some people get more. If you have abdominal trouble and get several X-rays, then you are adding a lot of radiation. It's to be avoided; doctors do not now use X-rays indiscriminately. The days when you could go into, I think Moore and McLeod along here, and put your foot on an X-ray machine and see whether your shoe fitted, well that could have been theoretically harmful, and those machines are illegal now. Now, we are shielded from cosmic radiation from other stars by the atmosphere. If you go to a city like Denver, Colorado, that's about a mile up, about 5,000 feet above sea level, you get a basic dose of radiation equivalent to about two feet - about double. They have done extensive studies of the occurrence of cancer in the population of Denver, and the results have been labelled inconclusive because basically there's less cancer in Denver than in the cities more near to sea level, and that has to be explained away by probably purer atmosphere and so on. If you move to Mexico City, you add about two feet of radiation to the one foot that you already have. The studies in Mexico City have been much less accurate statistically. There's one place in India, and there are other places in Brazil, where the same families have been living for many centuries, many generations, and the radiation there on this arbitrary scale, is equivalent to 20 or 30 feet, the height of this room say. And while detailed studies, statistical studies, have not been done, medical observers have sort of wandered around the town and have not been able to detect any unusual effects. Now these are the things that have not caused measurable effects. From Hiroshima and Nagasaki the effects of the two atomic bombs that have been dropped on people - if you assume radiation

Mr. MacKay (continued):

equivalent to what I have been talking about but measuring 3/8 of a mile on this one foot scale - this has killed about half of the people that it hit, and radiation equivalent to about 7/8 of a mile, 4,500 or something times ambient, has been always lethal as far as they could find. So you try to extrapolate what is safe from the tremendous amount of radiation from a nuclear bomb down to something very little. Now what radiation does a nuclear plant give out? Well since its start of operations, Pickering on this scale has given off radiation equivalent to a quarter of an inch, provided the person receiving it was living at the plant fence all the time, 24 hours a day. If you moved to the top of Tea Hill near Keppoch - I think that's the highest point on the Island - you would get an extra amount of radiation equivalent to about half an inch on this scale, about twice as much as living at the limits of the Pickering nuclear plant.

Now there's another point. To be safe, the International Committee on Radiological Protection which has no direct interest in nuclear power, either promoting it or not, and meets in Geneva or Vienna periodically, has assumed that from the amount of radiation which we know from nuclear bombs in Hiroshima will kill half the population, you can extrapolate down to saying that half that radiation will kill a quarter of the amount of people, a tenth of the radiation will kill a tenth of the number of people irradiated to that extent, and a millionth of that amount of radiation will kill a billionth of the number of people, in other words one person out of every two million that receive that amount of radiation. Well this is arbitrary but it seems safe. And it says that we should not add anything to the ambient radiation that we can avoid doing, which is what we are trying to do. However, I just want to point out that man has adapted to his present environment over centuries, thousands of years, so that almost every naturally occurring element or radiation or compound or what have you is beneficial to man or least harmful to man, in about the concentration in which it occurs. In other words if there were no sunlight you would get no crops, no potatoes, and so that would be fatal. Well it wouldn't be fatal to everybody. In Australia, where the sun is very strong and people expose themselves to it unnecessarily but not unattractively, there are many cases of skin cancer, which is relatively easily cured. One doctor told me that he figured that 40% of the cases that he saw in his office were skin cancer in Australia. So you can have too much sun, but the average amount of sun that the world gets is about right. Too much oxygen is fatal (it causes lung congestion); too little oxygen of course, is also fatal quite quickly. We spend a lot of money and in the past have used up a lot of gasoline because our cars are designed to reduce the amount of oxides of nitrogen emitted in the exhaust, because the amount emitted in San Francisco and Los Angeles is above the desirable amount. But most of the oxides of nitrogen in Canada, I believe, are created by lightning storms and occur naturally; this is one of the main natural ways of fixing

Mr. MacKay (continued):

nitrogen back into the soil. So there's an optimum amount of oxides of nitrogen; too much is fatal. You can have too little - I wouldn't say it's fatal, but it would affect the ecology. Potassium is radioactive - there's a certain percentage in our bodies. If you have too much of it, it is fatal; if you don't have enough of it, you go crazy. It affects your brain. No salt causes damage to various items, but too much salt is, I believe, an old Chinese way of committing suicide, neater than cutting open your last dinner. Now whether this assumption (the straight line extrapolation that if a lot of radiation is harmful, a little is less, and practically nothing, more than nothing, is the least harmful), is true or not, in the concentrations that affect us, could be determined by biological experiments. But it would take experiments, one United States scientist figured out, on about eight billion mice spread over quite a lot of years, many generations of mice, and then you would only know that it did or did not affect mice and you would have to relate mice to men. Now that's all I was going to say on radiation, and if anybody wants to know much more they can easily stump me on that subject.

Waste disposal, again, is a problem for the owner of the reactor and not for somebody merely buying power from it. Ultimately the intention is to bury it in the rock of the Canadian Shield, as I mentioned; but highjacking has been mentioned as a way in which terrorists could obtain plutonium from fuel being transported. Well, this isn't possible at all. The fuel containing the plutonium being transported to a reprocessing plant is tremendously radioactive, and to handle it at all, even for a second, would be fatal to the highjackers. It is carried normally in a 40-ton flask, which even a bunch of people don't pick up. That's a lead shielded flask. We could recycle plutonium by separating it out from used fuel in quite an expensive plant and behind heavy shielding so that everything is done remotely. We in Canada will not take the plutonium out of that plant but will, in the same plant, build it back into new fuel, which I think will probably end up being slightly radioactive but nothing like recently discharged fuel. So that we will never plan to ship plutonium as such. In the United States, particularly with fast breeder reactors, which need large quantities of plutonium to start up, there could be a requirement to ship plutonium and it would have to be guarded against highjacking. Incidentally, if we recycle plutonium and put it back into a reactor, it ceases to exist, and the problem of that plutonium of course is over. We do not have to keep it for 240 million years. Well, that's basically the situation in Canada. Partly we have a simpler problem because all the utilities that are using nuclear power, or are likely to use it directly, to buy nuclear plants, are government-owned, provincially-owned, and I guess if Maritime Electric ever used it on the mainland they would co-operate; but anyway the places in which nuclear wastes would be stored would be government-owned facilities, and the re-processing would certainly be government owned. And this

Mr. MacKay (continued):

is easier to cope with than the United States private enterprise system. Private enterprise has some advantages, don't get me wrong.

Now another thing that Nader said, as reported by the newspapers, was that the plutonium generated in India for their explosion was made in a Candu reactor. Well it was not made in the Candu power reactor, for the reasons that I mentioned. It was made in a research reactor which is called the Cirus, which stands for Canada India Research and then United States, because Canada supplied the reactor, India supplied their own fuel which they radiated, and the United States supplied the heavy water. India was also helped technically by at least Britain and France, I believe. This was sold in 1956, 20 years ago, before anybody ever thought of trying to define what a peaceful nuclear explosion was, and India promised not to use it for weapons. Anyway, the point is that exporting nuclear power plants does not, in my opinion, help anybody to make a nuclear explosive. If I may divert just a little bit, I am more familiar with Argentina than with Korea. Argentina has already an operating heavy water reactor which they bought from Germany. They bought one from us which is in the process of being built. They are still arguing about some of the safeguards, but they also have, if they wanted to generate weapons, grade plutonium, plutonium that would make a good explosive from either of these reactors. They would have to run them in a manner which would reduce the output of electricity. Well, they need the electricity, but the cost of doing this is extremely high, and they already have three small research reactors, the last one of which at any rate they designed themselves, and if they really wanted to make a bomb I am quite sure that they would have the capability and knowledge to build a reactor which could make a small amount of weapons-grade plutonium for their purposes. (Their only purpose would be to keep Brazil in line, if they thought Brazil was going to do something along the same lines, and Brazil would only do it if they thought Argentina was doing it). So I feel very strongly that exporting nuclear power plants has nothing to do with production or proliferation of nuclear weapons, but like chemical warfare, poison gas and biological warfare, mankind's only defence against them is from the diplomatic end, by agreeing not to use them or keeping some kind of a balance of power so that whoever uses them first will get hurt too, or something like that. I take quite a lot of encouragement from the fact that though millions of gas masks were made during the last war and carried around by many people, they were never used, as far as I know, for the purpose for which they were intended. Several countries have the capability for biological warfare. It's not expensive, but they have not used it and have not threatened it. I think that's the kind of route to avoiding nuclear proliferation. Now that's all I planned to say.

MR. WELLS: I wonder if it might be advisable to move on to the other two speakers immediately. I understand you can stay for awhile yet, and perhaps we could address questions to all three speakers following the two initial presentations. I understand the next two presentations will be about half an hour or less. I would now call on Dr. Gordon Edwards of Concordia University, Montreal, one of the founding members of the Canadian Coalition for Nuclear Responsibility, to talk about the problems of nuclear power.

The Hazards of Nuclear Power

DR. GORDON EDWARDS: Thank you very much. This is the first time I have ever been in Prince Edward Island, and I feel very privileged to be invited to address you. I think the Government of Prince Edward Island deserves a lot of credit for approaching these very serious problems of energy supply and energy demand, which are affecting everybody in the Western World, in such a refreshingly open and honest way, bringing the public as well as the entire Legislature, as much as possible into the discussion. People in other provinces, I think, are crying out for such openness, and in many cases they are not getting it. I think the people of Canada are also crying out for public accountability from the Government in Ottawa, and they're not getting it. This is witnessed by the recent debate, recorded in Hansard for Tuesday, March 23rd, which was the first debate ever held in Parliament on the nuclear question. It had to do with nuclear proliferation through foreign sales. I hope that you gentlemen are leading a parade. I think that in times like these, when even the people in Ottawa, and government leaders, the heads of corporations such as public utilities, really confess quite openly that they don't know the answers, or what the future holds in store, then in a situation like that, openness is the only sensible policy.

Now I would like to tell you just a tiny bit about myself, because I think it would be a good idea to let you know how I came by whatever information I have. The information which I have is almost all from available literature. You can get it from many different sources, but not everybody takes the same interest in following up a particular subject.

When I was in high school, I wanted very much to be a nuclear physicist. Like most young boys of my age I was absolutely infatuated with the power of science, and I firmly believed that science had the answer to most of the important problems facing mankind. Science seemed to be exact, precise, correct, predictable, reliable; there was no room in science for emotionalism or wishful thinking or superstition or stupidity. Science was based on truth and the truth of science did not seem to depend on anything like religious conviction, political persuasion, subconscious motivation or any of those subjective considerations which lead to clashes of opinion and violent disagreements. I graduated from high school in 1957, the same year that Sputnik went up. I was part of a parade, because there were certainly a lot of people going into science at just about that time. Well, 13 years later in 1970 I became the editor of an international ecology magazine called Survival. By that time I had become a mathematician, with advanced degrees in mathematics and also in English Literature, and about ten years experience teaching at the university level. It was only then, in 1970, that I began to learn about some of the dangers of nuclear energy. Until that time I had never had the slightest misgivings on this subject and I would like to just relate to you what happened to change my mind and to convince me that nuclear energy represents one of the most serious questions.

Dr. Edwards (continued):

If you like, nuclear energy is an extremely symbolic issue, because in a sense it raises the question of the role of science and technology in our society: to what extent should we entrust our future to the powers of science and technology? Well, the first shock came when I learned that the radioactive garbage from nuclear power plants does have to be stored safely for tens of thousands of years, and it also has to be cooled for a considerable period of time at the beginning of that storage period. Now, this is not an academic question; it's a very, very serious question. In the United Stated I learned that they had a liquid radioactive waste, which we do not have here in Canada at the present time. These liquid radioactive wastes were the result of re-processing of fuel, and they had hundreds of millions of gallons of these wastes stored in underground tanks made of stainless steel and concrete. These were designed to last 600 years, but after about 20 years, 5% of them were leaking and had already leaked several hundred thousand gallons of radioactive fluid into the soil. This radioactive waste which has leaked out fortunately has not done any great damage - it hasn't contaminated any water supplies or anything. The fact is, though, it shouldn't have happened, and it did. Now this material, as was indicated briefly, is extremely toxic. This material is not plutonium, incidentally; plutonium is a very small component in the waste. The main bulk of the radioactive waste consists of what are called fission fragments, the broken pieces of the uranium atoms that are split. When the uranium atom is split it doesn't disappear, but leaves broken pieces, which are themselves radioactive atoms of many many different kinds. They are called the fission fragments and are the major portion of radioactive waste. A single cupful of this liquid waste would be enough to ruin an entire city's water supply. Luckily this escaped liquid, as I said,has not contaminated any water supplies. But the question is raised of how to store a very dangerous quantity of material for that period of time. Considering that human civilization has only been on the face of the earth for 5,000 - 6,000 years, here we're talking about storing wastes tens, hundreds of thousands of years. It is certainly a sobering thought.

Now, I just want to say a word about the garbage which is produced. There was some mention made about the Hiroshima bomb and the toxic effects of the radiation. Of course it's known that besides immediate harmful effects such as death and radiation sickness and so on, there are also delayed effects. These include cancer and genetic effects which are passed on to the next generation. In regard to cancer production there is a latency period, so that it takes about five years after exposure to radiation before leukemia, as a result of the radiation exposure, begins to occur. And in the case of lung cancer it takes about 20 years, something of that order, so there is a period of time during which no effects in the population are noticed, followed by a sudden increase which is statistically significant and which is related to the radiation dose that was received. Now in a single medium-sized nuclear reactor in one year's operation you get a tremendous amount of radioactive garbage produced; it's the equivalent of more than a thousand Hiroshima bombs' worth of radioactive garbage, so that 1% of

Dr. Edwards (continued):

this radioactive inventory is, you might say, equal to ten Hiroshima bombs. This gives you some idea of the quantity of toxicity that we are talking about. As another point of comparison, when Pickering is completed there will be eight operating reactors. The radioactive inventory associated with a year's operation there is going to be an enormous amount; certainly a lot greater than the combined radioactive fallout from all the bombs that have ever been exploded in tests of any kind. Once again this is merely an attempt to convey to you some impression of the quantity of radioactive wastes involved.

Now in Canada we have not re-processed our spent fuel, as indicated by the previous speaker, because of the fact that we are in the infancy of our nuclear program. We've only worked with what you might call the front end of the fuel cycle; that is, the mining of the ore, the refining of the ore, the fabrication of the fuel, the insertion of the fuel, and the burn-up of the fuel. We have not yet addressed ourselves in Canada to the problem of what to do with the wastes when we are finished. And in fact nobody yet in the world has a solution ready at hand. This is a matter of extreme controversy throughout the world, and no one has come up with any scheme which has won anything like universal acceptance. I might mention one other scheme just in passing, called the Salt Vault Project. It was supposed to be fool-proof in the United States, where they have done a lot more work on this question of what to do with the waste. They claim to have spent $100 million and 15 years in research to determine the best geological site in the United States to dispose of waste, the idea being that the best way to dispose of wastes would be to bury the wastes in geological formations which had been stable for a long, long period of time, and located in remote, inaccessable areas. It certainly sounds like a good idea. What they finally settled on was a salt mine in Lyons, Kansas. Alvin Weinberg, who is the Director of Oak Ridge Laboratory, went to the United States Congressional Committee which authorizes finances for that sort of thing, and requested money to proceed immediately with disposing of wastes which were already accumulated in the salt mine. The Committee didn't want to give the money right off the bat. They said, "Well, why don't we give you 50% now, and when you've got fairly well along with the scheme, we'll review it and give you the rest." He said, "No, we would like to have the total amount right now, because we've spent a lot of time studying this and this is without a doubt the solution." It's all recorded - you can read exactly what Dr. Alvin Weinberg said. The fact is, he was wrong. Within a matter of months after he requested funds from Congress to use this mine, the idea came under very strong attack from a Dr. Hamilton who is in charge of the Kansas Geological Survey. He was very opposed to the scheme, and what he was afraid of was the fact that there might be water in the mine. If there was any seepage of water whatsoever into the mine, then because of the heat (these spent fuel rods are 1000° F or more) and when you have water seeping into the mine you could have a build-up of a steam explosion, which could lead to a venting of radioactivity.

Dr. Edwards (continued):

Now, it turns out that when they started poking about in the mine they discovered indeed that by drilling small holes they did get water and mud spurting into the mine, and it was later explained that there had been some tampering. These were man-made operations which had gone on and which had introduced water into the vicinity of the mine. The point that I am trying to make is that we are all only human, and mistakes are made. Everybody recognizes especially the people in industry, which is why they have taken such great pains to make the industry safe, that you really cannot tolerate any mistakes which are going to have major consequences in the nuclear industry. You have to make sure that you have complete control over the operation from beginning to end.

And I would also like to point out that, even if you did have a scheme for disposing of the wastes, you still have to transport them. You have to transport them from the reactor site to the disposal site, and in transporting them you have to use highways, you have to use rail, you have to use air, and you run into the problems of transportation accidents. Once again there has been work done in the United States on the consequences of various types of transportation accidents, and I don't believe there has been comparable work done in Canada, at least I haven't seen it. I think that it is assumed in Canada that the 40-ton shipping casks are going to be sufficiently strong that nothing will go wrong. Now in fact studies done in the United States indicate that in certain types of transportation accidents the shipping casks may not be enough to prevent an accident from occurring. So the first shock to my system was in realizing that despite all of the problems that we had brought upon ourselves through chemical pollution, which was really unanticipated - nobody set out to pollute the oceans of the world with DDT or anything else - here we were launching into another type of technology which was going to have a very dangerous by-product. The nice thing of course is that the technologists recognize the nature of the pollution well enough in advance to take precautions. But the sobering thought is, in view of our experience with big technology generally and with big bureaucracies generally, can we be assured that these precautions will be sufficient?

Well, the second shock came to my system about a year later in 1971, when I began to learn about the possibilities of accidents at nuclear reactors. Few people realize how demanding a technology is represented by a nuclear reactor. Some have called it the unforgiving technology, because severe damage amounting to, in some cases, the total destruction of the reactor can happen in just a few short minutes. The response times in emergency situations have to be extremely fast, appropriate emergency measures must be taken within a matter of seconds. This is why, of course, there is a tremendous reliance upon computer control and cybernetic control of one sort or another.

Now I would like to describe to you some of the theoretical accidents which everybody considers to be most unlikely. If anybody thought they were likely, nobody would build nuclear power plants. They are definitely unlikely accidents. These accidents are of a few types. One of them you might call a runaway accident. This happens when for some reason or other the rate of reaction within the reactor increases suddenly which, in fact, happens all the time. These rate increases are called

Dr. Edwards (continued):

transients, and the control rods are there in order to jockey the reactor back into normal operating mode. But occasionally you may have what's called a runaway, in which the reactivity builds up so fast that you're just forced to shut the reactor down right away, because if you don't shut it down right away the temperatures build up and you may have a melting of the fuel. The fuel and the tubes just begin to melt and when that melting occurs, you have violent chemical reactions taking place, and the chemical reactions may lead to chemical explosions, as has happened in various cases already. The other type of accident which is not a runaway accident but which results in a similar type of occurence, is called a loss-of-coolant accident. This happens when, once again through some very unlikely circumstance, you have a loss of cooling fluid passing through the core of the reactor. Once again, if the coolant is lost and if there is no substitute for that cooling fluid, then the heat builds up very, very quickly and within a matter of a minute, 30 seconds, the fuel begins to melt, and if this accident proceeds far enough if you have a very major melt-down as it's called. In the United States very crude calculations indicate that, for sure, in a very large meltdown, the melted material would be capable of melting through any structural materials in the reactor itself. This means that whatever floor you put on the building will be melted through, whether it's stainless steel or concrete or whatever it may be. And when this happens, you will have a release of radioactivity; you will have a release of at least the gaseous parts of the radioactive fission fragments that I described. They come in many different types; some of them are gases, and the gases amount to about 15 to 20% of the radioactivity. That's the order of 150 to 200 bombs' worth if you want to compare it with the original inventory. This kind of accident would obviously be a catastrophe, and the object of designing a nuclear reactor is to design it in such a way that this simply won't happen. The result is that you have a number of carefully worked-out safety devices. One of them is called the emergency core cooling system and it's purpose is to provide emergency cooling in case the original cooling system goes. Now I'm sorry to bring in these technical points, except that I don't think you can really have a meaningful discussion at all of the question as complex as nuclear safety without describing at least in general terms the possible things that might go wrong and what kind of protective systems exist to prevent those things from happening.

Well, I suppose I could enter into the whole discussion of the studies that have been done about consequences: what would be the consequence of a really major accident such as I've been describing, recognizing how unlikely it would be? There have been studies, again done in the United States (I know of no studies done in Canada; none exist that are publically available at least). But a 1957 study indicated that in the event of a major accident under very bad conditions, atmospheric conditions and so on, you could have radioactive contamination covering an area of 150,000 square miles, with property damage running into $7 billion (1957) and tens of thousands of people killed,

Dr. Edwards (continued):

some of them immediately, and some of them considerably later as a result of cancer induction. This report has since been superseded by several others. An update of the 1957 report in 1968 reached worse conclusions as to the consequences. I believe that its estimate was $17 billion in property damage and more deaths. More recently there has been a study done by Rasmussen, an engineer at Massachusetts Institute of Technology and a very well respected man, who did a careful study of accident analysis and probabilities. He concluded that although the probabilities of a major accident were somewhat greater than had previously been calculated, the effects of such accidents would be considerably less, although he still arrived at something of the order of $6 billion property damage. The exact figures I don't think are important as the fact that we are talking here about a catastrophe potential which from a man made technology I believe is unparalleled in human history. If through stupidity or through incompetence or through some kind of major accident, either internal, such as a major industrial accident, or external, such as a large plane crash or an earthquake, or through some act of malice, such an accident were to happen, then you would have an unprecedented catastrophe, which would result not only in immediate destruction of property and life but also in radioactive contamination which would last for a long time, and would make the area uninhabitable for a good long time. So this is of course a matter of great concern, and once again we ask whether this is an academic type of question, where you say, "Well maybe the worst possible thing could happen, maybe a meteor could crash into the city the size of Toronto and demolish it, if you had a large enough meteor." Is it that sort of thing? Well, no it is not. If it were that sort of thing, I think these fears would have been laid to rest long ago. The fact of the matter is that there have been accidents in reactors, and these accidents have almost always been of the kind that are totally unforeseen and they always involve a considerable component of human carelessness, human error, oversight.

For example, in 1952 in Chalk River there was a runaway accident at NRX reactor, which involved a partial meltdown of the fuel, just a little bit of melting of the fuel, but it was quite a serious accident. They had to remove the entire calandria, the entire core and replace it. About a million gallons of radioactive water flooded the basement of the building and subsequently were disposed of. Radioactive gases were emitted into the atmosphere. It was a lucky accident in a sense in that it could have been a lot worse, but no accident is really lucky. You wonder why it happened. It shouldn't have happened, and I think the AECL is not too proud of this particular incident and seem to wish to avoid mention of it at every possible occasion. When a question was put on the Order Paper in the House of Commons in Ottawa by Lloyd Francis as to whether the Chalk River facility has ever been shut down for repair, the answer which came back totally ignored the fact that there had been an accident in 1952. Perhaps this is a question of repression of things that you would like

Dr. Edwards (continued):

to forget. And although it is true that this happened a long time ago, and that technology has advanced a great deal from then, the fact is that the accident resulted from two independent workmen pushing wrong buttons, one after the other, and from certain mechanical failures which have yet to be explained. Certain control rods and shut-down rods were supposed to be released by gravity catches and drop into the core and stop the reaction and they didn't, and you know, nobody really knows to this day exactly what caused those rods to jam.

I am just going to give you a quick rundown on several accidents that have happened just to sort of persuade you that it's not just an academic question. In 1957 there was an accident in the Windscale reactor in Northern England. This ended up contaminating some 400 square miles of land and polluting the Irish Sea and the North Sea to such an extent that the Irish Sea is still one of the most radioactive waters in the world except for the Pacific testing area where there are more or less comparable levels. What happened there was that due to an unforeseen event something started going wrong in the core of the reactor and the fuel rod started burning. It was a different type of reactor from the Canadian reactor but it was natural uranium fueled. It started burning and this fire slowly spread for two whole days before anybody knew what was going on. The reason is that you cannot have access to the core of a reactor while it's operating - it's much too radioactive so you have to depend upon instruments, as was already pointed out by Mr. MacKay, to know what's going on in the core. And so it took a while for people to realize that they had a fire, which by that time was burning in a considerable portion of the core. There was a large amount of radioactivity released on this occasion, and in fact they were quite worried about what to do with it, because if they tried to douse it with fire there was a danger of having an explosion, a hydrogen chemical explosion or a steam explosion. But they did it anyway and it worked; they put it out.

I'll pass over the other accident at Chalk River which I don't know much about which was the NRU accident a little bit later.

In 1966 there was an accident at the FCRMI reactor, thirty miles away from Detroit. This is totally different type of reactor again, it was a prototype breeder reactor, and there they had a partial meltdown of fuel. Now the interesting thing I want to focus on is what caused the accident, and why the accident was worse than the maximum credible accident described in the licensing application. In the licensing application they have to describe what they consider to be the worse credible accident. Well this accident was worse. They considered that the worst possible credible accident would be a blocking of one fuel channel; that is, a blocking of the cooling fluid which would lead to a certain amount of melt-down in that little channel. But what happened is that three channels were blocked and the way it happened was that there was a poor welding connection - some welder didn't do quite as good a job as he could have done in welding a triangular piece of metal down at the bottom of the reactor - and during

Dr. Edwards (continued):

operation this piece of metal worked its way loose and floated up and lodged between fuel channels and blocked the coolant and this led to a reaction, to a melting of fuel and a shut-down of the reactor. For a couple of weeks they were worried about whether they should evacuate Detroit or not; there's a book out, I haven't read it, but I understand that while it's not sensational, it is written as a gripping account; it's called We Almost Lost Detroit, by Mr. Fuller. He also incidentally in that book describes that Chalk River accident.

In 1969 there was an accident in Lucens, Switzerland. The Lucens reactor has a pressure tube reaction, and also incidentally is fueled by natural uranium and moderated by heavy water much like the Candu, except it uses carbon dioxide as a cooling medium instead of heavy water as we do. But they had a pressure tube construction, which is somewhat similar to the Candu design; and they suffered an accident in 1969 which took four years to clean up, and it resulted in a total destruction of the core of the reactor. Fortunately again, it was arrested before it had progressed to the extent that it would release large amounts of radioactivity into the environment.

There have been a couple more accidents, some small ones. For example, in 1971 there was an experimental reactor at the Oak Ridge Laboratory. Remember I mentioned the emergency core cooling system? Well, the engineers designing these systems are extremely clever and ingenious and they figured that since the emergency core cooling system could possibly malfunction, there should be independent systems, so that if one system fails another system can come on. And at the Oakridge facility they had three independent systems for the emergency cooling system. Well, in 1971 it was discovered to the horror of the operators that they were operating this thing, and not one of the emergency cooling systems was working, and when they shut the reactor down and looked closely at it they found that it was an incredible combination, as it was described, of 21 errors in three independent systems.

Finally, the most recent accident that I know about was in 1975 at a 2000 megawatt plant called the Browns Ferry Plant, where there was a fire in the spreader room of the reactor. The spreader room is where all the electric cables pass through, and there were workmen down there who were using candles to try and detect pressure leaks by watching the candle flame to see if it was blown by air; if they saw the candle flame being blown then they would realize that there was some kind of pressure leak, which if not corrected, would develop into a larger leak. What happened was that the insulating material started to burn (there's a whole account about this fire you can read) and incredibly enough, ended up knocking out all of the safety systems of the reactor, including the ordinary cooling system. They had to use standby pumps which happened to be on hand and which were not part of the design of the reactor at all, to pump water into the core to prevent the core from being overheated and having a melt-down.

Dr. Edwards (continued):

So the point of all this is that accidents have happened. These accidents are quite incredible when you look at one of them. If they had been foreseen they would have been designed against; the reactor would have been designed so as to prevent that accident from happening. But the point is how far can you foresee all possible accidents? Some mention has been made about calculating probabilities of an accident by looking very carefully at all the things that might go wrong; this in fact is what Rasmussen did. As a mathematician, I would like to point out that this is a very unscientific way of going about an exercise of this importance. Why? Well, let's put it this way: we know for example that 50,000 people are killed on the highways every year in the United States; now how do you arrive at that number? You don't arrive at it by doing a careful study of the design of a car. You don't look at the car and carefully study how the clutch works, how the brake works, how the steering works, and somehow magically you arrive at the figure of 50,000 deaths per year. That just isn't how it's done. The way you arrive at these probabilities is by taking a look at experience, and of course if you want to predict what the frequency of an accident is going to be, then you will want to do some preliminary calculations which will help you out in estimating what the frequency might be. But as a matter of fact, in the case of nuclear energy mathematical calculations applied to emergency situations have been extremely unsuccessful.

Let me give you a couple of examples of this. I keep referring to the United States because in Canada none of these documents that I am mentioning have Canadian counterparts. As far as I know in Canada these questions have not only gone unanswered, they have gone unasked. Nobody has actually asked the Canadian nuclear establishment to provide details on any of these questions, for example, the emergency core cooling system for the Canadian reactor. But in the United States in 1972 they did start looking into the emergency cooling system. First of all they did six scale model tests to try and see how the emergency cooling system would work. All six tests failed, and they all failed for a different reason, and none of the failures were predicted mathematically or scientifically. So again, all I'm saying is that my experience as a mathematician suggests to me, as does experience that's on the record about nuclear reactors, that when you come to emergency conditions, when you get away from the question of normal routine operation and come to the question of what happens in the event of an emergency, scientific methodology does not exist which enables you to say what's going to happen.

I don't know where Mr. MacKay got his information about plutonium, but I would sure like to get a bibliography of all those references.

DR. MACKAY: It's all in print.
DR. EDWARDS: Oh, that's very good, because the problem is that in the question of toxicity of plutonium and of radiation in general there has been a lot of controversy over a long period of time, and to my knowledge nobody yet pretends to know what the actual long term toxicity

Dr. Edwards (continued):

of radioactive elements such as plutonium actually is. Only experience will tell, but certainly there have been laboratory experiments on beagles and animals of various kinds suggesting that as small a quantity as one millionth of a gram which is an invisible particle of plutonium oxide when inhaled, will cause lung cancer with almost 100% certainty. And some reports recently have indicated that the toxicity may be even a thousand times greater than that. The point that I'm trying to make is that when you talk about the toxicity of plutonium or the effects of many of these other radioactive elements which are created in the nuclear process, once again you are talking about mathemetical calculations, and these mathematical calculations historically have been pretty unsuccessful at predicting the actual mortality rates. As a matter of fact, I have a team of people in Montreal right now who are compiling a history of ICRP (International Commission on Radiological Protection) recommendations as to what should be a permissible dosage of radiation. They have constantly had to be lowered, because the ICRP has come to realize that time after time the effects of radiation were found to be more harmful than originally thought. I really don't think it is worthwhile to go into a lengthy discussion of the plutonium controversy, except to point out that it is extremely controversial and there are many scientists who do say that its toxicity is far greater than what you've heard here.

The other point that I would just briefly like to touch on has to do with bombs. A story out of Ottawa that we've been getting lately is that you can't make bombs from the plutonium produced in a Candu reactor. Apparently the argument is based upon the idea that there are two kinds of plutonium. They are called plutonium 239 and 240, and there are other kinds as well. What happens is that if you fuel a Candu reactor with natural uranium, you produce a certain amount of plutonium. The plutonium is a totally man-made substance; it's heavier than uranium, and the way it comes about is that the uranium atom, a uranium 238 atom, not the type that splits, grabs a neutron and becomes larger and undergoes some internal change and becomes plutonium. Sometimes it becomes plutonium 239, sometimes it becomes plutonium 240. Plutonium 239 is weapons-grade plutonium, which is used to make bombs. Plutonium 240 is not nearly so efficient, and in fact it can be regarded as a nuisance mixed in with the plutonium 239, and as was pointed out, it is rather difficult to separate these. There are two points here that I'd like to make. The first is: it's not at all clear that you cannot make a bomb with this lower grade plutonium. The only thing that is clear is that it would not be as efficient a bomb and you would require more plutonium in order to make such a bomb. The second point is one can simply change the burn-up time in the Candu reactor, which is easier to do, as Mr. MacKay pointed out, in Canada than in American reactors; this makes Candu superior to the American reactors. It's much easier to put the fuel through a Candu reactor and achieve higher burn-up in a shorter time, and when you do that, you

Dr. Edwards (continued):

eliminate the problem. You get very good quality plutonium 239 out of it for bomb-making. Now the advantage of Candu is that it does produce from two to three times the amount of plutonium as an equivalent American reactor, so that if you are interested in building one bomb or two bombs or a handful of bombs, you may go for a research reactor because you are only going to get a small amount of plutonium out of a research reactor. But if you want to build a stockpile of bombs, Candu is one of the best bets and one of the best bargains in the world, because a Candu reactor is going to give you a much better return of plutonium per the fuel that's burnt up. So once again I would refer Members of the Legislature to the March 23rd Hansard, the Tuesday debate, which is very interesting on the question of nuclear proliferation.

Now to close what I'm saying here, I want to talk about the entire fuel cycle, as it is called, and the whole idea of nuclear energy as a future power source. I'm not addressing myself at all here to the economics and the desirability of nuclear energy in a highly centralized, high growth technology- that's another type of question. But I do think it is worth asking the question now: If we are indeed thinking in terms of moving towards a conserver society, if we are really thinking that this kind of growth society cannot continue much further into the future, then shouldn't we begin thinking right now about what the appropriate measures are? In Ottawa there is a lot of lip service paid to the idea of a conserver society, but on the other hand they seem to be saying, "Well, look, we've got to push ahead with nuclear energy, we've got to keep doubling nuclear capacity every five years or so, we have to invest $212 billion in the energy producing sector in the next 15 years. That works out to $31,000 per family. This is all in Hansard, official Government answers to Lloyd Francis' questions. And we expect to have 112 nuclear reactors or maybe 120 nuclear reactors by the year 2000. I ask you, is this consistent with the idea of eventually moving toward a conserver society? Isn't it just essentially forcing, just by the sheer force of money and cash flow and investment and so on, a continued high growth society? In fact options towards conservation, towards a conserver society, towards a more stable society are really not going to be realistic options if that amount of capital is tied up in energy producing equipment. I would just like to throw that out as a general consideration.

To sum up nuclear energy, first of all I will just mention that there are many, many people throughout the world who have the highest scientific credentials, who seriously doubt the safety of nuclear powers. These include Nobel Prize winner in physics, Dr. Hannes Alfven in the United States, and nuclear engineers who have worked for 20 and 30 years in the nuclear industry, who have resigned their positions and joined anti-nuclear groups. One of these engineers was convinced by his experience of being in charge of a task force investigating reactor safety in the United States, that it is, in his own words, "impossible to regulate nuclear safety." Therefore he quit. I have spoken to a civil engineer at the University of Concordia where I am affiliated, who has worked for Canatom on reactor design, his job is to

Dr. Edwards (continued):

make sure that reactors are earthquake-proof, and he has told me that he has got very shoddy answers or no answers to the questions of a technical nature that he has raised and that basically the attitude has been to pooh-pooh these problems and to sweep them under the rug. I have talked to another gentleman who has worked in Winnipeg. He worked at the Whiteshell research laboratory for six years on reactor safety analysis (he is no longer working for AECL), and he has told me that he is very upset at the erroneous calculations and the erroneous mathematics employed, to the point where in some of their safety analyses methods here in Canada at Whiteshell, they do not even have the Law of Conservation of Mass as one of the necessary criteria for calculations. In other words, the mass of steam generated does not have to equal the mass of water that was there originally. He is now working on some independent analysis of his own to try and see what would happen if you just looked at the analysis a different way. I submit to you gentlemen, that there are real questions as to whether nuclear energy is a good thing; and that whether or not all of these fears turn out to be warranted, the only sensible thing to do is to have a complete, independent look at what these assumptions are, what these calculations are, what are the facts about safety in Canada. Right now in Canada the nuclear industry is one of the closest, tightest-run ships in the world, and that's one reason why there has been so little debate up till now. In Canada it's awfully hard to get detailed information about the Canadian program. The Canadian Coalition for Nuclear Responsibility is calling for a national debate, triggered by a public inquiry into nuclear energy, for the express purpose of acquainting the public with the hazards and benefits of nuclear energy. This involves taking a close look at things like safety and reactor design, possibility of accidents, consequence of accidents, transportation problems, waste storage, and so on and so on, as well as other aspects too, economic aspects. Who is in support of this demand? Well, Ed Broadbent, the Leader of the NDP Party, Joe Clark, the Leader of the Progressive Conservative Party, General Burns who is the head of the peacekeeping forces in the Middle East, two provincial premiers. There has been a lot of support in Canada for the idea of having an inquiry into nuclear energy, but Prime Minister Trudeau says there is no need for an inquiry, and there will not be an inquiry. And so the question really is: who doesn't want an inquiry, and why? What's so wrong in having an inquiry?

Well, I think I've more than used up my time, and I hope I haven't exhausted your patience. Thank you again for hearing me out and I'll be glad to answer any questions after the next speaker has spoken.

MR. WELLS: Thank you, Dr. Edwards. Our next speaker is Dr. Ray Jackson, a Senior Policy Advisor to the Science Council of Canada who will talk to us about some of the costs of nuclear power.

The Cost of Nuclear Power

DR. RAY JACKSON: It's a pleasure to be here. I'll try to be as brief as I can. My job in these kinds of affairs is to try to stay in the middle and see where there are problems for policy, for what you would call public policy or government policy. There are perhaps three questions in my mind at the moment. I'm going to deal only with the third one.

The first question is whether in the light of the kinds of things that Dr. Edwards has been raising and the events going on in the United States where these things are becoming very hot issues by the day, there should be that kind of inquiry in Canada. I have the impression that the Canadian program has been much better from its safety point of view than the American light water reactor; nevertheless, have we had the comparable kind of searching examination from outside the nuclear establishment that is building the reactors?

The second question which comes to mind is a policy issue regarding exporting ability of this technology. It is, after all, quite aside from its safety aspects or the possible facilitation of weaponry and such, a high technology approach to generating energy. It's a highly centralized approach, capital intensive, and it generates electrical energy. Is this the appropriate answer to the needs in many other parts of the world? It may be appropriate for the Canadian society, with relatively stable social conditions and government, with its well-developed industrial infrastructure and good law and order and such things. But what about all these other countries of the world? Might it be better to have some, let's say, more failsafe kind of technology to solve many of the problems? For example, some of the alternative approaches that Prince Edward Island may be taking that lead in developing in Canada might turn out to be better answers to less developed parts of the world. Our project on what we call the implications of the conserver society at the Science Council, in which I am closely involved, I think tends to grow along these kinds of lines. Might these lower technology alternatives be preferable for one reason or another, including the cost?

The third question is the cost of nuclear systems, and in particular the capital cost, which is becoming more and more the sticking point in considering the nuclear power alternative. Now the problem is, you often hear figures of $500 per installed kilowatt capacity at the present time for Candu systems, or you may hear figures up to $1,000 per kilowatt. But that is for the generating plant itself, and those figures may be more or less relevant if what you're doing is making comparisons with building a coal-fired generating station or perhaps a hydro station. But one must be careful if you are considering other kinds of alternatives, such as solar energy and biomass and wind and such things. And this is especially true bearing in mind that over half the energy use in Canada goes to heating purposes, and 90% of that used for heating is for relatively low temperatures, at least below 260°C, and more than half is for space heating, which is below the boiling point of water. Electricity is basically a very high quality energy capable of generating temperatures if you use it for

Dr. Jackson (continued):

heating, of a couple of thousand degrees Celsius, or almost anything you like in an electric arc or so on. And it makes a physicist, which I am, begin to ask questions when you find a basically high quality energy being used for very low quality purposes like simple generation of heat for space. These are reasons for trying to consider the total costs, considering what the energy is finally going to be used for, what is its end use. And when you do that, you get capital cost figures more in the range of $3,000 to $5,000 per kilowatt delivered, and when you see figures like that you wonder if the people considering windmills should worry extremely if the cost appears to be greater than $500 a kilowatt, they may be mistaken about the competition that they have to meet. If you are considering the use for heating, for example, then you would also want to compare that capital cost as a cost of delivering an amount of heat. If you translate that into delivering say a certain amount of heat content as represented by a barrel of oil, then the capital investment cost to be able to deliver per day the equivalent to a barrel of oil on the same basis would work out somewhere between $200,000 and $300,000.

And I would just give a brief outline of where those kinds of figures come from. In the first place it is the direct cost of the reactor itself, which may be $500 per kilowatt, but by the time you include other indirect costs, for the Candu for example, of the design, the heavy water, administration, the interest on the money and the escalation in cost which has been a feature of the industry so far, it would be more like $700 or $1,000 per kilowatt capacity. Then you have associated transmission and distribution costs, which as a general rule are reckoned as about doubling those initial figures. And since you are talking about an electrical system, you have transmission losses of another 10% or so. Looking at the figures, you are already getting up to about $3,000 a kilowatt installed, then there are some other miscellaneous costs, some of which depend on the circumstances, such as spinning reserve. Now nuclear just doesn't work well for rapid starting up and shutting down, so that it is used for base-load capacity, which means that if you are expanding the system via nuclear or if you are building a system with a large proportion of nuclear in it, then you may have to add other types of generating capacity suitable for this rapid peaking, and the necessary investment in that associated capacity should be regarded as an additional cost of the nuclear system. And there are other kinds of costs like the amortization of research and development. There may be some subsidies that are not fully explicit at the present time. For the Candu, these figures are not really developed at the present time. We are getting fairly good estimates of this sort for the United States systems, but this kind of approach to looking at the Candu system has not yet been carried through. Another possibly weighty term is decommissioning costs. Not everyone thinks ahead to when these reactors reach the end of their lives, but they may present problems in putting away, because many of their parts will be radioactive, and will be expensive to get at and expensive to dispose of. There have been estimates that the decommissioning costs might run 10% of the original construction cost; some people think it might even be 100%. So these miscellaneous other costs could bring it up to the kind of figure of $4,000 or $5,000 per installed

Dr. Jackson (continued):

kilowatt capacity. I just thought my contribution might be to introduce some kind of perspective to the consideration of nuclear power. Thank you.

MR. WELLS: Thank you very much, Dr. Jackson. Our three speakers are now together and before the Legislature, and I might throw it open to questions. Perhaps if you could address your question to one or two or all three of the speakers, then we could have them come to the podium and respond.

PREMIER ALEX B. CAMPBELL: I am wondering, Mr. Wells, whether Mr. MacKay would want to respond briefly to some comments which Dr. Edwards made, and certainly Dr. Edwards will have the same opportunity of response.

MR. MACKAY: Thank you. I would like to make a couple of comments. Dr. Edwards certainly did a very honest job of reporting a great deal of the data and opinions that are generally reported in the press, and I've no quarrel with almost all of his facts. I can explain perhaps a few of the things.

The tanks at Hanford that contained a liquid waste were the result of a war-time effort to produce plutonium for A-bombs as fast as possible in case the United States got bombed before it had defense. There's no way that that kind and amount of fission product could be stored legally in a liquid form, and in fact some years ago the then United States Atomic Energy Commission passed regulations that Hanford should solidify the wastes one way or another at a particular rate. Certainly they leaked.

There is one thing I think that perhaps you might deduce from Dr. Edward's talk. Although he started out by saying that nuclear energy is an unforgiving science or something, he recorded all these near misses which resulted in no damage to anybody, ever. Well, I don't know whether that's altogether unforgiving or not. As for fission products in a bomb versus the fission in a reactor: a bomb doesn't produce the tremendous amount of fission products because the number of megawatt hours that it produces is not very, well, it's considerable, but it's not a tremendous amount. Most of the people who had the misfortune to be bombed were not killed by the fission products; they were killed by gamma radiation, by heat burning, by blast, by collapse of structures, and later on by delayed radiation effects, radiation sickness and so on. Studies of children born within three months after the blasts from mothers who were irradiated have shown less than normal number of defective births, quite possible because they were better cared for after the bombing than they would have been before.

As to the NRX nuclear holocaust, as it was described in one of the United States magazines. I was there. Two operators standing on top of the reactor thought afterwards that they might have heard a rumbling sound, but they really didn't know anything had happened until they were told that the reactor was leaking active heavy water. It certainly did leak, and I was sloshing around the basement wiping it

Mr. MacKay (continued):

up at one time, and it certainly did have to have the new calandria. It was shut down for about a year, but nobody was hurt, nobody was irradiated beyond the tolerance that had been set at the time. I can't comment on NRU incident because, although I was in charge of the general design of it, I never heard of the 1966 event, I wasn't there. Windscale was again a reactor designed to produce plutonium in England in advance of when the Germans and the Russians were going to produce it. It was a graphite reactor cooled by air sucked in from the outside and discharged up stacks. Originally the discharge was not even going to be filtered but after they got these very large stacks up about half way they decided to put filters on them, so the stacks have a bulge up on them about half way up, which was as far as the stacks had got when they made that decision. It's the kind of reactor that could not possibly be approved for anything but military purpose and during a war. As to the radiation release, a study was done at Brookhaven in 1957, which has been quoted very many times. The question asked of the Brookhaven scientists was not what could be released from a reactor; the question asked was, what would happen if all of the fission products in the reactor that had been operating for a certain length of time were released into the atmosphere in an aerosol form? Nobody was either asked or came up with any suggestion of how this could happen, but the question was asked as a sort of background, I suppose. Core melt-downs are theoretically possible. With the United States type of reactor the core is about ten times as dense as with a Candu reactor; in other words the size of the core is about an eighth or a tenth of the volume of the core of a Candu reactor of the same power. Now the extra nine-tenths of the volume of the Candu reactor core is filled with relatively cold heavy water, about 485 tons I think for a 600 megawatt reactor, and surrounding that, surrounding the whole reactor, is another 500 or so tons of cold ordinary water, so there's a thousand tons of cold water in the core and surrounding it, and the possibility of that core melting due to any kind of control failure is much more remote than the possibility of a light water reactor melting. In addition, the amount of reactivity that there is available in a Candu reactor, whether we like it or not, is very low compared to the amount of reactivity available in a new light water reactor core. If you in effect open the throttle wide on a reactor that's already operating at full power, the rate at which it will increase its power is relatively low and is not particularly demanding at all on the control system. The one microgram of plutonium causing certain deaths, I don't know where that statement came from. I remember using it in the speech I gave 20 years ago anyway. Gofman in the United States has used it; he was challenged to produce any kind of support for it and he has eventually stopped using it. It was pure heresay as far as I was concerned - I don't think there's any scientific support of it. Gofman and Tamplin are co-authors and who is the other?

DR. EDWARDS: Cochran and Tamplin did work recently which they published within the last year, and Geesaman is another author. Also I must say that I think your inferences about Dr. Gofman are ill-advised, because he's certainly a reputable scientist.

MR. MACKAY: I won't challenge that at the moment. As to burn-up rate, amount of plutonium and production of weapons-grade plutonium in a Candu reactor: sure a Candu reactor can be used to produce weapons-grade plutonium by irradiating the fuel at about one-twentieth, to meet United States standards, of the rate at which it ordinarily is radiated. Now, that means that you have to run the reactor at one-twentieth of its output and sacrifice almost its whole output for the period that you want to produce weapons-grade plutonium with it, because it's not possible to load fuel. The fueling machines are designed to load about twice as much fuel as the average rate of consumption, but in Pickering they're just capable of keeping up with the reactors on the average. So it is possible to produce weapons-grade plutonium, but at much greater cost than building a reactor to do it. Candu reactors have never been built or intended to be built in high earthquake zones. Now Japan is a high earthquake zone: we are discussing the construction of Candu reactors in Japan - I think we're probably trying to get the Japanese to do the analysis. The greatest earthquake zone I guess is the Gentilly site, and it has certain accelerations and acceleration spectra, which basically the Candu reactor is designed to take, because it's not very demanding. Those are the main points I have.

DR. EDWARDS: The Coalition which I am a part of likes to avoid any kind of confrontation, polarization, or emotionalism, and therefore we don't like to engage in talking about questions which really are not factually based at all, but which are matters of opinion. One of the problems with a subject like nuclear energy is that the public is supposed to be well-informed; what they are told are conflicting opinions and they are not told the factual bases underlying the two opinions. So in fact since they don't really know what the opinions are based on, and consequently they can't form any judgement themselves, they say, "Well, if the experts can't agree, how can we?" Therefore I don't like to get into innuendos about the reputability of this scientist or that scientist. I do feel that it's worth pointing out to anyone who is interested that Dr. John Gofman was appointed by the United States Atomic Energy Commission as the Assistant Director of the Lawrence Radiation Laboratory in Livermore, California, and he was given the mandate of investigating the biomedical effects of radiation. He spent seven years doing this, and in his own assessment of the problems associated with the biological effects of radiation, he did pretty much of a 180° turn with regard to the acceptability of rapid proliferation of nuclear power plants. But I would reject the suggestion that just because a scientist happens to have opinions which you may not agree with, you discredit his work. Dr. Gofman is a very reputable scientist: he's a medical doctor, he has a Ph.D. in nuclear chemistry, he's a full professor at Berkeley University, he was awarded a $50,000 prize for heart research into

Dr. Edwards (continued):

arterial schlerosis involving the lipoprotein molecules, and this was after his termination of services with the Atomic Energy Commission. There is a lot more to this controversy than meets the eye. I don't really want to get involved in that and start saying this person is a saint and this person is a devil. There are different scientists with different opinions, and I would submit that to be logically consistent, if you are implying that the anti-nuclear opinions of a scientist color his scientific research, then you must also admit that the pro-nuclear opinions of other scientists may color their research, and leave it at that. There is something which I do feel deserves mention, which is that nobody who looks into this issue to any degree whatsoever can help but be impressed by the depth of the debate which is going on all over the world, within scientific circles and outside of scientific circles, over the ethical acceptability of nuclear energy. This is not a tempest in a teapot. This is a very serious issue. OK, let me indulge a little bit. I do think that it's somewhat irresponsible for a man of Mr. MacKay's reputation, representing AECL, to come into an Assembly like this and to talk in general terms about, for example, substances that you might have too much of or too little of, with both harmful, so that you have to have a balance. This implies there's some kind of optimum level, which is the desirable level. They were telling the people in Port Hope that the maximum permissible dose of radiation under law was what they constantly referred to as in the "recommended dose", as though if you don't get your recommended dose you are missing something. As a matter of fact every bit of scientific evidence that exists indicates that there is no such thing as a safe level of radiation, that every dose of radiation to a large population will bring about a certain percentage of cancers, leukemias, and so on. Geneticists throughout the world have voiced grave concern about any increase in the rate of mutation, because 99% of mutations, they figure, are harmful to the individual and to the species. In fact some people have gone so far, for instance the Russian radio-ecologist, Polykarpov, Joshua Lederberg, a Nobel Prize winner in genetics, James Watson, a Nobel Prize winner in genetics, as to say that the current research on genetics is inconsistent with the proliferation of nuclear power plants.

HON. JOHN H. MALONEY, M.D.: What are we really talking about? If we are talking about safety, what is the record? In Canada and the United States, for instance, has anybody ever been hurt? I'm talking about safety specifically in nuclear plants; if a fellow falls down, it's the same everywhere. What are the facts? Has anybody ever been killed by radiation? Has anybody ever had excessive dosage?

DR. EDWARDS: The facts are, that as I said during my talk, we have dealt only with the front end of the fuel cycle. We've carried the uranium only as far as the reactor and the cooling pond, and we haven't gone past that stage. Now, that front end of the fuel cycle is the safer end of the fuel cycle, because you are not dealing with the highly radioactive wastes that come out of the reactor. What have we done with respect to the front end? First of all, we have permitted our uranium miners to be exposed to levels of radiation which were known 30 years ago to produce excess lung cancer, when ten years ago in the United States the solution was known to be very simple. All you have to do is ventilate the mines, and if that raises the price of uranium we have been told that it doesn't matter too much, because it's not going to interfere with the economics of nuclear power. Nevertheless it was not until 1975 that a Commission of Inquiry in the Province of Ontario was inaugurated to look into this. When it comes to the refining of the ore, after the ore has been extracted, you are faced with the problem there of uranium tailings, which are radioactive because they contain all of the original radium which was in the ore to begin with. Now these uranium tailings have polluted lakes and rivers in Ontario; and in the town of Port Hope, as we've discovered recently, there have been homes and schools built on uranium tailings - its very similar to events in the United States. I have correspondence...

DR. MALONEY: But how many proven cases of damage due to radiation or excessive radiation are there?

DR. EDWARDS: You see, you cannot prove it. It's the perfect crime. It's a statistical thing; you can never prove that if somebody dies of cancer that that cancer was radiation induced.

DR. MALONEY: No, but you have epidemiological studies to find whether or not you have higher incidence and whether that is statistically significant. Has anybody done that type of thing?

DR. EDWARDS: Well, with regard to uranium miners it has been done, yes and the indications are that....

DR. MALONEY: Yes, that's quite true, we could say the same thing about coal miners; those hazards aren't specifically related to nuclear power generation, are they?

DR. EDWARDS: I agree 100% that the important thing about the front end of the fuel cycle is not the damage that has been done. The damage that has been done is not comparable to the damage caused by, for example, black lung disease in coal mining. What is important, in my opinion, is how effective have our regulatory agencies been in preventing harm, how effectively have they shown us that they can regulate this technology safely? I submit that a look at the record will show that they have done a poor job, and that in fact they do not have either the manpower or the mandate or the muscle to actually do a proper regulatory job. This gives me grave misgivings when it comes to the rear end of the fuel cycle, when it comes to waste disposal, when you are going to have 112 reactors and a lot of radioactive nuclear material being transported over highways and so on. I do not think that you can extrapolate from a very small situation, which is tightly controlled with a small number of dedicated people, to a large bureaucratic system and expect that you won't have a lot of incompetence, stupidity, and oversights creeping in manufacturing defects and things of that sort. So that the real significance, to my mind, of looking at the front end of the fuel cycle is not how much damage has been done, but how well has it been managed, and what does that bode for the future? So perhaps I am evading your question, I don't mean to evade it. I would say the damage done in terms of actual deaths of individuals is probably much less than, for example, in coal technology. I'm sure that's true.

DR. MALONEY: So actually we're talking about a danger which is a potential danger. Now if it hasn't happened in the working out of the methodologies of using it, it's very much less likely to occur later as man becomes more and more familiar with it. For example, you have electricity in every house. If a child picked up 110 volts, it would probably be electrocuted, and yet there hasn't probably been a child electrocuted in Canada in the last month because we've learned to live with that. Now if you don't get your problems in your cycle when you are working it out, you are much, much less likely to get it when your science becomes more mature.

DR. EDWARDS: Well, all I can say in answer to that is that experience in the United States, for example, has indicated that in the minds of people in the industry, some of these people who have resigned, the scales were tipped when they began to realize the scale of the operation that was being undertaken. In other words, as long as you had only a few reactors in the experimental stage being developed, they felt that they had a high degree of control, but they have found all kinds of things, foreign objects, built right into reactors through incompetent workmanship, poor welding jobs which have come apart, etc. The problem is just guaranteeing the very high degree of quality control necessary in the industry. Where is the highly qualified and dedicated manpower going to come from to man the nuclear stations and so on? In the United States they have found that once the industry progresses beyond a certain point, then the whole enterprise becomes subject to the same kind of difficulties that almost any bureaucracy becomes subject to - a certain amount of inefficiency in the system itself. I grant you that this is a hypothetical question in the sense that it's forward-looking, but I don't think that that lessens the importance of the question, because if you have a very widespread nuclear industry, and then you discover that things start going wrong in a very serious way, it's too late to recover, what do you do then? This is why the Coalition is urging that there should be a full, complete, independent inquiry right now while we are still in the infancy of nuclear energy. Does that in any way address your question?

DR. MALONEY: That's fine. Thank you very much.

DR. EDWARDS: OK, I don't think I have any other comments, I would really like to hear some questions, though.

HON. A. E. (BUD) INGS, DVS: We were told here, I believe yesterday, that if Canada were going to keep up to our total electrical needs, we would have to build a nuclear plant the size of Pickering about every four months up until the year 2000, and then we would still be 50% dependant on fossil fuels. What's your comment on that?

DR. EDWARDS: I don't know what the calculation base of that is. I do know that there's a growing number of people who feel that the whole concept of nuclear energy, as was explained by Mr. MacKay again, is inherently a large scale, centralized and therefore inefficient energy producing source; and there certainly is a considerable body of opinion, scientific and otherwise, that that is not a very sensible direction to go in the future if you are looking for energy efficiency. So for example, Dr. Hannes Alfven whom I've mentioned previously, a Nobel Laureate in Physics in 1970, argues that by instituting very technologically feasible and realizable efficiency measures in terms of engineering design and so on, for example, in efficiency of air conditioners and heating systems, the United States could save more energy than could be produced by technology in that country up until the year 2000. Quite clearly he figures that's a much better way to go.

DR. JACKSON: There's just one remark as another end of that debate that might give you a little basis for asking questions. That goes back to what I was saying about the nature of the end use of the energy: the facts that so much of it is used for heat, and that another large proportion of Canadian use is transportation that has to be supplied by liquid fuels of some sort or some equivalent. But if you look at all the uses that actually need electricity, regarding it as a high quality, valuable source, then you look at communications, electric motors, all the really high temperature processes in industry, and subways and such forms of transportation. I've heard the statement made that all of that adds up to probably less than 10% of the total Canadian energy use, and could be entirely satisfied by existing hydro installations without coal generating plants, without oil-fired plants, without nuclear. So you can take that as another end of the debate to try to establish the answer.

PREMIER CAMPBELL: If I might be allowed, I think that the Province has discarded the notion of building a nuclear plant in Prince Edward Island, and for capital reasons we have decided not to enter into an ownership position elsewhere. Our province does need security and steady supply of a base amount of electricity, whether it comes from nuclear, hydro, oil, or whatever source. We will have to be taking steps to guarantee that amount. That amount will be based on what Islanders are consuming and what they will be consuming - twice as much and three times as much over the next few years according to the projections. And so there are really two basic questions that seem to relate to nuclear in my own mind, and perhaps each of our three speakers could reply to them.

The first question is reliability: how reliable is and is likely to be the performance of the New Brunswick LePreau reactor, which I assume will be the source of the power we purchase? The reliability of the reactor will have a great deal to do with the price we pay for the power. The going rate may be very attractive but if it's only working half the time it will cost us twice as much, and obviously then other alternatives would have been much more attractive and much more wise for us. So reliability is certainly a very fundamental question when we are talking about committing ourselves to buying power for a long time, and I would like each of our speakers to address themselves to that question briefly.

And then fuel supply: I'm still not clear from various sources of information whether and for how long Canada can expect to meet its own domestic requirements for fuel as well as our international commitments. Are we simply entering into a modern oil electrical generation cycle only to find that 30 years down the road we are all disappointed once again, we are out of fuel?

MR. MACKAY: Just as a start, the average reliability of the Pickering reactors has been about 75%; in other words, they have generated about 75% as much energy as they would have generated if they had been run at full power ever since they started up. Now this is rather better than the light water reactors in the States, but part of the reason is that they do not have to shut down for refueling. The reliability of No. 4 unit, which was shut down for a large part of last year, up until last week was lower than that - I think it was about 60% since it started up. Hopefully that particular trouble would not recur either with it or with any other reactor. If you are talking about a single unit, as the LePreau unit, all you can say is that you hope its reliability will exceed 75% or its capability will exceed 75%. There's always a chance of a single unit maybe running into trouble. There's also an equally good chance that if it doesn't run into trouble, it would be capable of well over 80%, 85%. So with a single unit you don't know, you can't predict the reliability quite as accurately as with a multiple unit station.

DR. MALONEY: How does that figure compare with hydro, or coal, or oil?

MR. MACKAY: The average for Pickering has been better than the average for Lambton. I think I'm right in saying that the biggest single factor in losing production from Pickering has been a water seal on the generators, which have water-cooled rotors, I guess, and this single little bit of rubber takes a two-week shut down to repair. I think that's the biggest single cost, but in any case more of the time has been lost through the conventional end than through the nuclear end. And the reliability has compared favourably to that of the coal-fired plants. Incidentally the NPD plant, which is small, but is 14 years old now, ran I think 86% of its capacity last year in 1975, so the reliability is not something that necessarily falls off as the plant gets older.

Now fuel supply: the Department of Energy, Mines and Resources has agreed on an export restriction which reserves enough fuel for 30 years of life for every Canadian reactor that is in existence or planned. This means the Darlington reactors for Ontario Hydro; they've got a name and a site but the year of completion is not set. Thus any Canadian reactor which is committed now is assured of enough uranium fuel for 30 years of life. Well then, after that there are many options.

PREMIER CAMPBELL: At a price?

MR. MACKAY: Well, of course the price of uranium is likely to go up because uranium mine owners are likely to see a good thing, but as I mentioned before, this does not affect the cost of energy very much.

MELVIN J. MCQUAID, MLA: Am I right in my information that there is a life span of these nuclear power plants, that after a while they have to be completely rebuilt?

MR. MACKAY: For accounting purposes in calculating the cost of power, they are given in this country a life span of 30 years. Well now, whether its 20 years or 30 years or 40 years doesn't make very much difference if you are talking about present worth accounting, but 30 years is taken as the life span for accounting purposes. All parts of the Candu type of reactor that are subject to wear or damage can be replaced. And of the chief costs of replacing the tubes in the Pickering reactor, by far the greatest cost was the loss of output from the reactor during the time it was shut down, so that the actual life is really indefinite. Now the life of coal plants is generally determined by the time at which they become obsolete in terms of using too much fuel to compete with newer plants. Although it's not the case here and now, I understand, most coal plants lower their capacity factor as they get older. This is not necessarily the case with nuclear plants, because paying off the investment is the primary cost of their energy, and the older they get the more nearly this has been paid off.

MR. MCQUAID: Well, you have me more confused than ever. I'm not sure that whether you've said that they do have to be replaced or not. What I'm concerned about is this. Supposing we have to buy into Point LePreau. (I hope we never have to). There will come a time when Point LePreau will either have to be rebuilt or replaced, or there will have to be some considerable expense put on it. Now, have you any idea how long that period might be and what are the possible costs to do that necessary work? My understanding was originally that these nuclear plants wear out and they have to be scrapped, but I would judge from what you say that it is not a matter of scrapping them in their entirety, rather there could be replacements made.

MR. MACKAY: I would think that perhaps after 15 to 20 years, LePreau might have to be shut down for a considerable length of time, maybe a year, for replacement of perhaps the pressure tubes, perhaps rebuilding of the turbine or perhaps, I don't know. The United States have had a lot of trouble with heat exchangers, although we've had extremely little or none.

MR. MCQUAID: At a considerable cost.

MR. MACKAY: Primarily the cost of the lost energy.

MR. MCQUAID: I was at a loss all afternoon to decide why we were debating so long between yourself and Dr. Edwards as to the dangers inherent in a nuclear plant. We are never going to have a nuclear plant on Prince Edward Island, so the dangers that he points out and the benefits and the dangers that you say are not there are never going to be applicable to us here on Prince Edward Island at all, so we've spent all afternoon discussing that and I can't see the relevancy of it.

MR. MACKAY: Well, you're right. But LePreau could go on for 50 years and still be an economical energy producer, I think.

MR. WELLS: If I might I'd rise to defend our present position, in a sense, and suggest that certainly if Prince Edward Island were to buy into a portion of a nuclear power plant elsewhere, there would in my view anyway, be moral obligations to the people in the immediate vicinity of that plant on the part of Prince Edward Islanders, because we would be putting money into the establishment of a nuclear power plant.

MR. MCQUAID: We have no power so we have to buy into nuclear, be it Point LePreau or anywhere else. Unfortunately, perhaps according to Dr. Edwards, for people living close to that plant there may be inherent danger to their health, but, you know, we have no choice; if there's a nuclear plant, we are apparently going to have to buy into it.

MR. WELLS: But I think what we tried to present today was an examination of the possibilities, the problems and the costs of nuclear power in order to allow Prince Edward Island to make that kind of judgement.

HON. BRUCE STEWART: Dr. MacKay, what is the ordinary down time for maintenance on one of those plants? Looking at the cost factors now, are we figuring a 12 month operation, are we figuring a 46 week operation or what are we figuring per year?

MR. MACKAY: Down time I think you could say is about 15% of the time; what's that in weeks? Its about seven weeks. But the number of unplanned shutdowns at Pickering has been extremely small, about one per year per reactor, I believe, so that it's nearly all planned. Now 'planned' means that something happens where you don't shut down, but you fix it perhaps at the end of the week when the load is lower or something like that.

MR. STEWART: Does there have to be a cooling down period for ordinary yearly maintenance?

MR. MACKAY: Usually, yes. But it is the turbine that needs the maintenance. In the reactor itself, the fueling machines can be taken out of service and spare machines put in, that sort of thing.

MR. STEWART: Well the experience has been then about 45% operating efficiency.

MR. MACKAY: No, 85%, unless something goes wrong, like once in a lifetime hopefully, like these tubes that were a new alloy that wasn't created properly.

HON. GILBERT R. CLEMENTS: On the Point LePreau plant, what environmental concerns would you see apart from the possibility of a malfunction such as from the heat radiated and other things that would be inherent in that type of a plant?

MR. MACKAY: Well, all the heat that's wasted from trying to generate electricity from heat goes into the cooling water, so a fair bit more heat goes into the cooling water than in a steam station, a coal-burning or oil-burning station, because 10-12% of the heat generated by coal goes up the stack and the reactor has no particular heat loss like that. That's a problem in the southern States, certainly, where the term "thermal pollution" was coined, because if you are trying to put a large reactor on a small river and the river is already running at 90° or something, then if you heat it up it's too hot and kills off fish.

MR. CLEMENTS: You don't see a problem like that at Point LePreau, the amount of water it would take to cool that particular plant?

MR. MACKAY: Well, I don't know how much more heat it puts out into the water than a coal-burning or oil-burning station, but I guess it's in the order of 30 or 40% more. And of course there are large coal-burning stations on Lake Ontario, as well as Pickering and they have traced the measurable heat rise to as far away as about four miles under certain circumstances. Now the amount of heat the Pickering plant puts into Lake Ontario in a year is about the same as the sun puts into Lake Ontario in about four hours, so it doesn't really effect the temperature of the lake. The local effect is what comes out of the reactor at I think about 18° above the temperature at which it goes in, and in the winter at the outlet, of course it's ice-free and you see all sorts of water fowl swimming around in the warm water, warming their feet up, I guess.

HON. CATHERINE S. CALLBECK: I would like to ask your opinion on something I heard, that the amount of energy generated by a nuclear plant over its useful life is actually less than the energy it takes to build and operate the plant and to mine and transport the nuclear fuel to the plant.

MR. MACKAY: Yes, well that isn't so. It's kind of difficult to figure it out, but a Dr. Tupper at the Research Council last summer was trying to do that. A few months, six or eight months of its output would cover all the energy used in constructing it. The cost of the energy used in mining the fuel is completely negligible if you are mining enough ore to provide 100 tons or 50 tons of uranium. You really could supply a large nuclear reactor with fuel by carting the fuel on the back of your car. You would have to make regular trips.

J. WALTER DINGWELL, MLA: We heard a very frightening story here today in respect to the waste disposal from energy reactors, and the uncertainty as to whether or not they are efficient. That danger may be carried on for generations, and in the event of a natural or man-made catastrophe such as an earthquake or a war and those wastes were suddenly brought into the atmosphere, I understand by what you said they can cover the surface of many thousands of square miles. We would have to assess then on the basis of that picture the value of nuclear development as against the possible effects on the world it can have for generations. Is there any possibility of science discovering something that will dissipate the effect of those wastes as time goes on?

DR. EDWARDS: Well, there's always a possibility. At the present time there is no method known to neutralize the wastes in any way, because what you have are unstable atoms and no matter what you do to them, it's not going to change the fact that they are unstable atoms and they are going to sooner or later explode. If they happen to be in your body when they explode, then your body is subjected to possible radiation damage.

Now, I think that I sympathize with the feeling that perhaps in a sense you have been wasting your time because you are not going to have a nuclear reactor in Prince Edward Island, but I submit that there are two very important principles which are well worth considering. Any person living in the twentieth century must consider the question, where do you draw the line? If not with nuclear energy, where do you draw the line in risks, not only for this generation but for future generations? When do you actually decide that perhaps this thing is too risky and perhaps we shouldn't do it? Now there are a lot of people, as I have indicated, who have reached the conclusion on their own, that perhaps the risks are too much. They are definitely in the minority - the majority of people in science, I think, are probably in favor of nuclear energy, but you've seen a tremendous change just in the last few years. I see a tremendous change in opinion within the scientific community. There are more and more scientists who are questioning the sanity of going ahead with the technology. You see, we've given our scientists 30 years to work on this technology and get the bugs out of it. OK, here we are 30 years later ready to proliferate this thing all over the world; we're not going to have only our own waste management problems, we're also sending them to other countries. How are we going to look after accident possibilities in those countries? Do we take responsibility for that? How are we going to look after waste storage and waste transportation in those countries? Do we have a responsibility for that as well as in our own country? And so there is a growing body of opinion that this is a very, very central ethical question, that's one consideration.

The other consideration is the whole question of openness and the manner in which decisions are being made. And the feeling is growing in Canada I think, as elsewhere, that for decisions of this importance, of this significance, people should be bending over backwards to make sure that this thing is getting all the scrutiny it can possibly get from outside sources; and in fact the opposite has been happening. There has been an atmosphere of secrecy, it's been very difficult to get information, a lot of information has been obtained surreptitiously, documents are leaked, information is leaked, and it's very difficult to really find out exactly what's going on.

MR. MCQUAID: How can we ever make up our minds when two eminent scientists like you two have debated here this afternoon? I'm no wiser now than when you started, actually; there have been good arguments given on both sides.

DR. EDWARDS: Well, maybe as far as forming an opinion of your own, but perhaps you've learned a few things about what the issues are and what the questions are, and perhaps you might be able to form an opinion as to whether these questions are sufficiently weighty to warrant much further and much more careful inquiry. For instance, one of the things which I have been suggesting to the Science Council of Canada is that they should undertake to sponsor not a public inquiry, but simply a technical seminar into the questions of reactor safety and waste management problems involving scientists and engineers from completely outside the nuclear field in Canada and also involving some scientists from other countries as well who have had experience in this field. They would simply sit down with people from Chalk River and power projects in Whiteshell and teach them what the basis of their safety calculations are and so on, and to inject some critical questioning of their assumptions of their calculations, etc. I think that nothing but good could come out of that kind of a meeting, because there's no golden rule that is going to make you choose one opinion over another. What would come out of such a meeting would be a much clearer picture of what's known about the safety of the Candu System. A lot of effort in terms of dollars and manpower resources have been put into the study of reactor safety and into the question of waste management in the United States, and where are they? They are in a mess. You know, their program is rather in a shambles. Some people are saying that nuclear power in the United States is as dead as a doornail - it's just not going to expand the way they said it was going to expand. Here in Canada, no such independent investigation or scrutiny has taken place at all, and I'm not suggesting for one minute that it should take place in the same way that it did in the States, I don't think that in Canada we have spent even a fraction of our effort in trying to solve these problems compared to what they have done in the States.

MR. MCQUAID: Is there any strong reaction from Pickering or Point Le-Preau? For example, they must be apprised of the dangers you point out. Has there been any strong reaction there, in those areas?

DR. EDWARDS: A lot of citizens groups have formed around this issue, yes, opposing nuclear power. They have been making submissions to Premier Hatfield now for a considerable length of time, they have been communicating with people in Ottawa, they have sent delegations to Ottawa, they managed to get a kind of a public hearing. But unfortunately, you see, all of the money and resources are all on one side, and I don't think that there has been yet a real effort to have a thoroughly, balanced investigation of these questions, to really try and get to the bottom of them.

MR. DINGWELL: Mr. Chairman, I wonder if I got my question answered yet. I asked about effects of the possibility, and it could be a possibility, an action by man or by nature exploding those waste disposal areas, or of the Fundy fault coming about, or an earthquake or something.

DR. EDWARDS: I can't tell you that; I don't know. I don't think anybody knows. You see, I never even got involved in any of these kinds of questions until 1970, as I indicated. My concern as a scientist is that I feel that science, which has been making fantastic progress for hundreds of years, is now using the world as its laboratory, and I think that the answer to these questions will be found out only by history; as events unfold we will learn.

MR. DINGWELL: When it happens, it can be too late.

DR. EDWARDS: That's right, many people feel, and I'm among them, that it will be too late, because once this radioactive material, if it is disseminated very massively in some unforseen way into the environment through accidental means, doesn't affect just the local people. It's passed from species to species through the food chain just like DDT. You may know that DDT concentrates as it goes up the food chain. If you have a predator and a prey, the predator will end up with hundreds of times higher concentration of DDT than the prey species, and it goes on this way all the way up the food chain. Well the same thing happens with some of these radioactive substances, and people are very concerned with the fact that once this material does get out into the environment, it doesn't just sort of disappear in a flash; it stays around a very long time and enters the food chain. So the concern is a very broad concern.

MR. DINGWELL: That may not be a very good comparison to use here today, the predator and the prey, because we might compare that to Maritime Electric and the farmer!

PREMIER CAMPBELL: I heard a definition of confidence: confidence is the thing you start out with before getting all the facts, and it might be an appropriate description given the questions that you've raised. I certainly share some of the concerns over the future of the nuclear program. The great minds of North America haven't yet discovered a way of transporting potatoes to Toronto without letting frost get in; how are we going to move these wastes to the Laurentians without radioactivity getting out? You have given us perhaps even more reason to consider very fully the various options that are open to us, and I think you will appreciate that we in the governmental side have a responsibility to see that power is available, at night the furnaces run to keep people warm and alive and to keep industry going.

DR. EDWARDS: Thank you very much.

MR. WELLS: We now have slightly passed the proposed hour of finishing, and it's been a long two days. I don't know about the rest of you but I found it stimulating and worthwhile from an informational point of view, and I hope that the experience has been similar elsewhere. I would like, as co-ordinator of this program, to express the Institute's appreciation, and I hope on behalf of the members of the Legislature, our appreciation to all participants who have taken the time and effort to come before the Legislature and present their briefs. I once again would like to thank the CBC for the most excellent co-operation and assistance given to us in getting this information from the Legislature out to the general public in Prince Edward Island.

Now that we've had a look at the present situation, some of the problems, some of the possibilities, some of the areas that require further examination, it is our hope to present a stimulating and informative two-day session April 12 and April 13, on what possibilities might lie before us in energy production for Prince Edward Island. Once again, thank you very much.

April 12, 1976, A.M.

6. ENERGY ALTERNATIVES

MR. ANDREW WELLS: Good morning. Mr. Speaker, Members of the Legislature: In the last two sessions at the end of March, we attempted to place in some perspective the present situation in respect to enengy on Prince Edward Island and to determine the dimensions of the problems we face. In that process, we examined virtually all of our energy requirements in both quantity and quality; our use of energy as it relates to the home, to business, to transportation, to fisheries and to agriculture. We explored the various forms in which our energy comes, in gas and oil, and electricity which is, in Prince Edward Island's case, really just another use of oil, in wood and in fertilizers. We looked also at the potential of nuclear power in the meeting of some of our energy requirements. And in that examination we also discussed the conservation of energy, the potential savings through conservation efforts and the responsibility of both the government and the governed to conserve a dwindling resource. Throughout those two days it became abundantly clear, at least to me, that we in this province are presently dependent upon the importation of energy in virtually every facet of our lives. That is, in order to adequately live and work in the modern North American sense, we must look beyond our provincial boundaries for the fuel to function. We are almost 100% dependent upon other Canadians, indeed other nations, and their varied wealth, to allow us our very existence. We also had brought home to us the fact that not only are we very wasteful in our energy use, but that our whole economic and social structure is based upon the premise of a continuous supply of cheap energy - cheap energy, which we must not only import, but which is no longer cheap, and apparently, no longer continuous. It has been said that we have been living on our energy capital as opposed to our energy income. Alright, where do we go from here? During the next two days we will endeavour to develop answers to the question, "Where does Prince Edward Island go from here?" Today we will have the opportunity to hear of alternatives. Tomorrow we will have an opportunity to hear the views of a number of people who have devoted the better part of their lives and personal energies to the perplexing and complex problems of energy, resources, and society. I would now like to call upon Mr. Peter Middleton, of Peter Middleton and Associates, to introduce the program on alternatives.

MR. PETER MIDDLETON: The search for alternatives leads to other conventional energy forms not currently used on the Island, and we will look at one today - coal. It also encompasses renewable energy resources: capturing the energy of the sun and the winds, converting wood and organic wastes to electricity for fuels or chemicals. Renewable energy resources are a major focus of our presentation today. But the search for energy alternatives must also lead to a reassessment of how we use energy, wherever it may come from. This subject was dealt with to some extent in a previous session on energy conservation. Today, however, we will look in some detail at two sectors of primary importance to the Prince Edward Island economy: agriculture and transportation, to determine how the whole pattern of energy use might be altered such that these two sectors will remain viable. The thrust of our presentation is that highly desirable alternatives exist or will exist shortly, that there is an increasing concensus among those who do not have a vested interest in current approaches that these alternatives will play a key role in our future. Other governments and private corporations, large and small, are making substantial investments in some of these alternatives, and their viability in particular applications is being demonstrated. Our aim today, then, is to convince you that these alternatives are real (we are not talking about science fiction), to indicate clearly that some of them are relative to Prince Edward Island (all of them undoubtedly will not be), and to suggest that because of the lead time necessary to put such technologies and approaches into place, the process of implementation, the assessment and the planning, must start today.

Our first speaker today will deal with a conventional alternative, coal. The source of the coal that we are going to be talking about is Cape Breton Island, so near but yet so far, I think as we will find out. And we have with us Mr. John Dodge, Vice-President of Planning and Marketing of Devco, the Cape Breton Development Corporation.

Prospects for Coal

MR. JOHN DODGE: Mr. Chairman, Honorable Members of the Legislature: It is certainly a pleasure for me to be here this morning to be able to talk to you about the conventional forms of energy and some of the alternatives in coal which you have not considered up to this point. And I think it's very important that each province take a look at its own opportunities and its own problems. I think that the Institute of Man and Resources should be congratulated for instigating this kind of public awareness that is going to be very important in the future when we look at our alternatives.

I think I would like to start off by just taking a look at a little bit of the history of coal. In retrospect, why was there such an interest in coal in the past, why has it declined and why is there an interest now? Back in 1720 in Cape Breton we supplied coal for the Louisbourg Fortress. Uses were mostly domestic, and through the 1900's, 1910 to 1946, the production of coal increased. But in the 1950's, of course, we all remember the decline of the coal industry. The cheap, so called efficient fuels, oil and gas, started to take over. The coal industry throughout Cape Breton and of course, throughout North America, declined. We were not alone in this. But something peculiar

Mr. Dodge (continued):

was happening in the early 1960's. We really didn't recognize it in the Maritimes because we had old mines, and some inefficient operations at that time. And what happened was that the efficient mines, some of them out West, were competing very effectively against oil. And two things were happening in the marketplace. Originally in the early 1940's there was a lot of domestic use - home heating - and a little bit for power generation and some for steel production in Canada and in the United States, it was not that great. But after the resurgence of the steel industry in the early 1960's, and also the thermal generation capacity went up, we found that there was a renewed interest in coal in the 1960's. We found that there was a change in pattern from the domestic user to what I would call the industrial user. This carried through, of course, into the early 1970's and it wasn't really highlighted to most of us until 1973, when the energy crisis came. If we look back over some of the data, we find that even some of the so-called oil-rich provinces are using a tremendous amount of coal, because it is an efficient alternative. For instance, the western Canadian provinces in 1962 used 1.6 million tons, and in 1973 they were up to eight million tons, over four times in ten years. This is to give you some perspective to your own use; if you used coal here, you would use about 275,000 tons a year. Alberta, or the western Canadian provinces used eight million in 1973. Ontario went from 4-1/2 million tons to 7-1/2 million tons between 1964 and 1974, and by 1985 they plan to go up to 18 million tons - a quadrupling in 20 years. This is a province that is using nuclear, and if you read the recent reports, you will find that they have in fact decided, as far as I can gather, to switch to the coal alternative.

The reasons for this escalating use include several advantages to coal that we have a tendency to overlook. One of course, is proven design and technology. We know we can almost certainly buy it off the shelf. Secondly, and this is becoming more and more important for governments everywhere and for utilities, it's less than half of the capital cost. And we know that the comparative costs of running and operating appear to be pretty close to the same if you are sitting very close to the reserves. One other advantage of coal is the fact that it can be flexible in meeting the various demand loads within the province.

Now you might say, "Where will coal fit generally as an energy alternative?" Usually if you are sitting very close to the reserve, it's very compatible with nuclear: for instance, in Nova Scotia where you are sitting on the reserves and you don't have to transport it, you can compete effectively against nuclear power. For other areas coal is usually cheaper and certainly more flexible than nuclear for peaking or flexible demand, and in some situations it is cheaper than oil. To give you some idea, we are now temporarily within the foreign markets for coal because we are changing methods and we are getting into production for steel plants. We have some thermal power, some thermal coal, we have some metallurgical coal. But if we look at the thermal coal markets throughout Europe, we find that we are

Mr. Dodge (continued):

effectively competing against nuclear and oil in Europe, and at the world market oil price throughout the world you will find that they are using coal instead of oil. In the world market the coal per BTU is cheaper than the BTU basis that you are going to get from oil. For instance, at the world market price of $12 a barrel it is approximately $44 a ton for coal. Now if we look at what it is now selling for in Canada, it's considerably less than that. I would say probably the equivalent, if you equated it to what we are selling in certain parts to oil equivalent in Nova Scotia, to a little more than $30 a ton. So you will find that at the world market price for oil, coal is a cheaper alternative, even if you have to go into the world market and buy it. Ontario, which plans to use 18 million tons in 1985, at the present time brings in every bit of their coal, over and above a little smattering, from the United States. None of it is Canadian coal. So there are provinces, there are people in Europe who are using coal as one of their alternatives.

Now the key thing, and I would like to get into this a little bit later, is the fact that transportation of coal is a key factor. Coal is a heavy commodity and expensive to move around.

Now if coal is such a good alternative, what kind of reserves do we have close by? Can we get hold of it, can we use it? Well, Devco (Cape Breton Development Corporation) is now operating three mines - two are new and one is remodeled or a modernized mine. Most of our production will be geared to the steel markets but a third to a half of our production will be thermal coal. We are operating at the present time in the Sydney coal field; this would be pretty close to a radius of 20 miles around Sydney. If you look at our reserves, they stretch out underneath the water. They begin on the edge, they outcrop on the edge, and they dip out under the sea. If we took five miles out from the shoreline and 4,000 feet down in depth as our cutoff point, we expect to have 400 million tons in the Sydney area. Some of it is unproven; half of it is proven, and we are now carrying out extensive programs to prove up the reserves. But offhand, a quarter of this 100 million tons will be recoverable for thermal purposes; there's still more recoverable for metallurgical purposes, which is a more expensive and higher grade coal. The Province of Nova Scotia, we feel, has taken the lead in saying that they wish to have that production for provincial use. Tentatively we feel that we can compete against the alternative forms of energy, and we look forward to the use of coal in Nova Scotia. The mines within Cape Breton have changed. You may think that they are the old antiquated operations. Our productivity per man is equal to most or all mines that I am aware of in Europe at the present time, we are certainly equal to a lot of the American mines at the present time. This is a definite change over the last three years. Our production is going from about 1.3 million tons in 1974 to about three million tons this financial year. Last year we went up over 50%, very close to two million tons, so our productivity is up, and we can compete against other fuels, using modern technology and good management, and still keep within the very realistic safety precautions that are necessary in

Mr. Dodge (continued):

underground mining. So what I am saying is the Sydney Coal Field, the main coal field that we operate on is dedicated to the Province of Nova Scotia. But we feel that there are other reserves that are still unproven in Nova Scotia that might be available for other users. On the Western side of Cape Breton, that would be the side facing Prince Edward Island on the Northumberland Strait and the Gulf, Port Hood, Mabou, Inverness, on this side, it is expected that there are 11 million tons within that area. Again it starts on land and dips under the sea. There are some difficulties with this seam. There were mines operating there which are very very steep, some of them go down with gradients over 30%, but the geologists feel that they go down and level out. What would be necessary is for someone, particularly Energy, Mines and Resources or the provinces, to get involved in offshore drilling in that area to prove up the reserves.

Now this is a nice alternative for yourselves. In fact you can check out the geological conditions to ensure that the reserves can be economically mined and that's a key. But it's a nice location, in the fact that it could be very close barge shipment to Prince Edward Island, and it's within your usage; it would give you quite a time span, probably forty years of coal supply in that area. But of course, these reserves, I must highlight, are not proven. They are expected to be there and there would have to be more drilling done offshore. Since most of our coal dips under the ocean we can do it only on test holes from the ground and some of the underground samples that have been taken in existing mines. Within mainland Nova Scotia there are certain reserves that are known, but not with the degree of exactness that has been expected. Under a subsidiary agreement for mineral resources the Department of Regional Economic Expansion and the Province of Nova Scotia have entered into an extensive inventory. Nothing has been released on this, but I would expect that there would be over a total of 35 million tons in mainland Nova Scotia. But the economics of recovery and recovery rates are certainly open to dispute at this time. So we have two main reserves, some on mainland Nova Scotia, some on the area facing Prince Edward Island that may be available for other provinces or other customers to use. But at this time they are not proven and extensive drilling would have to be carried out. There's some belief, although there are certainly arguments about this, that the coal reserves that are in Pictou County and also up on the western side of Cape Breton Island do stretch over towards Prince Edward Island. I know that we've had indications off Sydney that our coal reserves stretch through to Newfoundland, and several drilling rigs have hit our coal seams 20 and 30 miles off. So we know they continue. But we do know there are, in certain areas, geological faults. So the question about the coal in the ground is a different matter than getting it up; you have to mine it economically, you have to transport it and then you have to use it in a power station. So you are a long way from bringing it home when you have it in the ground. There are certain geological

Mr. Dodge (continued):

conditions: faults, stones, slips in the seams; dips in it; certain safety precautions necessary to recover it. We are all familiar with some of the mine disasters and it is very important in this day to be primarily concerned with safety. These are things that must be considered. Trained equipment and coal quality is also very important. Other than the Sydney Coal Field which we are now operating, there is a lot of uncertainty about the use of the other seams and other reserves in the province. But there should be work done on this and I am sure that you should follow these prospects with a great deal of interest.

Now assuming that we can get it out of the ground, let's look at the transportation. I don't think I have to say too much in this Legislature about costs of rail shipments. We've done a lot of work with Canadian National Railway, and we find that we are now losing Canadian markets for coal because of the rail shipments. We have been forced to export certain coal to Europe, to England, to Germany cheaper than we can move coal into New Brunswick. So if you have to get into moving coal, it is certainly a barging and stockpiling operation. It has to move by water. It can't use conventional transportation systems. It's very important to look at those alternatives. We can't seem to ship over long distance through rail except on unique situations where there are certain negotiated rates and certain unit trains can be set up. It appears when you look at the economics, that it might be cheaper to have a power plant closer to the mine and transmit the power than it is to transmit the coal. So what I am saying is that if you can't get the coal, maybe you should buy, or consider buying, coal-generated power close to the reserves. If you can't ship it by railroad cheaply and you can't barge it within an efficient area without difficulties of storage, then consideration should be given to the transmission of that power from the reserves. Nothing new, just the same alternative, of course, as from the nuclear or hydro from other provinces. But consideration should be given.

Another fact is once you get the coal out of the ground and get it transported, you've got to use it at your stations. From my little amount of research, I understand that you have approximately 150 megawatts of capacity within Prince Edward Island. About half that, or some 60 megawatts, is steam-generated. That half might be convertible to coal. It's very, very expensive to convert from oil usage stations to coal. You have a lot of extra handling equipment, you've got to put conveyors in, you have to provide a lot of extra space and capital equipment to convert back. So there are physical limitations of coal handling in an existing oil station. But some stations are considering converting back, and in some areas of the world they have converted back, if the trade-offs and the savings are there. Within the older stations the environmental aspects may not be adhered to in the way your province wishes. The older stations may not be set up to handle the special environmental problems of coal as compared to oil, not that they are any different, but the fact is that the older stations don't necessarily have the equipment that a modern station would.

Mr. Dodge (continued):

So if we converted back, say, for instance we had a hundred megawatts of power within Prince Edward Island. That is an equivalent of about 275,000 tons of coal. That's about 10% of our present rate of production. It's not a lot of coal but it's certainly important to your province. Less than half of that can be converted, and it's very possible that a quarter of that 70,000 tons can be converted in one or two of your large units. That kind of resource is not hard to get on a long term contractual arrangement from world suppliers and it may be received from Canadian suppliers within our own operation. It's not a large amount of coal to us.

But that's looking at the existing stations. You say,"Well, do we want to put in a new station, a new power plant?" I'm not a power station expert, no energy expert when it relates to the use of coal within power generation systems. But we do hear within the business that a 300 megawatt power station seems to be the minimum economic size. Whether it's true or not, I don't know. Nova Scotia's planning a 150 megawatt unit as the first one, which is in effect more power generation than you now have on the Island. So it appears that within your realm it is not economic to put in a new base load use of coal generation for your new additional power. It would be worth studying the particular economics of it, but it doesn't appear from the surface that coal is an alternative for a small load growth, which is planned within your province. Even if you went up to 130, 140 megawatts by 1980-81 it is still only a net increase of 40 megawatts, not a significant amount when it comes to economic sizes of power units.

In summary, coal has an important economic prospect for certain energy alternatives within Canada, particularly within Nova Scotia, but Prince Edward Island offers a limited possibility for the use of power generation with coal. The only alternative that I could see might be the use of coal on conversion of some of your smaller parts of a unit from world supplies of coal. It might be cheaper delivered from some of the world markets than your oil alternative; or the possibility of maybe joint venturing with Nova Scotia in a coal-fired station which would be fully competitive with nuclear at the present time, meaning lower capital cost and all the side benefits that you get from the use of coal in an energy system, and much more flexible. So in Prince Edward Island, small scale economics should be considered. It might be very useful to tie in with some of the coal generation right near the pit to allow for the benefit of transportation versus the transmission of that energy.

Today I haven't mentioned anything about the use of coal within a domestic scene, the use on the farm, the use in home heating systems, and I've deliberately done this. The transportation of coal in small lots is not economic at the present time. It's an expensive system. It would be more expensive than oil at the present freight rates and the minimum sized lots and it is not an alternative to use in small lots. It might be an alternative to use within your energy system on a larger scale. I hope that this short talk has been informative and I would be glad to entertain any questions that you might have.

PREMIER ALEX B. CAMPBELL: Well, Mr. Dodge, if I could start out, you are the Vice-President of Planning and Marketing of Devco, and I think something central to your whole presentation was your forecast at the price of coal. Our inquiries to Devco earlier, as we examined the possibilities of coal, led us to the understanding that coal will follow the international oil price and if coal or its equivalent BTU value is to be pegged to or to follow international oil prices, then how can we conclude that coal will be competitive with nuclear or in some cases cheaper than oil?

MR. DODGE: Mr. Premier, coal has a tendency to follow the same direction as other alternatives. Some of our customers have pegged their price to oil on a delivered basis. This means that we must absorb all delivery charges and as I've said, the economics of transportation are the very key of this whole argument. If you look at an FOB price Sydney, it's less expensive for some of our commercial customers to use coal than oil. In fact we are moving coal within Prince Edward Island to some of the Armed Services Bases in competition with oil at the present time, and we are moving to a small barging operation this summer for the first time. It's a real question whether the long-term direction will follow very closely the energy equivalent costs in oil. Costs in mining are going up, and there's certainly a lot of variable cost contained within it. I don't know if I've answered your question or not, but at the present time your FOB cost Sydney is probably cheaper than your oil cost at Sydney.

HON. JOHN H. MALONEY, MD: With the reserves that you have, and as in Nova Scotia your power demand increases, you don't really have much more than a 50-year supply for your own needs, do you?

MR. DODGE: Yes, this is a non-renewable resource and we should look at the limits which I've placed on it. I said five miles out, I said a 50% recovery, I said no further than 4,000 feet in depth. That's in a certain area; those are proven. We can anticipate. We know it stretches to Newfoundland, we know it goes out twenty miles, we are only out to five miles. We hope over 40 or 50 years, technology will keep pace. The assumption is that if we are right for 40 years, it's not a bad decision. But you are right; it is non-renewable, although we expect that there will be a continual growth in the reserves as technology improves recovery rates and the distance of which you can work from the surface.

DANIEL COMPTON, MLA: Are any mines operating in Pictou County at the present time?

MR. DODGE: There's a small recovery operation now but nothing of any significance. The total production of coal other than Devco, I could stand corrected on this, I think is not much more than 30,000 tons and we will produce very close to three million tons this year.

VERNON MCINTYRE, MLA: I am wondering, Mr. Dodge, what has happened to the mines in Springhill and Kemptown, are they still operating?

MR. DODGE: No, there are some small reclaim operations but they are very, very small. These are the reserves that I'm talking about that must be proven up; we must take a very close look at the geological conditions and the feasibility of safely mining a lot of those reserves. We know there's coal there and we know it's quite deep, and we know that there's some geological problems that create at times maybe some unsafe conditions but we hope that there will be, over the next five years, an opening of some of these other reserves. But it's certainly in the hands of the Provincial Government of Nova Scotia and not in Cape Breton Development Corporation's hands.

PREMIER CAMPBELL: You referred to the Sydney coal field and the coal in the west coast; are you referring only to the coal reserves over which Devco has managerial responsibility?

MR. DODGE: We have at the present time only under lease really the Sydney coal field. We have, I believe, some prior rights to other operations in Cape Breton, but we are only operating under the Sydney coal field at the present time.

PREMIER CAMPBELL: Well, are there other reserves of coal which you have not referred to in Cape Breton today?

MR. DODGE: Other than the west side of Mabou - Inverness there are some other small reserves but not significant enough. There are traces throughout Cape Breton, but not of any significance. A lot of the smaller areas have very thin seams, one and two feet thick with a lot of faults, and you will see traces of it as a tourist but they are really not an economic reserve. At the present time we discount those.

PREMIER CAMPBELL: So you don't see going back to Stellarton or Westville?

MR. DODGE: As you are well aware, we are a Federal Crown Corporation, 100% federally funded, and our jurisdiction is only the Cape Breton Island. I'm certainly offering opinions on reserves that we do not hold, but it's not in my power to say how they should be best used. I do have some views that there is a potential there, and the Province of Nova Scotia is certainly looking at it.

MR. MCINTYRE: Who controls the quality of coal mined within Nova Scotia? In years gone by apparently there've been several grades of coal coming on the Island, some of it was good, some of it was not so good. Has this been changed in any way; is there any protection for the consumer regarding the quality of coal?

MR. DODGE: There are several grades of coal mined; some of it is washed, some of it is oiled, some of it is treated, some of it is screened. So there are many different varieties of coal. Within Devco we have a quality control department and we also have a product grade supervisor - actually a supervisor of distribution we call him - who selects different grades for different customers. Now most of our customers have a contract saying exactly the coal they wish and any customer can say that this is the specification, this is the size he wants, this is the kind of ash he wants, we will do our best to deliver that within certain ranges. I think in the old days there weren't maybe the lab work and the specifications and the sizing that is done today.

MR. MCINTYRE: What is the difference of cost between these various grades?

MR. DODGE: At the present time they can vary as much as 50% in price.

MR. MCINTYRE: They can, and do they now?

MR. DODGE: Yes, some of our domestic coal sold is sold at premiums of 30 to 50% because of the extra costs mostly in handling, sizing, and oiling, and looking after the special qualities that a customer will demand. But this is a very, very small market. Our domestic coal usage now is only 42,000 tons out of three million tons production. It is a very, very small part of our business now. It's a changing way and most of that is used by employees.

MR. MCINTYRE: That $44 a ton that you quoted earlier, that's just at the mine, that's not treated or anything other than that?

MR. DODGE: That $44 a ton is not what the present selling price is. That is an oil equivalent price of $12 barrel oil. That's roughly four to one to convert a barrel of oil to the cost per ton; it depends on the BTU and the quality and so on.

MR. MCINTYRE: What is the equivalent price per ton today at the pithead?

MR. DODGE: I would say that the price per pithead for about 70,000 tons today would be in the range of $30 a ton. That's on a volume basis. That's on about a 70,000 ton lot. These prices are mostly in large volumes or negotiated rates. I don't like to particularly hold on to that particular number, as they vary from year to year and customer to customer and with special requirements of quality that the customer may desire, but that's a guide.

HON. BRUCE STEWART: Have you any figures on the difference in cost of delivering coal from Sydney to Summerside by barge as opposed to the conventional way?

MR. DODGE: Yes, I do, but I really don't have them here and I wouldn't want to quote them, although I believe one quote we had from the CNR was $18 a ton and I think that the barge operation will be considerably less than that, maybe half of that. You can see when 50% of the cost goes into transportation that we have to look at alternatives; I think this is what the changing world has forced us all to do. I'm not saying barging is the answer because there are extra costs associated with it. You must store it; it's a very limited shipping season. There's extra handling; you have to truck it. You just don't barge it; you have to get it on the barge, you have to store it, you have to tamp it, you have to watch it to make sure it's not carried off, and you have to make sure it doesn't catch fire, and there are a lot of other precautions and caretaking that must go along with a barging operation.

HON. GEORGE A. PROUD: You are talking about conversion from oil to coal in generating stations; do you see this happening in Nova Scotia?

MR. DODGE: Within Nova Scotia the amount of coal usage has been limited in certain cases by the amount of coal that we could supply. We have been going through a modernization and expansion operation. Now that we have developed one new mine called the Prince Mine we have the capability or the capacity to increase the mining of thermal coal. It is primarily from that mine that the new units will be built in Nova Scotia.

MR. PROUD: That power company in Cape Breton, Seaboard Power, do they generate by coal?

MR. DODGE: Yes, they do. They use 350,000 tons a year, which is about equivalent of about 1-1/2 times what you would use in Prince Edward Island. Now coal is an alternative for oil, but when you have probably 25-megawatt units, which are considered small but servicable within the world context, it may not be worth the extra conversion cost to convert; it would require quite a lot of engineering studies and you would have to ensure before you went ahead with it that you had that long term contractual supply of coal. There are extra costs in using coal: extra ash handling, extra environmental precautions, and a lot of other considerations.

MELVIN J. MCQUAID, MLA: Well if Prince Edward Island were to convert from oil to coal for generating electricity, presumably we would have to depend on the coal on the western coast of Nova Scotia?

MR. DODGE: Yes, the only other alternative would be of course the mainland, Pictou County, Cumberland County and the like, but the only way you could get part of the reserves for the Sydney coal field for long-term contracts is by dealing with the Provincial Government, because we've dedicated probably up to 2.4 million tons a year to Nova Scotia.

MR. MCQUAID: With whom would we have to deal for this coal that is available on the west coast?

MR. DODGE: I would say that the Department of Mines in the Province of Nova Scotia would be primarily interested in that; the Deputy Minister of course could handle any questions directly, or of course, the Minister.

MR. MCQUAID: And would they undertake to mine this coal for us supposing we did decide to convert?

MR. DODGE: At the present time the Department of Mines in Nova Scotia is not operating any mines, and they have not indicated that they wish to get into the mining business. They are very interested in inventorying and getting other people interested in mining. But there is one small company doing a little bit of work in that area now, and was last summer, and were planning to do, I believe, some reclaiming of some of the old pits to see if there was anything worth recovering but I'm not sure what actually took place.

MR. MCQUAID: For all practical purposes that source of energy is practically out for us, I mean, we couldn't go over there and start mining it.

MR. DODGE: I would say that it might be a marginal saving, but for practical purposes a very limited possibility. But it is worth a professional engineer looking at it to see if you can get long-term contractual supplies and then at the economics of conversion. You can easily compare the cost savings of coal versus the capital cost you would have to put in to renovate some of your existing systems. The other alternative might be to buy from the larger units in other provinces that do have larger units. Nova Scotia generates about ten times the power that you people do.

MR. MCQUAID: Have they got power to spare over there?

MR. DODGE: Not at this time, but they are expanding their capacity and they might be able to build in extra capacity for yourselves at this time.

DR. MALONEY: Do you have the comparison between coal generation and high voltage line loss on the one hand, and the shipping charges or costs on the other?

MR. DODGE: No, I don't. We have dealt with the Nova Scotia Power Corporation on this and they feel it's to their advantage to transmit the power over high voltage lines. They have some very, very high voltage lines within the Province of Nova Scotia and they feel that's an efficient way of handling it rather than transporting the coal, but it would not be very hard to get that information.

PREMIER CAMPBELL: I think that's the information we have to have - whether to ship it in or whether to bring it in by wire. You didn't mention coal gasification, a subject Dr. Gray of Halifax is very strong on. Is Devco doing any research or working in this field?

MR. DODGE: We are not, at the present time, doing any primary research in this area. If we look at coal gasification, most of the coal gasification work that's been done is being looked at primarily for feeding into existing pipelines and there's no pipelines in the Maritime Region now; anyway we really have enough to cope with using conventional means.

PREMIER CAMPBELL: But what about creating the gas as a source of on-site power for thermal generation?

MR. DODGE: We are starting probably to collect our methane gas from the mines, and that will be used by the Nova Scotia Power Corporation, as a way of using some of the gases off the coal. We are now just dispersing it into the air, but we plan to collect it and sell it. Over the next five years we'll be into that business. We have done some feasibility studies on it, and it looks quite good.

PREMIER CAMPBELL: Devco is not doing any research, however, in recovering gasified coal from a non-commercial coal field or a coal field where the contemporary means of extracting the coal are too expensive?

MR. DODGE: Maybe I could step back a little bit and say that there are two grades of coal: one is metallurgical and one is thermal. At the present time, two-thirds of our coal is metallurgical grade coal and our thermal coal is about a 50% discount in the price of met coal; our priorities are metallurgical steel-making markets, which are more profitable. Our production has gone up 50% last year and it will go up nearly 50% again next year. We opened one mine in 1972, began renewed work on it, opened another one last year, and modernized another one. We are now planning a fourth. We've done some strip mining operations with total environmental reclaim. We certainly haven't stood still in the conventional sense and I think down the road, within the next ten years, coal gasification in some of the areas might be looked at, but I do think that our alternative, and we are starting to do work on this, is to look at the foreign coke business which is a use of metallurgical coal or low grade coals or thermal coals which can be converted into form coke to be used in steel-making. So there are other alternative uses of coal other than just burning it.

MR. MCINTYRE: I am wondering who has the control of the Cape Breton coal industry, is that Devco, or does the Nova Scotia government have control of that?

MR. DODGE: The Nova Scotia Government of course owns the reserves, and I don't think we should fool ourselves. They control the reserves through a Mineral Resources Act which causes us to discuss with them and to allow them to approve in effect our off-island contracts. They also control the royalties on our coal. So they certainly have controls on our business but we are an independent corporation and they do not have any management function in the mines themselves. This is strictly with the Crown Corporation of Devco, or Cape Breton Development Corporation. We have about 3,700 employees at the present time.

MR. MCINTYRE: Supposing the Province of Prince Edward Island wanted to negotiate a contract for the coming year, who do they negotiate with, your company or the Government?

MR. DODGE: In fact they would probably deal with myself, being the Vice-President of Marketing for Coal. We could dedicate short-term supplies, but as to long-term supplies we would have to look at our production and sales; our production and sales are in balance pretty well because we've committed or dedicated most of that to the Province of Nova Scotia.

MR. MCINTYRE: I believe you stated earlier that coal is important within Nova Scotia but the potential for Prince Edward Island is limited. Just what did you mean by that, in tonnage or in time?

MR. DODGE: It really stems from the fact that the Nova Scotia Government has taken a considerable interest in coal, so there will be very little left for other customers, in this case Prince Edward Island.

MR. MCINTYRE: So there just isn't any amount available for us even if we were interested.

MR. DODGE: Not in the present mining plan. If you defined particularly what you required and it was a small amount, we could discuss that with the Province of Nova Scotia to see if they had that much flexibility in their demand. Today if we are setting 2.5 million tons for 1983, they may really require only 2.2 or 2.3, and that's more than you will ever need; so every customer must have some flexibility in their contracts and we have to balance these year by year. So if you knew exactly what your plan was and what your needs were, we could discuss them but it has to be done certainly in line with the alternative of transportation and conversion of your existing plants.

MR. COMPTON: You mentioned a rail rate of $18 a ton.

MR. DODGE: I really shouldn't have said that off the cuff; I thought it was $18 but I am not sure, because it seems awfully high in retrospect.

MR. COMPTON: You would get a truckage rate much cheaper than that.

MR. DODGE: No the CNR has been very good; on carload lots or on less than carload lots it is very, very difficult to get special rates. There are certain commodity rates, I agree, on a tonnage.

MR. MCINTYRE: Have you had any experience with water shipments on a rate basis in comparison?

MR. DODGE: Not to Prince Edward Island, no, but we are shipping to Europe now, and we can probably ship to Truro at the same cost as to Germany.

MR. MCINTYRE: What would your rate be to Truro?

MR. DODGE: Well, I really wouldn't want to say at this point because most of these are negotiated rates, but that gives you the comparison.

MR. PROUD: What would the heat rate be for a 25-megawatt station with high sulfur coal - the BTU per kilowatt hour?

MR. DODGE: I am generally using the rule of thumb that it takes about

400,000 tons for a 150 megawatt station, so you are talking approximately 60,000 or 65,000 tons. That's why I said that a quarter of your units might be converted.

MR. MCINTYRE: What percentage of your mining of coal now goes into the steel industry in Nova Scotia?

MR. DODGE: At the present time about 25% of our output goes into the steel industry in Nova Scotia. It's a changing thing, we have a new preparation plant to reduce sulphur and to improve the sizing. We'll increase our capacity in the metallurgical grade markets. We are just starting to begin to export ore in this year in fact, export metallurgical coal, so that's really our only customer at the present time but we are starting to ship coming this fall to one of the steel plants in Ontario by water.

PREMIER CAMPBELL: What percentage of the known reserves - this follows Mr. McIntyre's question - what percentage of the known or proven reserves has been committed now to all purposes? Have you committed in your marketing program all of your presently proven reserves?

MR. DODGE: We've taken on rough rule of thumb that we do not wish to shorten the economic life of the reserves by over-producing at the present time; we don't want to get into a social problem that we once incurred and we want to at least keep ahead of the technology; our rule of thumb is 40 years. So at present we have committed all our thermal coal - we haven't quite yet but we are very close to that - to the Province of Nova Scotia.

PREMIER CAMPBELL: And that's the Sydney Coal Fields.

MR. DODGE: The Sydney Coal Fields; but you know, our drilling keeps going on and some of the estimates were over 400 million and maybe a billion. There's a whole area not too far from Sydney that we haven't done any drilling on and which will require offshore drilling to prove out the reserve because the outcrops are under water, they are not land at all.

MR. COMPTON: Is this sufficiently high quality coal for use in the steel industry?

MR. DODGE: Yes, it is. It has certain fluidity characteristics and has certain qualities to make a good coke that holds together. And of course they have a tighter restriction on sulfur limitations. The reserves on the western side of Cape Breton, I should remind you, are not only steep, but some of them have a very high sulfur too. It's something worth considering.

PREMIER CAMPBELL: So what you have really told us, then, is that all the coal in Cape Breton is committed one way or another, and that perhaps we should be examining the potential on the west coast, the Pictou area?

MR. DODGE: Yes. Sorry I couldn't give you more positive views, but that's the way the situation is today.

PREMIER CAMPBELL: Thank you.

MR. MIDDLETON: Thank you, Mr. Dodge. Canada's energy consumption has increased 16-fold since 1900, and may well double again before the end of the century. And it's taking more and more energy to deliver this energy to the consumer. Some of this growth will be met by coal, as we have heard, in some places by remote sources of oil,

Mr. Middleton (continued):

and by nuclear power, although the public debate about nuclear safety is far from over. And some of this projected growth may be curbed by serious energy conservation programs, proper home construction and insulation, more efficient automobiles and the substitution of human energy for oil and gas. But a look at what energy we currently use suggests that meeting increasing demand at a time of declining petroleum resources may not be easy. Our reliance on fossil fuel based resources is enormous, representing about 88% of our energy use in Canada, and it's obviously higher slightly in this province. So we are highly dependent on fossil fuels at a time of decreasing production. New energy sources will be required if we are to dramatically decrease this reliance on oil and gas. All around us are energy resources whose potential has been obscured by the promise of cheap, abundant petroleum and natural gas. Unlike fossil fuels, they are, if managed properly, for all intents and purposes inexhaustible. Unlike fossil fuels, many of them require extensive transportation systems because they are located where the demand for energy happens to be. And they can offer lower environmental impact, increased security of supply, and long-term cost savings. These advantages were not lost on earlier generations of Canadians. Wind, wood and water power played a cental role in the development of this country. Unfortunately, most of the significant falling water resource has already been harnessed, and remaining sites are limited, although many do have potential for small-scale exploitation. The so-called energy crisis of recent years has, however, prompted massive research and development programs in other countries to tap less concentrated renewable energy resources. Radiation from the sun is now being used directly for space heating purposes. Canada's first solar house was built in Surrey, British Columbia, in 1971; almost half of its space and water heating needs are supplied by the sun. Contrary to popular belief, Canada's northern latitudes do not make solar energy technologies impractical. This map, which shows solar radiation levels, indicates that most Canadians live in areas which enjoy higher levels of sunlight than the Surrey house. Other solar-heated houses have been built in the past few years, such as one in Mississauga near Toronto. Generally, they incorporate a collector, a storage mechanism (water or stones) and a distribution system. Various approaches may be taken. Provident House, near Toronto, promises to supply 100% of heating demand through the use of long-term storage; the Ark in Prince Edward Island combines solar heating and food production. In the Cote Nord experimental housing for Quebec Indians, the house wall itself becomes a passive collector, and the north wall is partially buried to minimize heat loss. It is encouraging that several large multinational corporations are developing solar collectors which maintain efficiency in cold climates. Solar collectors can be incorporated into traditional housing designs, or the solar heating aspect may be emphasized. Although we have focussed on detached homes, solar heating will likely prove even more

Mr. Middleton (continued):

economical in multiple family dwellings. Demonstrations involving an old folks' home and a school are underway. In fact, our acres of suburban roofs represent trillions of BTU of untapped potential energy.

Direct solar energy can also be converted to electrical power. A solar cell only a few inches in diameter transforms light into DC electrical current. Developed first for the space program, solar cells are now used to power communications relays in New Zealand and navigational aids on drilling platforms, and to provide reliable crossing approach signals for Canadian Pacific Railways in their Montreal yards. A most interesting application will be the combination of solar cells with solar collectors to supply both electrical and heating needs to residential, commercial and some industrial establishments.

Wind power has a long history in Canada. Across the nation the wind-powered water pump has been a familiar sight. During the 1930s and 1940s before rural electrification wind generators were also widely employed. And today, wind generators continue to prove reliable and economical in remote locations, such as farms in northern communities, where electricity costs and wind speeds happen both to be very high. On a larger scale, a mill at Gedser, Denmark delivered more than 400,000 kilowatts per year to the local electrical grid, beginning in 1957. An experimental 100 kilowatt mill has recently been erected by NASA near Cleveland, Ohio. And a larger version of Canada's own vertical axis model developed by the National Research Council is soon to be installed by Hydro Quebec on the Magdalen Islands in the Gulf of St. Lawrence.

Biomass is a term used to describe living and once living material found on the earth's surface. Canada, with its large land mass, has one of the highest biomass per capita ratios in the world. Agricultural and livestock wastes are two of the biomass sources of energy which are being investigated seriously by several provinces and the Federal Government. One system envisages the use of bacteria to convert waste to produce methane gas to be used for a variety of purposes on the farm itself. Canada's forest resource is even more extensive. At the moment, however, only a small proportion of it is converted to energy. Roughly 2% of Canadians currently use wood for heating and cooking, although the percentage is higher in this province. Forestry wastes, on the other hand, are increasingly being sought and burnt by pulp and paper mills to generate steam, and future concepts include the management of forests and woodlots specifically to produce fuel. Systems proposed to increase the self-sufficiency of outlying communities include electricity production and the use of waste steam and hot water for district heating. Like wood, urban waste, which represents a growing cost to municipalities, can be turned to an advantage if, after all recyclable materials have been recovered, it is burned to produce steam and electricity. Or any of these biomass resources can be converted by pyrolysis or a similar process to synthetic

Mr. Middleton (continued):

natural gas or synthetic syngas and then to ammonia or other chemicals or to methanol, which may eventually replace gasoline in our cars.

Potential renewable resources, however, lie not only on the earth's surface, but beneath it. In some parts of the world, readily available geothermal energy is already being tapped in the form of hot water or steam. In Italy, underground heat is used to generate electricity. In Japan, it heats greenhouses for food production. And in New Zealand geothermal energy provides 30% of their pulp and paper mills processed heat. These are only examples of the wide range of uses to which geothermal energy is currently being put in these and other countries.

Finally, the oceans: Canada has hundreds of miles of coastline, and it is estimated, that each meter of wave front represents a power potential of nine to 18 kilowatts. The British have designed a wave generator; the Japanese are currently constructing a 5-megawatt model of their own design. Tidal energy has also been the study of numerous feasibility studies. The largest tidal installation in the world is located at the mouth of the Rheims River in France, and it has a capacity of 240 megawatts. Canada's Bay of Fundy may some day prove a significant source of energy for the Maritimes. Many sites have been considered. But in the long run, perhaps the greatest potential lies in combining some or all of these multiple sources for specific applications, such as a shelter and food production unit, or to sustain small or large communities. The right mix of renewable and conventional sources will depend on the particular region of the country and what it has to offer, and on the particular needs of its people and of its industries. A program to develop renewable energy resources will require several things: a serious political and financial commitment by federal and provincial governments to make renewable energy part of Canada's energy mix; demonstration by government and industry sponsored projects that renewable energy technologies are feasible and economical; education of both energy producers and energy users; and a vigorous program to develop the manufacturing facilities and speed the transition to a larger scale reliance on renewable energy sources which will sustain us for centuries.

I would now like to introduce my colleague, Dr. Robert Macdonald, who will share the duties of the Chair with me and introduce our next speaker.

DR. ROBERT MACDONALD: Mr. Speaker, Members of the Legislature, for the remainder of this morning's discussions, we would like to focus on two specific aspects of the broad overview of renewable energy which Peter Middleton has just presented. In this regard, I would like to introduce our next speaker, Professor Frank Hooper, of the Department of Mechanical Engineering at the University of Toronto. Professor Hooper is indisputably the dean of Canadian solar energy researchers, for it was in 1948 that Professor Hooper first began research and design on solar energy collectors and solar powered residential heating systems. In this regard, Professor Hooper has pioneered in the design of houses which can obtain

100% of their heating needs from the sun. At the present time an entirely solar-heated house designed by Professor Hooper in association with architect John Hix is nearing completion outside of Toronto. This demonstration of the practical use of renewable energy is aptly christened Provident House. Professor Hooper is currently engaged on work on several other entirely solar-heated buildings in Canada and the United States. May I present to you Professor Frank Hooper.

Solar Energy

PROFESSOR FRANK HOOPER: Thank you, Dr. Macdonald, Mr. Speaker, Members of the Legislature.

Solar energy has a literally tremendous potential for the future. There is an abundant supply of solar energy. There is 6,000 times as much solar energy falling on the earth as we are expecting to use in the year 2000. Solar energy has certain other very desirable characteristics. It is completely without the aspects of pollution. It does not interfere with the ecology. It is essentially a utilization of energy that naturally falls upon the earth and if we can utilize it in a transient way, we can live in total equilibrium with the income of energy and with the general balance of nature. So solar energy is safe, it is available. In the narrowest sense it is free. One suspects, though, that maybe at some time in the future one might be able to tax it.

It has then, almost all of the characteristics that one looks for in the ideal energy source. Unfortunately there are also fundamental difficulties in the use of solar energy. It's extremely diffuse. The energy falls uniformly distributed over the whole earth and therefore it takes rather a large physical collector to collect a significant amount of the energy and therefore the collection means is inherently expensive. And the other difficulty is that solar energy, as we all know, falls only during the sunlight hours, and therefore it is not a continuous supply of energy. So other provisions must be made to supply energy when the sun is not shining. Now solar energy can be used for whatever purposes to which we put energy but generally we think of energy in terms of electrical energy or mechanical forms of energy or heat. And these are so different in their means of utilization that we should talk about them separately.

Now solar energy applied in the form of power or converted to power is not as readily available; it is not as easy to do as to collect it as heat. We can convert solar energy directly to electrical power in several ways. I think possibly the most promising is the direct solar cell. The solar cell, as Mr. Middleton was pointing out, can convert solar energy directly into electricity - it's simply a thin layer of solid state material. When exposed to the sun it converts about 15% of the energy in the sun to electrical energy. In terms of energy conversion this is a respectable efficiency but the difficulty with this conversion is mainly the cost. Although it is entirely economic to use this sort of conversion device in space satellites, when thinking in terms of major power production, it is at the moment very costly indeed. To put the thing into perspective, one kilowatt of generating capacity using fossil fuels, oil or coal, costs about $500 capital outlay for the plant.

Professor Hooper (continued):

For one kilowatt of nuclear generating capacity the cost is on the order of $1,000 a kilowatt. For the solid state converters at the moment, it runs somewhere in the order of $20,000 to $50,000 per kilowatt. Now there is no way that one can argue that that is at the moment an economic or viable system. However, there is every prospect that technological development will, over the reasonably near future - the next decade or 20 years - develop a means of achieving more or less comparable efficiencies at a small fraction of the cost. There are immense prospects for the future. One can see individual solar collectors: they are very simple, apparently have a very long life (50 years, possibly 100 years), need virtually no servicing, and have almost no hazard associated with them.

However, looking to the immediate future, and the decisions that I see this Legislature being concerned with, I think this approach is rather too distant to be a practical solution for your purposes at the present time. Now this could change rapidly with what is called a 'technical breakthrough', but at the moment is not possible.

There is another way of getting power from the sun by very direct means. That's simply by focussing the sun on some steam generator, some surface in which you have water, and generate steam at fairly high pressure, and take that steam to a steam turbine in the same way as you take steam generated by nuclear or fossil fuels to a steam turbine. And you can generate in that way electrical power. The technology is entirely known, but to do it on a reasonably large scale is also very expensive. Just to give you an idea of the way it is done and why it is expensive: you would normally mount a boiler on about a 500 foot tower - it would be a small surface blackened - and then in a field about one mile square around that tower you would have a very large number of mirrors each individually steerable so as to reflect the sun onto the tower. This has the effect, then, of focussing possibly a thousand-fold the sun upon that boiler tower, and there you would generate the steam at high pressure and temperature; it would run through the steam turbine and generate power. Again the cost of that would appear to be many times the costs of the conventional fossil fuel or nuclear powered plant. Of course you have no expense, no outlay whatsoever for fuel, but to overcome the very high capital investment appears at the moment to be difficult. It is not, it seems, at the moment economically competitive with alternative forms. Again it might well be developed to do so. I've made a rough estimate, and I believe I am correct in this, that it would require a capital investment of somewhere in the order of $10,000 per capita to install such a system in Prince Edward Island to meet the total current energy demands. This isn't absurd, but it is very high in cost. It would represent a capital outlay of a very large order, on the order of a billion dollars, and this, of course, represents as we all know great difficulties. So that regretfully I must say that at the moment and over the next decade or possibly the next two decades, solar energy

Professor Hooper (continued):

for the production of power does not look to me to be a good prospect for Prince Edward Island. This situation could change, and I think beyond, say, 20 years the situation may be quite different. I think for the longer term, the 50-year term, the 100-year term, we may well find that the solar energy economy is the ultimate answer to mankind living in happy equilibrium with the environment. In the interim we have economic problems and difficulties with that application.

However, when we turn to the other use of solar energy, the situation is very different indeed. And this is the direct use of solar energy for space heating purposes, for heating houses and buildings of all kinds. In my view we are already either economically in balance or so close to being economically competitive with other sources of heating energy that the solar heating alternative is highly attractive, especially, I would think, for a place like Prince Edward Island, where you have no native fuel energy resources. As Mr. Middleton pointed out, any solar heating system really has basically three elements. The solar collector is often mounted on the roof of the building. The building would be oriented so as to face south, and the collector is set at an angle that is about optimum. In Prince Edward Island that would probably be somewhere about 50 to 60 degrees from the horizontal. I'll describe the manner of operation of the solar collector in a little bit more detail in a moment. The second component is a storage means, such as hot water. The sun would heat water that would be circulated through the collector and the heated water from the collector would be taken to a storage area, an insulated tank, whose function is the obvious one of storing heat from times when a surplus is available to times where there's a deficiency in the amount that one can collect. The third component is the heating system of the house. It's very like a conventional heating system. One would take the hot water from the storage, circulate it through heat transfer surfaces, and return the cooled water to the storage. The heating system is a little bit different in that the heat transfer surfaces have to be somewhat more extensive because the temperature of the water that we store would be lower than the temperature we normally use in heating systems. The temperature of heat available from the sun is economical at a lower temperature than that available from combustion. This system, though, can be in fact entirely self-sufficient, and need not be particularly expensive.

The solar collector itself is inherently a very physically simple device. Normally it has a single sheet of glass and a sheet of blackened metal below that. Now the solar energy originates at quite a high temperature on the surface of the sun and is very short wave radiation. Glass is transparent to short wave radiation and it passes directly through the glass and is absorbed as heat on the blackened metal surface. There is, of course, a re-radiation from the warmed metal surface but that's at a relatively low

Professor Hooper (continued):

temperature. Low temperature radiation is long wave radiation and long wave radiation will not pass through glass. Glass is opaque to long wave radiation so a solar collector then is truly a solar trap. It allows the solar radiation to pass through the glass but it does not allow the re-radiation to pass back out of it. In consequence the equilibrium temperature that can be achieved by the black metal surface is quite high. You can do certain things to improve the performance of that surface. You can add so-called selective coatings that will allow it to absorb a much higher percentage of the radiation than it re-radiates, and there are other technological tricks that are of some importance. You then have a warm metal surface and you solder or otherwise attach tubing or a fluid passage to the metal. And through that passage you circulate the water, in this case the water that you take from the storage, allow it to be heated by cooling the plate; and return it as heated water to the storage. Typically the storage would be at a temperature somehwere between about 95°F and, say, 165°F. And you would heat the water as it passed through. That then is the collector. It is not a difficult thing to build. It's always, of course, difficult to build anything that is truly efficient, but there's no high technology and there's no great difficulty in building or mounting this type of equipment.

The storage, of course, is an important element because the sun shines only for a restricted number of hours in the year. You can have either what is described as a short term storage, which may store heat for only enough to carry you overnight or for one or two days; or as in the case here, there is a sufficient capacity that we can store heat literally from the summer over into the winter, annual heat storage. I should explain the concept of annual heat storage. In Canada, generally in the high latitudes, and most certainly for Prince Edward Island, the total amount of solar insolation, the solar energy falling on a properly oriented collector, is almost as high as it is anywhere on the continent. This one I should explain. Although the total amount of solar radiation falling per square foot of horizontal surface this far north is a lot lower than it is toward the equator where the sun shines more or less vertically down (and hence we have a cold climate), if we orient our collector at the proper angle, then the sun is shining perpendicularly to our collector, or very nearly so on average throughout the year. And so the intensity of the sun per square foot of the collector properly oriented is virtually as great in northern latitudes as it is further south. We have a higher atmospheric absorption of the solar radiation as it passes through the atmosphere because it passes through more atmosphere to reach our collector in the north than further south. But that is only about a 10 to 12% difference, so that, in fact we have a lot of solar radiation throughout Canada. The problem, however, is that in the northern latitudes our hours of sunlight are very short in the winter time when we need the heat,

Professor Hooper (continued):

and they tend to be very long in the summer when we don't particularly need it. So indeed, on Prince Edward Island in December we have something less than 70 hours of bright sunlight, whereas in July there is considerably in excess of 320 hours of bright sunlight, so that if we attempt to use solar heating to heat a building in Prince Edward Island with only short term storage, we are going to need a very large collector in order to collect within 70 hours of sunlight in December enough energy to heat that building through the month. Whereas, if we use annual heat storage, so that we collect whatever radiation falls throughout the year and notably that large proportion which falls through the summer, and store it, we are able by that means to have really quite a small collector, a collector that is on the order of one quarter the size that you would need if you were using the short-term storage. And so one would hope that he could build a long-term, an annual storage, for a cost that was compatible with the amount of collector that he saves. And in fact, in Provident House in Toronto and in two or three other buildings that I have designed and are currently in one stage or another of being built, this is, I think, borne out. The cost of the large storage is considerably less than the cost of the collector that is displaced. This means that this should be a more economic type of solar heating system for Canada than the short-term system. Now I must caution you that this is my thing, this is my particular notion. There are about 200 solar heated buildings in the northern part of North America, in the United States and Canada. All of these, with the exception of the buildings that I have designed, are in fact not annual storage but shorter-term storage. But I think that we are winning an increasing number of converts to the concept that north of latitude approximately 40% of the annual heat storage is the more economic answer.

But whether annual heat storage or a shorter-term heat storage is the answer, solar-heated buildings such as this can use the solar energy for heating, and of course the problem then becomes one of the amount of the relative cost, the capital investment, whether you can retire this investment. And properly regarded, this is really a question of the life cycle cost. If we consider the economic life of a house as short as 20 years - we know that this is a reasonably short period, and in reality we get longer life - and take the capital investment in this house at this present time, we would have to, on the life cycle cost analysis, compare the value of that house taken over 20 years with the value of an alternative house with say a fossil fueled heating system, an oil heating system. The conclusion you reach about whether this is or is not an economic sort of heating depends entirely on what you postulate to be the costs of energy, of the fossil fuel, over the next 20 years. Making what I consider to be reasonable estimates of the escalation of fuel price over the next 20 years, the life cycle costing of a house such as this looks very good. There was recently in Ontario a competition, conducted by the

Professor Hooper (continued):

Ontario Housing Corporation, for the design of a 30-unit solar heated senior citizens apartment building. They, of course, had to postulate some sort of costing, which was a 20% per annum rise in the cost of fuel over the 1975 to 1980 five-year period. Beyond that, the next five years, a 10% per annum escalation and beyond that the next ten years, a plateau for ten years, in the cost of energy. Now that is not, in my view, a very severe prediction of the escalation of fuel price. As a matter of fact, fuel price has already outrun the current year's estimate by about 5%. Well, I would just point out that using that life cycle costing, we designed a 30-unit apartment building for this competition, and that showed on the life cycle cost about a $40,000 total benefit at the end of 20 years for the solar as compared to the fossil heating estimate. This was, incidentally, a competition in which there were a large number of entries, 56 entries in fact on the international basis, and our design was the winner on an evaluated life cycle costing. I make this statement really to support the concept of annual heat storage, which I think is particularly applicable to Prince Edward Island. As I say, you do share with Toronto and several other locations in Canada the circumstance where the December - January insolation, just when you need the heat, is pathetically low. But the annual insolation is entirely adequate, and I believe therefore, that this kind of system is the sort that is likely to evolve as the economic choice for Prince Edward Island and similar locations. The total capital cost on a production basis is really very difficult to assess. I would think, though, that a small five or six room house, the typical single family residence, would be able to have a solar heated system installed if they were being produced in some quantity with an established experience on the part of contractors and manufacturers of equipment, in the order of $10,000. This is, of course, very much higher, six or seven times as high as the investment in the corresponding fossil fuel system, but of course there is no energy to purchase beyond that cost. I would point out too that it is necessary, if you are going to do this, to have a well designed building, well insulated, with double glazing, probably the use of insulated shutters at night, using a heat recovery heat exchanger on the ventilation air so that you collect the heat from the exhaust air to preheat the incoming air, and several other devices that will reduce the total energy demand in a house. Such steps will cut in half the energy requirements of any house. And indeed this is the first step, I think, that one needs to take.

Provident House near Toronto is a rather large house that has the entirely solar heated scheme. It has 717 square feet of collector area on the roof. It has 4,000 square feet of heated area, about 2,800 of that finished, and it has 60,000 gallons of water in a large insulated tank in the basement. That tank is 27-1/2 feet square and 12 feet deep, insulated with 6 inches of a foamed plastic insulation, and it should be entirely self-sufficient in terms of energy. It also provides for domestic hot water; about 80% of the energy to heat the

Professor Hooper (continued):

domestic hot water is obtained from the solar heating system. This makes, then, a house that tends to be very nearly autonomous with respect to its energy requirements. I would point out that we have also on that site a vertical axis type windmill provided by Dominion Aluminum on an experimental basis, and we'll be monitoring the possibilities of that. We'll be using the energy from the windmill to heat the solarium that is located between the garage and the house proper. That's a very large house, I might point out, rather larger than we would normally expect.

I think I should speak a little bit to the concept of retrofitting, or putting solar heating systems into houses presently heated with fossil fuel or electric heating systems. As much as I would like to be enthusiastic about the prospect, I would have to point out that probably fewer than 25% of existing houses are really suitable for retrofitting with solar heating systems, for several reasons. Mainly, it's very difficult to find a proper place on which to fit the collector without it being totally unsightly and very expensive, because you must have a roof that slopes almost due south and at approximately the correct angle to be economic and, most existing houses, of course, do not have this particular orientation. Also the existing heating systems within the house are dependent on a higher temperature fluid water or steam or warm air at 180° whereas we want to use much lower temperature heat in order to be economic to collect the heat. A collector is much more efficient as a solar collector if we are collecting heat at temperatures around 120°F, 130°F than if we are collecting heat around 190°F. And so also the efficiency in Provident House is about 75%: about 75% of all the heat that is put into that storage through the year is available for use for heating when necessary, corresponding to about a 25% loss from the house. As you get to larger units such as the 30-unit apartment building that I spoke of, or even larger units, 100-family apartment buildings, then the size of the storage gets very much bigger. And when the size of the storage increases, the cost of the storage becomes very much lower on a per unit of capacity basis. The reason is because of the square cube loss. The capacity goes up as the square of the dimension. The surface area goes up as the square of the dimension, so it does not increase nearly as rapidly as the volume or the capacity. Therefore, the cost which is proportional to the surface area goes up very slowly, and the unit cost comes down as the size increases, and also the efficiency of the storage, because the heat losses are proportional to the surface area, improves. And so the senior citizens apartment house has a storage efficiency more nearly like 90%, with a unit cost of storage that is considerably lower. And this means that the economics of either apartment buildings or school buildings or clusters of houses for solar heating of this type are very much better than the economics for single family houses. Groups of houses, the order of 10 or 20, or row houses or small apartment buildings would

Professor Hooper (continued):

be the economic choice of a designer who was trying to get an economically competitive system.

I think it quite important to recognize, however, that it is not only on a direct economic basis that one has to compete. Rationally it seems to me that if, for instance, one foresaw in 1985 a shortfall of 25% in the total energy requirement in Prince Edward Island, which I think is maybe not an unreasonable guess at where you might be in ten years time, and if the shortfall in conventional sources were on the order of 25%, it would be necessary to turn to alternative energy sources for that 25% or literally to suffer the economic consequences of being unable to supply it - lower standard of living and economic depression. If that were the case, it would seem to me that the same significant part of the new building in Prince Edward Island should be dedicated to solar heating, but it would also seem to me that the owners of the new building should not bear the total cost of the new system that, in fact, it should be a shared cost. And so it would seem that an action of government would be indicated to try to share the cost in some way amongst everyone, if some members of the community undertook to operate systems that made them non-consumers of the fossil fuels, the scarce resource.

I have one or two suggestions about how that might be done. One might be simply the ownership of the heating system, the solar heating system, by the province in much the same way as in many places the domestic hot water heating unit is owned by the public utility and simply leased on a monthly basis to the tenant; that is, they supply at a flat rate hot water to the tenant. In the same way the province could be the owner of the solar heating system that was installed in a given building or house, and make energy from the system available at a cost to the tenant no higher than the cost that he might have to pay through a competitive fossil fuel system. And in that way, whether or not you could show an economic advantage over alternative or conventional systems, you could fill the gap that it seems to me must be filled in some way.

And because the cost of energy is being subsidized in this country, the economically competitive position of the alternative systems is at a disadvantage. That is, looking at the life cycle cost again of that 30-unit apartment building: had we been comparing the life cycle cost with the world cost of fuel, rather than with the Canadian cost of fuel, the advantage of the solar system would have been very much greater. So that we cannot expect to see alternative systems self-generated in a circumstance in which the conventional fuel is being subsidized. The impact of subsidy of any product is, of course, to encourage its use, and I think that offsetting legislation by way of equal subsidy should really be considered by any legislature.

Professor Hooper (continued):

There are one or two other legislative means that can encourage the use of alternative energy systems that I think should be mentioned. One of these especially on solar heating systems, but also on wind power and other alternative systems, is that it seems to me that such systems, even though they are a part of a building, should not be a part of the assessed property value of that building. Because if the solar heating system of a building were worth \$40,000 and the building correspondingly assessed \$40,000 higher, then the owner of that building would be expected to pay more taxes, although in fact he was by virtue of use of that system, removing from the general public burden a certain consumption of fossil fuel. So I would think that legislation at least to exempt from property taxes energy conserving devices such as solar heat collectors, such as energy heat exchangers, that is recovery heat exchangers to recover the waste heat, is an indicated consideration that can be taken more or less immediately and have the effect of making the development of alternative systems much more attractive.

To return to the technology of Provident House, in the annual heat storage system the temperature of the storage rises of course to a maximum at the end of the summer. At the end of October, early in November the temperature reaches about 170-175°F in that tank. It reaches a minimum about the 15th of March when it gets down to about 95°F, and then of course it starts to rise again and you get annual cycles of temperature. One has to design a heating system that can effectively use very low temperature water, water at 95°F or 92°F as at Provident House to heat the building in cold weather. That means you have to have a larger heat transfer surface and a higher rate of air circulation through the house. It's well within our technology, it's really not a difficulty at all.

And so to conclude, with some regret I point out that for all buildings, but notably for solar heated buildings, the single family residence is considerably less efficient in a great many ways. It uses more material and more energy, is more difficult and costly to service, in terms of the supply of materials, whether it's an autonomous grouping or whether it's connected to the general municipal supplies of water and sewage. And so I point out that the small community rather than the individual house is possibly the direction that one must think of taking over in a period of stringent energy and material economy, such as may be faced in the future. I think I should terminate my remarks at this point and consider any questions that may arise.

PREMIER CAMPBELL: I think you will have lots of questions. Thank you very much, sir, for your contribution to these discussions, and if I might lead off with a few questions: Certainly many Islanders are beginning to realize that the heating bill is becoming the major concern. It used to be the mortgage bill, but the way the costs for heating have gone up, it has given us cause to consider whether we can afford to live in our own homes at retirement or even before then. Could you tell us something about the present state of the art in terms of architectural interest and competence in the field of designing public and private buildings in Canada; and the hardware, and whether it's available. What are the opportunities on Prince Edward Island for manufacturing it? Is that too general a question or do you want to tackle it in that form?

PROFESSOR HOOPER: I very much welcome the question. I think it's a very significant question. The technology, in a scientific sense, has been available for at least 25 years. But because of the socio-economic circumstances nobody was interested until the oil crisis developed. We now have a growing number of people with some degree of experience or competence in the design of solar heating systems. I think we have the capacity of rendering the number of competent designers entirely adequate within quite a short period, within a year, two years. Our engineering community is entirely able to acquire the necessary knowledge and skills to execute competent designs of this sort. There are, of course, existing companies which have already done some designs, and I must say that I am myself president of one such company. There is a range of points of view on what is the right technical approach. Different engineers have different views, and until we have developed some considerable background of built buildings where we can see the impact of the real life economics, the realities, we are going to be without some of the answers. But I think the circumstance is that you can build these buildings in different ways which all have a potential for working. Some may be economically better than others, but this should not of itself be a barrier. At the moment the production of the solar equipment, by which we really have to mean the solar collectors, is very restricted. There are possibly four companies in Canada who say they are in the business of manufacturing solar collectors, again including our own. The total number of units manufactured by all of these companies taken together is something that is really pathetically small, something below 200 units, and we have 44 units on Provident House alone. However, we have a manufacturing capacity in this country to produce these units. There is an entirely adequate technology and manufacturing equipment to go into our own manufacture of these, and I believe that we can build units that are altogether as efficient and as reliable as any made anywhere, and that are probably almost as inexpensive. In Canada manufacturing operations tend to be a little bit more expensive than in the United States or Europe, but there's a 25% tariff protection. And I think that we could be self-sufficient in terms of Canadian manufacture of our solar equipment. The construction of the tanks is really a matter of using materials already available in this country and techniques already in use. And the heating system also uses materials and techniques and manufacturing capacity already in Canada, so I would think that the solar space heating industry that I am concerned with will develop and which I think will be quite big, will be almost entirely a Canadian industry, using Canadian materials, Canadian manufacture, and specifically using Canadian design. The circumstances for the design in Canada are different from that elsewhere, although they tend to coincide with those in northern Europe, particularly in Scandinavia.

DR. MALONEY: Professor Hooper, several questions. In some of your houses, if not all, you show the ground high in the north side. Do you really need that type of thing with the high R-factor insulation in materials that you have today?

PROFESSOR HOOPER: No, you don't really need it. In Provident House we were attempting to use as many techniques and devices as possible to reduce energy consumption and this was one such device. But where we do use it, and it's an architectural extension really, we run earth berms out to the east and west of the house. The house of course faces south. Our cold winds come from the north and northwest. By building the earth berms in that fashion you get a sheltered area to the south of the house that in effect, extends the summer about three weeks on both ends, as far as your own enjoyment of your garden is concerned. Also the berm, where it passes adjacent to the heat storage tank, which is below the house, gives a little bit of additional insulation, not very much.

DR. MALONEY: Now the vulnerability of your heat panels: Do you run antifreeze in them in winter or do you depend on water, and are you scared of ice or that somebody with a BB gun could do really a tremendous amount of damage?

PROFESSOR HOOPER: There are some 200 solar-heated houses of one form or another throughout the northern part of the continent. Vandalism has proven to be a problem only in one location in Boston. As far as freezing is concerned, that's a real problem. In Provident House our pump which circulates the water from the tank through the collectors comes on only when the temperature of the collectors is higher than the temperature of the tank, and the water flushes back down out of the panels whenever the pump goes off, so that we are protected against freezing in that way. Other systems use an anti-freeze solution and they close a circuit between a heat exchanger coil that is in the storage tank and the collector, so that they are protected in that way. There are advantages and disadvantages to both systems and I think one will economically survive the other but I'm not sure which.

DR. MALONEY: Have you used any other materials like Glauber's salts or stone? Is there any advantage to using stone or a solid concrete mass rather than water?

PROFESSOR HOOPER: For short-term storage up to seven days, stone has an advantage. Then you use air as the circulating fluid. You heat the air in the collector and you store it in a stone bed. The volume of that bed is about three times the volume of the corresponding water storage tank. However, for short term storage it has some considerable advantages. The power required to operate the fan tends to be fairly high in those circumstances. I think that for the long-term storage gravel tends to be too cumbersome a heat storage bed, although the answers again are economic and in the future; they depend upon building a very considerable number of houses and evolving over a period of time an economic design. We are, of course, using heating systems in this country of which we have millions of examples already built. We have evolved techniques and economic procedures, production gambits that allow us to produce this very economically, and we know what isn't economic just through experience. We have built only the first five solar-heated buildings in Canada now. I hope that there'll be 50 in a year's time. But it's not until we are into 50 or 500 or maybe 5,000 that we begin to have the knowledge that will really answer the sort of question that you have.

LLOYD G. MACPHAIL, MLA: When the temperature of the water storage is at its lower point, you mentioned 92-95°, you mentioned that you would have to have increased air circulation. Would this produce more or less diminishing returns the power needed to increase the air circulation?

PROFESSOR HOOPER: Not for a while. I assessed the power required for the fan and for the two circulating pumps in Provident House, and it comes to something on the order of 2% of the total thermal energy collected, so that the ratio is not high. Now, of course, this is careful design. If you go to small duct works and therefore high pressure losses in the water systems, your power to the fan and to the pumps could rise quite sharply. It wouldn't be difficult if you wanted to fake it, as a matter of fact, to get enough power into the pumps and fan to do a substantial part of the heating of the house from the I^2R losses and the friction losses, but proper design allows you to keep it well below the 5% mark.

MR. MACPHAIL: Would it be practical in periods like this if the temperature dropped low to have a system whereby you could supplement the heating of the water say with oil-fired or some other means of heat under low periods?

PROFESSOR HOOPER: Yes, as a matter of fact, I would have to say that's the conventional concept. Almost all of the solar heating systems currently installed in the northern United States supply from 30 to 70% of their heat by solar means and the balance by some auxiliary system. Usually they opt for electric resistance heating, which is kind of defeating. Some use the heat pump system which is, I think, a much better solution.

MR. MACPHAIL: From what you and others have been telling us, it seems that the single family dwelling is going to be a thing of the past before too long.

PROFESSOR HOOPER: I said that with considerable regret, and I think it's maybe not that simply true. But it is probably true that you pay a penalty for this, and it may be a penalty worth paying, and in many circumstances, of course, as in the farm circumstance there's no alternative. But it may well be that in some future economy you have your choice of a 2,000 sq. ft. residence that is a part of an apartment complex, or a 1,200 sq. ft. residence that is a separate building and they may, in fact, be equal energy consumers and the choice is a trade-off.

MR. MACPHAIL: As you have been saying, the penalty becomes higher and higher and there will be a point, if this trend continues, when the penalty will become too high in many cases.

PROFESSOR HOOPER: I guess we'd have to say that this trend is already well established in our cities. I don't think there's been a single family house built in the city of Toronto in the last 15 years, within the actual city limits of Toronto. Certainly, about five out of six housing units now built in Metropolitan Toronto are apartments. There are other economic considerations besides the straight energy economy that lead to this consideration: the cost of servicing, the cost of roadways and all of the services necessary which contribute very sharply to the cost of land. Also, of course, there are other considerations such as taking land out of agricultural use in order to put it into a suburban sort of housing environment, a threat in some places. The Niagara Peninsula in Ontario, which is a relatively small, exceedingly fertile and very important part of our agricultural land, is being taken out of agricultural service at a totally alarming rate by industry and housing. And I understand that some considerations of the same sort have been expressed in Prince Edward Island.

MR. MCQUAID: Does a solar house have to be any particular design, or can you design your own home and install this system in it?

PROFESSOR HOOPER: Oh yes, I think so. I think the fact is that I look to a totally different appearance in a home. We have so far tried to marry the conventional styles of architecture with the requirements of the solar heating system. However, I think in the very near future we should move to an architectural style that is totally functional. I'm particularly fond of the concept of a cylindrical house possibly 30 feet in diameter. The cylinder has a lot of advantages. It has the minimum surface area to volume ratio so that your heat loss through the outside skin is minimum. It's also true that this would make the optimum shape of storage tank in the basement. Also, it overcomes some architectural problems associated with the orientation. You could cut off the roof of a circular house at the appropriate angle and install your collector on the roof. You can put the front door toward the street so you could have a winding street and a lot of cylindrical houses sitting along the street, and your front doors would all be on the street, the roofs all cut off at the south facing angle. And, as a matter of fact, in such a circumstance you would anywhere in Canada know your latitude by the angle of cut and know the direction by how it was facing. I think that this and other configurations that are functionally correct would develop an aesthetic validity in the minds of people, after only a very short time, in the same way that a suspension bridge or the Spitfire aircraft or any number of examples of proper functional design come to be accepted as things of beauty. I think that a properly designed solar house, recognizing the functions of its components, would come to have an association with warmth and economy and security in the minds of people that would ultimately give it an emotional appeal that was at least equal to the picture of the thatched cottage with vine-covered walls.

MR. MCQUAID: But supposing you had built a house quite recently, and insulated it well. Did I understand you to say that it probably would not be practical to install solar heating now in that house?

PROFESSOR HOOPER: Yes. And again I said that with great regret because I would like nothing more than to feel that retrofit was a short-cut solution to some of our energy problems in this country. But my assessments are that it would be a very considerably more expensive undertaking to retrofit a house than the corresponding cost of installing a solar system in a new house, in a house designed for that purpose. Only a small percentage of existing houses will have a roof at the right angle and the proper orientation and free of windows and obstructions such that you can put the collector there conveniently. Now you can put the collector out in the garden but it costs more money, it's not as efficient. Also, it's difficult to find a place to put the thermal storage in an existing building - it wasn't designed into the building, and the heating system as I have said, is inappropriate by virtue of the temperature at which it operates. So it would mean a considerable restructuring of the building, which is expensive. I would prefer to see as many systems as possible of this sort in new houses as the first direction.

MR. PROUD: In your buildings, what is the capacity for the hot water? How much storage space do you have there?

PROFESSOR HOOPER: For Provident House, a single family house, we have 100 gallons domestic hot water storage. For the 30-unit apartment building, we have a total, I guess, of 280 gallons, but that one is a little different because it also shares the heat from the main storage tank as well.

MR. PROUD: The other gentlemen across the room were talking of the designs of the houses, the single family houses; I personally would like to see a change in the design of our structures, and possibly this is one way to get it - by solar heat. As to the conventional three-bedroom bungalow, every one of them looks the same and I would hope that the design of these solar heated houses and any other types of houses would be a change from the ones we have now, the conventional one, the type I live in myself. And you were saying you see the day coming when we would pay a penalty for the single-family dwelling. I think even in Prince Edward Island you see that coming, not right today, but so many years down the road. I hate to see it coming, but I feel that due to costs, it is coming. But I do like to see the different designs, this type of design you have here, for instance, and I hope that we do get a mixture of designs for single family housing.

PROFESSOR HOOPER: Yes, there's no forced restriction upon the freedom of the imagination of the designer imposed by the solar heating. I would think rather, it imposes a direction, it gives a meaning, a purpose to some of the elements of the structure that have in many cases been too decorative and too little functional in the past.

MR. WELLS: I wonder in the area of retrofit if you would care to comment on the possible application of solar heating for domestic hot water purposes.

PROFESSOR HOOPER: Yes. We've done two systems. The one at Provident House uses a separate set of collectors to heat the domestic hot water. In the 30-unit senior citizens apartment building we use the heat stored in the main storage tank as the source of heat and so we collect the heat through the main collector system. In both systems we see about 80% of the heat being supplied by solar energy. Remember that domestic hot water has to be supplied somewhere around 130°F. In our system we will have the temperature of the storage below 130°F through about four months of the year, so that during that period, say, when the temperature of the tank is at 100°F we could preheat our incoming water from say 45° up to about 100°, and then we would have to use some auxiliary form of heat to do the rest of the heating up to 130°. Doing the calculation laboriously one comes out with an estimate of about 80% of the heat being supplied by the solar and about 20% being supplied by some auxiliary system. You can make it 100% but I think the economics would be against you; you'd have to go to rather large storages.

MR. WELLS: I wonder though in the aspect of retrofitting, you've suggested that it's a pretty difficult thing to consider for a whole house but what about just in the area of domestic water heating.

PROFESSOR HOOPER: Yes, that is I think very much better. I think we will have on the market rather soon unit systems that you can put in your garden or on the roof so that you can put a collector and the necessary pump system in, and it will have a 40 to 50 gallon storage tank as a part of it, and an auxiliary heating system. I think that they also have a potential of giving you about 80% of your domestic hot water in that way. Now the economics of that system are not too bad. It depends on the cost, but if we see electricity at 4-1/2 or 5¢ a kilowatt hour or higher it is probable that that system would become economic. Certainly in Japan, in Israel, in certain other parts of the world, it is already economical. There are over a million of these installations, I understand, in Japan. There are several tens of thousands in Australia, and they are undoubtedly there because they are economically competitive with or preferable to the alternatives. And so I would think that this might well be an area in which in the near term, the next five years, there could be a considerable energy economy and probably a cost economy for the users of such systems.

MR. STEWART: In the Northern Hemisphere as the days get shorter of course, we get fewer and fewer hours of sunshine. Do you see the day when there will probably be islands of reflectors placed in the sky to pick up the sun and direct it towards this particular part of the country?

PROFESSOR HOOPER: No, I really don't. A couple of Buck Rogers inventions have received an undue amount of attention in the press, collectors mounted in the sky or focussing radiation. Without getting into a lot of detail, the amount of energy it takes to launch one of those devices is just orders of magnitude higher than the energy recovery over any reasonable period of time. Also, it is postulated that you are going to send the power of microwave to the earth at an efficiency of transmission on the order of 5%. The whole thing is ridiculous. It's a Buck Rogers notion with considerable appeal as a fictional device but I am sure it can have no engineering realization within certainly our lifetime.

PREMIER CAMPBELL: Have you, sir, seen any of the backyard A-frame home heating furnaces which you see advertised in popular magazines actually demonstrated?
PROFESSOR HOOPER: Yes, I've been at two or three exhibitions in the United States, in Los Angeles and elsewhere, where they are being demonstrated. The one that has received very much more advertising support than any other is, in my view, a notably inefficient design and economically impossible. It's something on the order of 100 sq. ft. of collector for about $4,000, which is coming out about $40.00 per sq. ft. That's about double the cost that most of the workers in the area feel is achievable today and in fact is economically required.
PREMIER CAMPBELL: Perhaps one of the first projects we should engage your talents in is in the facility now occupied by the Institute of Man and Resources, which is a lovely, charming, ancient Prince Edward Island home with a fuel bill of what is it,$300 a month in the winter - I think some innovation might be demonstrated there.
MR. WELLS: There's no insulation in it, that's a good start.
PREMIER CAMPBELL: Well, you don't need a solar expert to get to that. Perhaps in equally as serious a vein, we in this province are certainly giving very serious consideration now to designs of important public buildings. I am thinking of a hospital, certainly a court house, the corrections centre and school constructions. And, the Minister of Housing says, a 100-unit senior citizens home, and you've shown us a design or prototype for that. Is it probable that we can, within the very near future, take advantage of a present and proven technology in such as these buildings?
PROFESSOR HOOPER: I believe so; I believe that on the 20-year life cycle for a building on the order of 20,000 sq. ft. or greater, that solar heating is already economical. This is within a particular prediction of the cost of energy in the future. But certainly it is very close. The other alternative energy forms we are looking at at the moment tend to be more expensive than our present system by some factor of two or three or five, depending on which one you are looking at. I think solar energy for space heating is starting into the area where we are quibbling whether it's 20% more than another system or not, where the happenstance of the marketplace is going to make the distinction between what is the most economical. That is, it's a different class of struggle. If we are talking about solar energy for space heating, we are very nearly there. And I think in most circumstances, we are probably already there for buildings of moderate size. For single family houses, I tend to feel that maybe we are still a year or two away although it depends on your crystal ball, on the energy price.
MR. MCQUAID: Would you recommend us taking a chance and installing solar heat alone in an institution such as a hospital; do you think it is safe enough to go to that extent right now?
PROFESSOR HOOPER: Yes, I think actually it's safer because you see, with annual storage, which is the concept, you have in fact enough heat in that storage to carry you six or eight weeks without any

incoming solar energy at all at most times of the year. And you can, of course, readily put in emergency heat sources on about a 48-hour notice. You can either have a small auxiliary heating system built in, or you can in fact bring in an auxiliary energy supply on a portable basis without difficulty. So that in terms of reliability you are already better and there are some advantages that are not insignificant. There is no combustion whatsoever, therefore no fire hazard due to combustion; there is no pollution. There is, in fact, a reservoir of water that can be used for firefighting purposes, and there's some coincidence then between the need for firefighting water reservoirs and the existence of a reservoir, and some economy that could be achieved in that sense. We are currently looking at a couple of buildings on that order of magnitude including a hospital, and with the admission that I am a particular enthusiast for this kind of system, I am nevertheless convinced that this is the direction that they should move, on the economic basis if on no other.

PREMIER CAMPBELL: You mentioned something about protection against freezing. I am wondering about the solar panels exposed to the outside and what the consequences of freezing rain or freezing ice and the gathering of snow on these panels are.

PROFESSOR HOOPER: This is one of the things that everyone worries about, naturally, in Canada. I have pictures of solar collectors that I have had in use, including one from 25 years ago, and within about an hour of the sun coming out, frozen ice and snow on a collector slides off. The mechanism is interesting; I've investigated it. There's a sufficient transparency in both ice and snow that a certain percentage of the solar radiation passes through to the collector. Of course it slowly warms up and once it hits 32°F it melts just a very thin film and the whole thing slides off. Since we are always at an angle of 45 degrees or higher, it slides off quite conveniently, and I've never seen an accumulation of snow or ice on a collector in Canada for more than a few minutes after the sun has come out for the first time.

DR. MALONEY: Professor Hooper, are you familiar with a film that you can apply to glass that will stop the loss of radiant heat from the inside out?

PROFESSOR HOOPER: Yes, but it also stops the gain of solar energy from the outside in. I don't want to leave this point without pointing out that there's a validity in the claim that is being made by some people that if you use this reflecting glass, which is principally put in to reduce the cooling load in the summer - it reflects the solar energy - in the winter time it also reflects a small but measurable amount of the low temperature radiation from the inside of the building that would otherwise be lost. Now it doesn't prevent it from going through the glass, it prevents it from striking the glass and being absorbed. Instead it strikes the glass and is reflected back into the room and acts as a reflective insulation. So it's a valid claim, although it's a small factor in the heat loss of a house.

PREMIER CAMPBELL: Do you expect to be able to live in Provident House in the summer months? How do you turn the system off?
PROFESSOR HOOPER: I shan't be living in the house; however, the house is fitted with an attic fan, a 4,000 cfm attic fan. In the summertime, in the hot weather, as soon as the outdoor evening temperature falls below the indoor temperature, one turns on the attic fan, allows it to run by night. By morning the house is normally cooled down to about 70°F or the overnight outdoor temperature: you then button up the house, close the windows. In a house so well insulated as Provident House, we calculate a rise of temperature no more than 8°F during the day to about 78°F which is normally acceptable. Of course that doesn't do anything to reduce the discomfort of the high humidity that one encounters on some occasions during the summer, but these occasions are by count about eight or ten days a year in Toronto: I suspect they are no more frequent here. And I don't think that discomfort due to overheating in a well insulated house properly fitted with night ventilation should be a problem.
MR. MCINTYRE: I am wondering , Professor Hooper, how this compares when we are talking about fans for cooling and larger piping to carry the water economically, with some of our present sources of heating?
PROFESSOR HOOPER: Well, I can tell you our present source costs, which are remarkably low. A typical oil heating system in a warm air application probably goes in at around $1,200 capital cost into a small house. My guess is that the corresponding cost would be about $10,000 when we've got a couple hundred of these systems installed in Canada. Now the cost of fuel saved is a matter of the insulation and the cost of the fuel, as I say, over 20 years. It's a rather complex calculation, and it depends on the assumptions you make, but with the assumption that fuel is going to escalate at 20% per annum for five years, 10% per annum for the subsequent five years, and then remain at that plateau value for the next ten years after that, my calculations indicate that the solar heated building would be economic. That's either a large house or a row house or a small apartment building. Provident House is probably just about on the break-even point on that sort of analysis.
MR. MCINTYRE: As most of us on Prince Edward Island are concerned with single family dwellings, I gathered from your earlier remarks that you were a little bit pessimistic in this type of heating. Do you see anything in the foreseeable future where we can install these units and it might become viable?
PROFESSOR HOOPER: I think I should correct an impression I may have given. If you are going to have a single family house, you are better off to have it solar heated than heated by fossil fuel. It's just that the total economics of the single family house are not as good as for multiple dwellings.
MR. MCINTYRE: What about your initial cost of installation for a single family dwelling?
PROFESSOR HOOPER: It's high; as I say, my guess is about $10,000 for the solar system.
MR. MCINTYRE: What about the life span?

PROFESSOR HOOPER: Well, I call a 20-year life span but we all know that really houses last a lot longer, although in the solar heating system the collectors might have to be replaced at about that period. Also, going beyond 20 years, from 20 to 30 years for instance, does not make very much difference in the economic assessment. By the time you are that many years down the line, it's a diminishing difference.

HON. W. BENNETT CAMPBELL: Professor Hooper, have you had any experimentation done with respect to combinations using solar heat as your main source and supplementing it with probably an oil burning unit to supplement the solar system?

PROFESSOR HOOPER: Yes, we've certainly done this. We find that a totally solar heated building is more economic with annual storage. The thing is that the second half of the capacity costs are no more than the first half, because you have a factor of use on the collector of 100%. If you haven't annual storage then your factor of use on the collector falls way down. And as you go to a larger collector, the factor of use falls off more rapidly, so that the economics of that short term storage is quite different, and with that short term storage you must have an auxiliary heating system to be anywhere close to economic. But on the annual heat storage system my calculations show me, and I think logic confirms, that you should do 100% solar heating and avoid the cost of installation of the auxiliary system which is a significant capital cost that you can avoid.

PREMIER CAMPBELL: I understand that Provident House has a two car garage; is that part of the future you visualize in transportation?

PROFESSOR HOOPER: That's 25 miles out of the city, and probably the final owners of the house will work in the city. Let me just briefly justify what we did. We were given an appropriation by the Federal Government and the Provincial Government jointly to build such a house. I then made a deal with a local builder that he would build the house for us on land he owned. He would own the house and we would pay only the difference between the cost of the solar heating system and the cost of a conventional heating system. By that means I was able to build, instead of a 1,200 sq. ft. minimal standard house, a 4,000 sq. ft. house which is quite impressive. We felt it important that the public image of solar heated houses should be one of high desirability and not one of minimal standards. So we wanted to begin with a house that would be aspired to by almost everyone who saw it, and by this mechanism we have done so. But it is not a testimony to my own view of the way of life of the future to put in a two car garage, implying that everyone should have at least two.

Energy from Wind

DR. MACDONALD: Thank you Professor Hooper. Our next presentation will focus on another form of renewable energy - energy from the wind. Wind, the motion of large masses of air, ultimately derives its energy from the solar energy incident upon the earth. In this sense it constitutes a form of solar energy. I think it's no coincidence

Dr. Macdonald (continued):

that Professor Hooper, who is an articulate and dedicated exponent of solar energy, is also an ardent sailor and quite prepared to deal with the dangers and the perils of that particular form of renewable energy. The harnessing of wind energy in a wide variety of applications has had a long and important history. The windmills of medieval Europe played a central role in laying the foundations of the Industrial Revolution and until well on into the 19th and even the early part of the 20th century large windmills in England, Holland and elsewhere were important components of local energy economies. It was wind powered ships which carried the goods of international trade and commerce for hundreds, even thousands of years. The advent of new technology and cheap energy spelled the demise of these large energy installations. Smaller windmills continued until more recent times to play a useful role in a number of areas of the world including North America. Large areas of this continent were in large measure made habitable through the application of windmills for pumping water and irrigation, in livestock production, and for the generation of relatively small amounts of electricity in individual households remote from central grid electrical systems. Indeed, as Mr. Middleton pointed out, during the thirties and forties many thousands of wind-operated electrical generators were employed in Canada and the United States. Again, with the advent of rural electrification and its relatively inexpensive electricity, the use of wind-powered generators became rare except in a few isolated areas. Today with a new energy situation upon us, a situation characterized by rising costs, greater likelihood of energy shortages, and an increased awareness of environmental problems, wind energy is again becoming of interest. In areas with average wind speeds in excess of 12 mph or about that, electricity supplied by wind generators appears feasible. Large regions of Canada, especially the Atlantic Provinces, possess appropriate wind regimes. Prince Edward Island, with its north shore average wind speeds during the winter especially of about 18 to 20 mph on average, appears particularly favorable. This is due to the fact, of course, that the power obtainable from the wind is proportional to the cube of the wind speed. Today, small wind-powered electrical generators, such as the sort which we employed in large numbers during the thirties and forties, constitute a proven technology. Such generators range in electrical output from around 400 watts for one of the small units, up to about 10,000 watts and are commercially available from a large number of companies. Of growing interest and perhaps imminent application are large scale wind-powered electrical generators which could feed electrical energy into the existing electrical grid system as a supplement to conventionally generated electricity. It is a relatively little known energy fact mentioned by Mr. Middleton that during the 1950s and the early 1960s Denmark had developed and operated a relatively sophisticated electrical generation system, wind-powered, which fed alternating current into their national electrical grid.

Dr. Macdonald (continued):

The most sophisticated of these generators, located at Gedser in Denmark, was rated at about 200 kilowatts. The wind regimes of Gedser in Denmark are similar to those which exist in Cape Breton Island, while the wind regimes of Prince Edward Island are even more favorable than Gedser due to the higher average wind speeds. Canada today is playing an important role in the development both of small and of large wind turbines. Of special interest here is a rather innovative design called the vertical axis wind turbine. Our next speaker, Mr. Mike Hume, is the representative in Prince Edward Island of Dominion Aluminum Fabricating Limited, a company which is designing and manufacturing this innovative type of wind turbine. I would like to present to you Mr. Mike Hume.

MR. MICHAEL HUME: Mr. Chairman, Honorable Members of the Legislature, it gives me pleasure to speak for a few minutes on the topic of the vertical axis wind turbines and on behalf of Dominion Aluminum Fabricating Limited, I would like to express their appreciation for this opportunity. In this review I'd like to cover the following areas: first, a brief history of the development of the vertical axis wind turbine in Canada from 1968 to 1974, when our company became involved and of the development of the 200 kilowatt capacity turbine to be installed later this year on the Magdalen Islands. Second, I shall describe the advantages of the vertical axis wind turbine over the conventional propeller-driven horizontal axis turbines. Third, I shall relate this turbine to its possible use and application on the Island.

For the history, we can go back to 1968 and to the National Aeronautical Laboratories in Ottawa. There an engineer by the name of Peter South invented what seemed to be an entirely new concept in windmill design, a turbine on a vertical axis. After patent searches were made, however, it was discovered that the design was not new and that a Frenchman by the name of Darrieus had patented the design way back in 1925. However, no development had taken place at that time for the simple reason that there were easier ways to go about the generation of electric power than through windmills. Perhaps no one was very interested in the project even in 1968, for this is about five years before the energy crunch came. However, Mr. South and two colleagues, Messrs.Templin and Rangi worked on the project in wind tunnel experiments over the years using hand built models in fact until 1974, when after carrying out extensive research and development, the National Research Council contracted with DAF to do the structural engineering and fabrication of six prototype turbines. Later on after more development work was done and testing, we came up with the two-bladed version.

Now this is the type of turbine which our company now manufactures. They have been performance tested and evaluated and are built in two sizes. They have a diameter across the blades at the widest point of 15 feet and 20 feet, and they are rated at three kilowatts and six kilowatts respectively. Now in late 1974, our

Mr. Hume (continued):

company, recognizing the tremendous advantages of this sort of turbine and the potential in view of the energy crisis, and looking for alternative means of electrical generation, made a proposal to the Department of Supply and Services in Ottawa for the fabrication of a much larger turbine, one that should have a capacity of between 100 and 300 kilowatts. This was quickly taken up by the Federal Government and a contract was signed early in 1975 for the fabrication of a 200 kilowatt capacity turbine, and this is the one to be installed later this year on the Magdalen Islands. The diameter of the blades at the equator is about 80 feet, the upright central shaft is about 120 feet high, and it stands on a tower of about 30 feet. The turbine blades are curved and they are attached to the vertical shaft. As the blades catch the wind, the vertical shaft rotates upon bearings at the top and the bottom. Now the cross-section of the blades is an air foil section, so that the power obtained from the wind is obtained in the way of a lift component. The blades act like the wing foil of an airplane as it cuts through the air and the lift is what makes the blades rotate. In other words, quite unlike what we are used to in a windmill - that the wind will push the blades - in fact this sort of turbine goes against the wind and gets its force to rotate from a pulling effect. Now one advantage these turbines offer is that through their design they can accept winds from any direction, and no matter how many times the winds might change there's no need for propeller blades to have to face round to have to head on into the wind. The wind can come from a 180° switch, and it won't affect the operation of the turbine one little bit, so we can offer an advantage in the fact that there's no yawing mechanism required for this type of turbine. Another advantage, the power take-off, that is the drive system of the generator, is at the lower end of the shaft, much closer to the ground. Therefore we need a much shorter tower than is the case with conventional windmills which have to have a much taller tower in order to perch the propeller blades high up into the air. And of course, the weight of the generating equipment perched on a tall tower adds tremendously to the cost of construction of a tower, so there's another money-saving feature. The third advantage is that the blades are relatively simple in design. They are made from extruded aluminum and they undergo no stresses and deflection problems associated with the propeller types of blades. The only stress on the blade is a tensile stress; that is, a sort of stretching effect within the blade and this is not the sort of stress that can cause the blade to twist out of shape or to snap as it turns around. The wear and tear on the blade is an important factor in considering windmill design because there is a tendency for the propeller-driven blades to have quite a considerable wear and tear and after a few years of operation have to be replaced through cracks and so on. Yet another advantage is that the turbine is built and engineered to withstand wind speeds of 100 mph and gusts even higher, up to 130, so that the conception that in a high wind all the work that has gone into erecting these turbines across the Island for instance

Mr. Hume (continued):

(if there's a high wind they'd all be blown over) is something we don't have to worry about. The advantages I've mentioned show up in the fact that here we are able to talk about a 50% cost of manufacture of this sort of turbine compared with the horizontal axis propeller-driven turbines. Now the turbine that is being installed on the Magdalen Islands is estimated to produce about half a million kilowatt hours annually. It is going to be hooked into Quebec Hydro's grid and there the final monitoring and evaluation will be done, of course, to confirm what we know ahead of time is the reality that the turbine can produce power, electrical power - electrical energy - more cheaply than the diesel units that are installed on the Island. The cost should be somewhere in the range of 3-1/2¢ to 4¢ a kilowatt hour. And I believe the customers there are paying 6¢ to 8¢ a kilowatt hour.

Closer to home, the Department of Supply and Services on the Island is considering the purchase of a 20-foot turbine for installation on the new school to be built at St. Eleanor's outside Summerside. This windmill will be used in conjunction with solar energy. The turbine will be used to generate through resistance heating the domestic hot water supply and the further hot water that might be produced will be used in the heating system of the school.

Now we believe that we are at the beginning of a very interesting new business in harnessing wind power. We believe that it is this form of turbine that has the future potential - the one that has been developed in Canada here by the National Research Council and engineered by Dominion Aluminum Fabricating, and it's the one that I think we will see a lot more of. I might say that in this technology, Canada is in the lead position. Work has been going on perhaps longer here than elsewhere and we figure we have about a year to a year and a half lead. As manufacturers, of course, we hope that we will be able to keep this lead.

There are basically the two sizes of turbine that can be considered. The smaller one would be useful to individuals, home owners, small businesses, small industries, farmers, and people like this; and the larger one, such as the one to be installed on Magdalen Island, could be integrated with grid systems. Due to the simplicity of the design, it is foreseeable that we will be able to produce a large range of intermediate sizes; however, in the near future, our company will be developing a turbine that has five times the capacity of the one that is to be installed on the Magdalen Islands; that is, a turbine that has a capacity of one megawatt, and this is, of course, talking seriously about harnessing wind power. On the scale of producing kilowatts, it would be about 2-1/2 million kwh annually.

As regards the output of the 200 kilowatt model, in order to relate this in terms of Island consumption rates, let me give some figures: the average consumption of electricity among rural users on the Island in February this year was 656 kwh. This rate of consumption of course will drop in the summer. Last July the rate of

Mr. Hume (continued):

consumption on the average was 422 kwh. Now assuming the anticipated output of the 200-kilowatt turbine as 500,000 kwh, one unit would service 63 Island households for all their electrical needs in the winter, and about 100 in the summer, at least given the current rates for kilowatt hours. For the larger turbines which we will see in the future, of the one megawatt capacity, we can multiply this figure by five times; in other words, about 300 homes in the winter and about 500 in the summer. Now, one way to go with the large turbines is to hook them into the grid. Over a period of years, the installation of turbines such as these could augment to a considerable extent the capacity of the central generating station. It is possible of course to look at the large turbines used to service small communities separately but on Prince Edward Island there is already an extensive grid system installed; it seems wiser to consider the alternative of using the grid system and integrate the turbines into the grid. Of course, I am not going to get into discussing how. There are certain technical problems which would have to be overcome but nothing insoluable. The advantage of course of integrating with the grid is that the power generated by the turbines could be supplied to the grid without the need of any storage system while the grid, being linked with the turbines, could supply peak loads. Eventually economic storage systems for wind turbines will no doubt be developed to take care of the peaks and valleys of demand and of course research and development in this field is being carried out extensively.

Well, what economic impact might investment in alternative energy have in the future economy of the Island, compared with continued investment in the conventional non-renewable resources of oil, coal, and nuclear power? Economically speaking, which way does the province want to see its energy dollars flow? As Islanders we have two choices: we can go on buying oil, and invest our dollars in mainland coal, mainland nuclear plants, all sources of finite energy; or keep our dollars on the Island by utilizing those resources that we have in abundance - the sun, wood, and wind. All these are renewable, infinite sources of energy. Converting to alternative energy sources will still cost money; there is no way around that, I am afraid.

What can be done then to encourage consumers to convert at this present time? Well, this government has taken the initiative by removing the 8% provincial sales tax from energy-saving equipment and materials. During the housing crisis, the 12% federal sales tax was removed from all building materials used by the construction industry and the savings passed on to the consumer. Could this also be done for alternative energy materials and equipment during our energy crisis? Would not a further inducement be a generous capital cost allowance for energy-saving equipment on annual income tax returns? At present it is possible for an average commercial dairy farmer, for instance, to spend $2,000 a year operating his farm on electrical power and that is a tax deductable expense. If such a farmer

Mr. Hume (continued):

invests, say, $10,000 in a wind turbine under the present classification for windmills, which is 5%, he could claim only $500 in the first year in capital cost allowance and then the next year $475 and so on downwards. Thus he is being penalized $1,500 of tax-deductable expense for saving $2,000 worth of electrical power - hardly an incentive to conserve energy.

Further, both of these suggested measures would be of benefit not only to Maritimers where the problem is at its most acute in electric power rates but to all Canadians. In conclusion, my thoughts are that despite the fact that the Island's consumption of oil is a mere drop from the national bucket and conservation measures undertaken by this province will have little impact on the nation-wide consumption, we are here to discuss the future reality for Prince Edward Island. For this province reality means that when world shortages become acute and oil is worth more than diamonds, Islanders will still need to keep warm, will still need light, will still need electrical power. We must face the reality before it overwhelms us. The number of doom-watchers grows daily and will continue to grow until reality is faced. Doom watching will not correct the situation. Government and industry must act now to harness the Island's energy resources: the sun, the wind, and the trees, if we are to remain "The place to be in" in the twenty-first century. Thank you very much, I will try to answer any questions you care to throw at me.

PREMIER CAMPBELL: Thank you very much, Mr. Hume. You will be happy to know that windmills and other alternative energy generating equipment are included in the sales tax exemption in Prince Edward Island.

Have you calculated comparisons between the capital costs of establishing 200 kilowatt turbines and/or one-megawatt turbines, with the conventional types: nuclear, diesel or coal?

MR. HUME: On the subject of the costs, the one for the Magdalen Islands is probably higher than will be the case in production - that was $235,000. But we are looking probably around $170,000 for the 200-kilowatt model at the present time.

PREMIER CAMPBELL: You have the advantage of location near a transmission wire so that you are not having to calculate the transmission costs into your capital investment.

MR. HUME: That is correct, yes. I see the way that these large turbines would go would be to integrate them into the grid and as the power is generated from the turbine, it has to go somewhere. If it is not being consumed by the individual serviced by that turbine, then it has to go into storage systems which we are trying to avoid at the present time. And so the excess power demands could go into the grid system and augment the capacity of the central generating station. The other disadvantage of a turbine might be that you only get the power when the wind blows. But the grid attached to the turbine would be able to come up with the power at peak times.

I meant to refer, as far as the sales tax question is concerned, to the fact that I recognize that the Province has already taken a very good step in taking these types of materials and equipment off

the provincial sales tax; I was referring to the federal sales tax.
MR. WELLS: I think doing some very quick calculations more specifically on the comparative costs, a 200-kilowatt plant would be in the vicinity of $850 per kilowatt installed capacity. Oil and coal currently run somewhere between $500 to $700 and nuclear is estimated to be about $1,000.
PREMIER CAMPBELL: Well, we will have to look at those figures more carefully but then you have no fuel costs to pay monthly.
DR. MALONEY: But you have to link into something else....
PREMIER CAMPBELL: Yes. The unit you are installing on the Magdalen Islands for demonstration purposes - and we will certainly have to get over and see it - you calculate will service about 63 households. Now, do you mean all the normal requirements, the dishwashers, clothes-dryers, in the normal household? And you are not including, let's say, dairy barns in there?
MR. HUME: Well, in order to get some relationship from Island consumption rates, I got from Maritime Electric the total consumption of rural users, not including small industries, and divided that figure by the number of householders. It is not exactly rural because it really refers to all those not in Charlottetown; they count Borden, Summerside and so on, as rural. But I took the figure and it came up to 656 in the winter time. And so, if people don't install a lot more electrical gadgets, the turbine would service 63 at the present consumption rate during the winter and in the summer that would go up to about 100.
PREMIER CAMPBELL: Well, you are referring then to 63 rural customers of Maritime Electric by sampling, and this might include a general merchant, and it might include two or three dairy farms in that sampling and in that average 656.
MR. HUME: Yes, could do very well.
PREMIER CAMPBELL: Do you see a wind profile on Prince Edward Island that would drive this machine and is it noisy?
MR. HUME: Well, any wind speed over eight or nine mph is interesting: anything below that, we are not talking about generating an awful lot of power. But before large scale windmills are installed, of course, the first essential step would be to undertake a very extensive wind study program, to gather the data, in order to establish the best site locations. We would look, hopefully to locations that would have a wind speed of 15 to 18 mph. Then we are talking about the sort of output that I have mentioned for the one on the Magdalen Islands,the wind speed on the location there is about 18 miles an hour. Each mile an hour you can add to wind velocity makes a lot of difference to the power output, because it is a cube of the wind velocity that we are talking about here; the extra power comes from the cube of the wind velocity.
PREMIER CAMPBELL: What wind speed do you assume in meeting the needs of 63 households?
MR. HUME: About 18 mph. The wind speed varies but we have what we call a rated wind speed and the turbine and the apparatus linked to it are designed to certain rated wind speeds. Now these might vary; it doesn't mean to say it is not economic to put a turbine up in a

site location where there are only 15 or fewer mph wind but the higher we get of course, the more interesting the electrical capacity of the turbine.

PREMIER CAMPBELL: What about noise; if you put it on a school for example, is it going to distract people in the neighborhood?

MR. HUME: Well, the only distraction I see is they might like to take a jump on the blades for a roundabout but the noise factor is not as bad as perhaps with the propeller sort which make a constant noise. The turbine would be located some way from a building because guy-wires are needed from the top to the ground. We don't foresee it on top of normal buildings; however, it could be on the tops of buildings where the roof is reinforced. So basically there is no noise to talk of; it makes a swishing noise as it goes round but depending on where you stood you would hear it as it passed, like a gentle swoosh, and it would be gone.

MR. MCINTYRE: What type of study was done regarding the wind velocity in the Magdalen Islands before you installed this?

MR. HUME: Well, they, of course studied the data; they may have chosen a site where they had a history of recordings. I'm not sure that I can answer specifically what they did to study the wind there but they did have what they call a histogram; which shows the number of hours per year that the wind blows at certain velocities and from this kind of diagram they were able to establish how to rate this turbine to 200 kilowatts in that location.

MR. MCINTYRE: To be more specific, then, what will we have to do on Prince Edward Island - just take the weather readings over a given time, or just what type of survey would you do before an installation would be feasible?

MR. HUME: People are more versed in wind energy than I am; I don't want to claim to be knowledgeable in that field. I would say that you would need several years. However, it seems that one year would be a minimum time because you want to know how the wind speed is in January to December and thereafter you would need to go on examining the winds. I would say that the most important thing that could be done now without any delay would be to institute an extensive wind study program. We might be a year away then from being able to site one of these large turbines on the Island, if we started today.

MR. WELLS: I might say, Mr. Hume, that our Departments of Agricultures both the federal and provincial, and of course, our Department of Transport, have been operating weather stations for some time in the province. There are I think six weather stations that our agricultural people are involved in scattered across the province and they do take, I understand, a daily reading of the wind speeds, so we do have some rather significant knowledge presently which could be up-dated rather quickly or supplemented rather quickly for specific purposes.

MR. HUME: That is correct, there are six stations, and there are the Summerside and Charlottetown airports, as well, but this only gives you the readings of those particular locations. You might not be able to draw contours between them to say that the wind speed of in-between points is whatever it is. You would have to study quite extensively; you might want to put turbines where there aren't readings at the present moment. I don't think these sitingsare particularly where the wind is blowing.

MR. WELLS: No, not necessarily, although some of them are very interesting wind regimes. I think of the one in Tignish, for example, I have forgotten the precise figure, but it is quite significant.

MR. HUME: Yes it does give an indication, that is true.

DR. MALONEY: Mr. Hume, the technology to make the blades of that type of turbine, is that cast, is that a permanent mold, is it low pressure, is it high pressure?

MR. HUME: That die is made for that size blade and they are extruded; this is done in the States.

DR. MALONEY: A cold extrusion?

MR. HUME: That I couldn't tell you, I'm afraid.

DR. MALONEY: Your tower, is that steel?

MR. HUME: Aluminum.

DR. MALONEY: So the only steel would be in your bearing and your generators?

MR. HUME: Yes; I wouldn't like to say yes forever on that but it is mostly aluminum that goes into these large turbines.

MR. COMPTON: If a person installed those windmills, would it be necessary for him tc have a set of storage batteries with them? I mean, there would be days that he wouldn't be generating any power.

MR. HUME: Well, the best way to go for somebody considering a windmill is to avoid, if possible, the use of storage batteries at the present time and link with the grid. Then, if, for instance his windmill is not generating part of the time he needs it, he can obtain his power from the grid.

MR. MCINTYRE: I believe you said earlier, Mr. Hume, the cost of installation in the Magdalen Islands was something in the vicinity of $235,000, and that would serve something like 63 residents. Would this compare to the same rate on Prince Edward Island, that we would have to invest $235,000 for every 63 residents?

MR. HUME: No, I think we are looking at a very much lower figure than that, at the present time prcbably around $170,000. Now these were ball park figures, I'm afraid; I don't want to be pinned down on that, it might be possible to do it for less.

MR. MCINTYRE: What would be the - again it would have to be a ballpark figure of course - what would be the maintenance on a $10,000 unit for a 20 year period?

MR. HUME: Well, we haven't got the experience of these over a period of time to say definitely, but the expectation is for a very long time; 20 years would be, I would think in this respect, quite a short time. Windmills in Europe in previous centuries have lasted centuries. Only the blades needed replacing from time to time, every 15 years, and really for the turbine itself, there are no parts that need replacing. We see no wear and tear on the blades; it would just be a matter of bearings from time to time and I think we are talking about a fairly light type of turbine here.

MR. MCPHAIL: You mentioned the figure of $170,000 as the installation cost of the 200-kilowatt turbine and of course you mentioned the one-megawatt one which would produce five times the amount of power. What would be the installation capital cost of the larger unit, would it be five times as much or less than that?

MR. HUME: I cannot give company figures on this because there aren't any that I can quote. I don't see the reason why we should multiply all costs by five. We are talking about heavier installation of the one-megawatt turbine. As we get into larger turbines, we are talking about a lower cost per kilowatt hour, and it is reducing the cost of the net output of these turbines which we are really interested in, so the idea of going to a larger turbine is in order to reduce the costs of electrical power generated.

MR. MCPHAIL: Quite aside from the initial capital cost, what would be the relative advantages or disadvantages of having one large one as opposed to five of the 200-kilowatt?

MR. HUME: The advantage I see of the large one is taking up of less ground space. You might be able to use one good site and get the advantage out of one of these large ones, whereas you would be using up five good sites for the smaller ones. So there is the question, how many turbines do we want to see on our horizon? If we can get the one-megawatt type, I think we are reducing the numbers of turbines and, I think, the costs of these turbines. The one-megawatt turbine might well cost less than five small ones.

MR. MCPHAIL: Would the average wind speed be a factor in whether or not to use the smaller or the larger unit?

MR. HUME: It wouldn't really be a factor. The design is so simple basically that we have the advantage that we can expand the size of these relatively easily. The engineering is a lot simpler than it is with the horizontal axis turbines, the small wind chargers of three-kilowatt capacity. It may be six of one and half a dozen of the other; but as you get to the larger and larger turbines, the reduction in the capital cost is enormous with this type of design.

JAMES M. LEE, MLA: Would it be any problem to install a turbine in a single family home? You mentioned there are two sizes, the large one and the smaller one; do you have any figures on this?

MR. HUME: I don't have a figure. There is not an awful lot to putting in one of these turbines. The tower comes broken down, so that one can put it together with nuts and bolts. One needs a concrete pad to put it on. How much work a man can do for himself comes into it; you might need a contractor to do some work. However, building the tower can be done by the ordinary man and you need an electrical contractor to hook it up.

MR. LEE: Do you have any costs then of the actual package itself?

MR. HUME: The cost of a three-kilowatt capacity turbine at the moment is $4,100 - that includes the turbine, the tower, and the drive system and the generator; the larger one, the six-kilowatt capacity, is $6,100.

MR. LEE: Have you installed any of them as yet on the Island?

MR. HUME: There isn't one installed on the Island yet, no.

J. WALTER DINGWELL, MLA: Mr. Hume, I was wondering, in all of those resources that have been mentioned, we don't seem to have any universal power system. We have glass houses to generate our heat; we have windmills to generate our light; and we have been used to a universal system of dumping oil into our tractor or into our homes, or into the energy producing systems. What potential is there in any resource to be of a more universal nature to our need, rather than having a complexity of resources, one for a certain thing, and one for another aspect of our need?

MR. HUME: I don't think there is one universal alternative resource available. The fact is, the windmill is most useful to generate electricity and as that is a highgrade energy, that should be used for machinery and not space heating so much. I see on the Island, according to the Department of Agriculture and Forestry, that 80% of the present capacity of the Island can be looked after by wood. We are not looking to wind to give the total solution. I can see in the future, perhaps, that we can be independent on the Island of the fossil fuels and the energies from the mainland by utilizing the wind and the wood and solar energy in a combination. Exactly what combination that might take, I cannot say at the moment. But those are the three elements, the three renewable resources that can be utilized together to make up the energy needs of the Island.

MR. MCINTYRE: Supposing a rural community of 25 homes or an equivalent in either Charlottetown or Summerside, were interested in investing in this type of thing for generating electricity. What would the cost be there in comparison to our $4,100 or $6,100 that we mentioned earlier?

MR. HUME: Well, without going into the figures which I haven't got, if they were sharing a turbine between them, the cost would be less than one turbine each. Does that answer your question at all?

MR. MCINTYRE: Partially, I am wondering about the demands on it in the evening, for instance, in rural areas where you have the milking machines and this type of thing all on at practically the same time. Would you have enough electricity to accommodate these people within a given hour or two?

MR. HUME: Well, you would design the turbine to deliver average power needs. You wouldn't be designing its capability to meet maximum peak loads and therefore when all the dairy farmers put on their milking machines at once, you would have a problem. It would be uneconomic to try to meet the peak loads of dairy farmers for instance. That is why it is advisable to link up to the grid, because then when the load is demanded it is available; and we might then see a reduction in the demand on the central generating station except where peaks can come on. They can be the alternative to the electrical output from the windmill.

MR. MCINTYRE: In other words these 25 people couldn't watch "The Edge of Night".

MR. HUME: If they want to watch it in the dark, maybe.

MR. COMPTON: Would land elevation have any effect on the power that you might get? It wouldn't be necessary to have this windmill installed on high ground?

MR. HUME: Not necessarily. The pattern of the wind varies with the lay of the land. You can site these things on tops of hills but there are also other places. There are enough data available to ensure that people don't put these in deadwind areas, so to speak. You don't have to be on a high hill. The beauty of the Island is that there are breezes blowing more or less all the time, more or less throughout the Island. The winds are generated by air movements over the ocean and we have a lot of coastline which would get good wind velocities.
MR. MCINTYRE: Did you establish a height? Was it 80-120 feet?
MR. HUME: The turbine on the Magdalen Islands has a diameter between the blades, an equator of 80 feet, and the central rotating shaft is 120 feet from its base on the tower to the top. It is a pretty big turbine.

MR. WELLS: Thank you, Mr. Hume. We do have a full afternoon scheduled. We are now going to look at Energy from Wood, Energy and Agriculture, and Energy and Transportation. Dr. Macdonald will introduce the next speaker.
DR. MACDONALD: During the previous presentations, two forms of renewable energy were discussed in some detail: solar energy, with particular application to residential space heating; and wind energy, with particular application to the generation of electricity. During this afternoon's session, our first three speakers will be examining a third form of renewable energy: energy in the form of organic materials, often called biomass energy, in reference to its biological origins. These organic materials, which include wood, garbage, and animal or plant wastes, have their origin in the process of photosynthesis whereby green plants convert solar energy to stored chemical energy in the form of organic plant material. This stored energy can be utilized in a number of ways which offer the promise of meeting energy needs not immediately provided by solar or wind.

Our first speaker this afternoon is Dr. Stephen Manley, a Forestry Geneticist with the Prince Edward Island Department of Agriculture and Forestry, who will be discussing the subject of energy from wood. Dr. Manley.

Energy from Wood

DR. STEPHEN MANLEY: Mr. Chairman, Members of the Legislative Assembly, Guests, and Members of the media: The Department of Agriculture and Forestry has been asked to describe the potential for farming and harvesting fast-growing tree species, such as alder and poplar, for fibre to provide energy. Such a proposal must necessarily depend on the yield potential of these usually non-commercial species compared to the yields of the natural native forest. There are pertinent and accurate data available to answer this basic question. In addition, other alternatives are included which may apply more directly to land capability and utilization on Prince Edward Island. Significant research and development has been initiated in Maine to determine the yield and potential of harvesting small tree stems after only one to a few years of growth. This work has been accomplished with similar species that grow here in the Maritimes. The techniques have been developed mainly for wild, unimproved, naturally occurring stands of poplars, maples, alders, and birches; however, this work provides an ideal framework for comparing short rotation woody fibre farming without genetically improved plants, with traditional forest yields. These dense young forest stands of poplar and apsen are known in the northeast as pucker brush. Unimproved pucker brush stands or crops, naturally and artifically established, produce approximately 1.2 tons of dry matter fibre per acre per year. One ton of this type of dry matter is approximately equivalent to one cord of wood and approximately equivalent to 1.2 tons of coal. Harvesting of pucker brush involves removing all stems and branches after one or a few years of growth. Leaves are not usually harvested because they are not composed of appreciable amounts of cellulose fibre and are much more important as compost.

Traditional natural forest yields on Prince Edward Island, in pulpwood or saw log size trees, can be conservatively estimated to range between a half ton per acre per year, and one ton per acre per year, depending on the site and species. These figures would also approximately estimate the potential yield of wild tree seed currently used in our Provincial Tree Nursery. If all branches and tops were included, as practised with pucker brush, yields could be increased by 50%; volumes would then be increased as high as 1.5 tons per acre per year. The marginal gain obtained with pucker brush results from the total occupation of the site by initial rapid growth rates. Repeated frequent harvesting of wild alder and poplar stands, called coppicing, has not proven economical because it progressively reduced yields. Similar average yields have been reported in studies in pulp and paper companies throughout North America for various related species, wild rapidly growing hardwoods.

The simple economics of these data suggests that careful consideration be given to investment in specialized equipment to farm wild pucker brush species or for that matter, to farm the wild forest. If more complete tree harvesting were practised in the traditional forest, yields would be approximately equivalent. Proponents of pucker brush farming are not dealing with similar land or land use patterns to those on Prince Edward Island. As an example, the State of Maine is currently concerned with an estimated two million acres of these naturally occurring stands of willow, poplar and birch. Obviously this represents a large potential of fibre to them and this is a land area greater in size than Prince Edward Island. However, pucker brush harvesting has been recommended for better use of land under transmission lines and along rights-of-way. There are 3,000 miles of roads on Prince Edward Island.

Short rotation woody fibre farming has the greatest potential when the following requirements are met:

Dr. Manley (continued):

1. High yielding soils, preferably alluvial, similar to soils along the Saint John River, in New Brunswick.
2. A central seed bank, or seed farm, capable of supplying the required genetically improved plants or seed.
3. Genetically improved lines have to be developed to provide yields high enough to justify investments.
4. A time lag of approximately five years would be required to develop appropriate strains adapted to one or two year rotations.
5. You must contend with the high establishment costs at the production or farm level, due to the necessity of dense plantings.
6. An intensive farming approach to tree production would be required, including cultivation, fertilization and pest control.
7. To be realistic, markets must be stable and varied enough to justify investments in the specialized product or any product for that matter.

The best experience in Eastern Canada with this technique has been developed in Ontario using poplar produced from control breeding. If you were giving these figures, you would find it harder to say it than I do because the difference is so large; it also represents a lot of hard work to get that far but yields as high as ten oven dry tons per acre per year, or ten cords per acre per year of fibre have been produced in these dense plantations with one-foot spacing. The improved varieties exceed natural forest yield, both as pucker brush and as traditional forest, by a factor of ten. This makes a big difference in any kind of economic calculation. These yields are extreme and result from intensive farming of the crop as well as intensive breeding. The Prince Edward Island Department of Agriculture and Forestry is currently developing a small tree breeding seed production and nursery, or tree farm program, that will be geared mainly for improving the yield and quality of major forest tree species. If necessary, this program could be directed entirely or partially to the production of superior strains capable of initial high fibre yield. This would involve adjustments in supporting staff and budget depending on the required intensity of development. The other criteria previously mentioned for the short rotation management are not completely met by Prince Edward Island conditions. Ontario and Maine have considered these farming and harvesting techniques for one to two year old trees to supply fibre to pulp and paper companies. This type of option would essentially be unavailable to Prince Edward Island. Another option that has been developed in the last ten years is the use of these small stems for silage. Species of sycamore in the southern United States are farmed for silage in this manner. This option might be available for people on Prince Edward Island.

The type of alluvial soil present in the Saint John River Valley is scarcely available on Prince Edward Island. The richest Charlottetown soils not presently being cultivated or unacceptable to the short rotation tree farming, I believe, for the same reasons these lands are inaccessible to conventional farming. If improved plants

Dr. Manley (continued):

or seeds were available, farmers interested in these operations would experience high establishment costs, both in time and direct expenditure. The time required for planting these dense stands is probably the major limiting factor in this system of farming. However, the use of improved genetic strains, together with the more intensive use of logging residue and available pucker brush, still make short rotation tree farming an interesting supplemental source of fibre despite the drawbacks I have pointed out.

At this point it would be easy to leave the evaluation of this management, pucker brush, to administration and government to weigh the pros and cons of mini-rotation wood. This was essentially the question I was asked. I would prefer, though, to suggest that there are other important alternatives which have not been suggested. These can have as much, even more, relevance to better land use in the province. The alternative of course to short rotation one-year tree farming, is to develop tree farming and tree breeding using traditional planting densities - 500 to 1,000 stems per acre - instead of 20,000 to 40,000 plants per acre. Using genetically improved trees, the 600,000 acres of forest land in the province, with the cooperation of the farmer, could be progressively turned into important revenue and energy.

Forest tree species here on the Island have served the wood requirements of 15 generations of residents. As a consequence of intensive harvesting and burning, many species have deteriorated in quality, growth rate and merchantable yield. Historical indications are that we started with well-endowed forests, despite wind-swept specimens common along the coasts. We can redevelop our forests with long overdue investments in a resource from which we have removed the very best for 300 years and provided nothing in return. The intention of forest rehabilitation is not to compete with agriculture but to develop thorough land use. Without restraints imposed by high density planting and short one-year rotation, the forest soils and unused agricultural soils of the province have the potential of producing early-maturing forest crops. In addition to their potentially high yields compared to many mainland forest soils, these forest soils and forest lands are the most accessible in Canada.

The Department of Agriculture and Forestry's recently established tree improvement program was, as mentioned earlier, initiated with an emphasis on quality and restoration and is currently developing improved white spruce seed for the Provincial Nursery. The gains from the program are expected to range from 20-50% depending on the strain. A continuing support of the program will result in increased yields with each generation. The actual gain in growth through control breeding can and will be complemented by increased value of the final improved tree product as compared with the present heavy branching and resultant minimum quality of many Island spruce. Given proper spacing, improved white spruce should be ready for harvest as

Dr. Manley (continued):

pulpwood in 20 years; reasonably sized saw logs, in 30. The breeding program will include this year an effort to produce valuable improved hardwood seed to maximize the value realized from these available land resources. The first improved white spruce seed should be available in the nursery within four years. It is difficult to predict the first production of hardwood seed, perhaps five to six years. The tree improvement program in addition will provide a guaranteed source of tested seed to the nursery, perhaps to respond to emergencies such as we seem to have now and provide the soil and silvacultural management to the Provincial Tree Farm.

In currently established tree breeding programs, gains of only 1% to 5% have been found to be sufficient to offset the cost of development. The trees may be bred to be adapted to less intensive cultivation than is required by mini-rotation tree farming. With less intensive cultivation required, additional marginal farmland can be utilized and conventional mechanical and manual harvesting techniques could still be employed. The provincial tree improvement nursery program could supply additional lines or species as required at an intensified level, given government and management support.

Under the slightly longer midi-rotation, as I am suggesting, species such as birches and aspens have particularly high breeding and yielding potential. It is worthwhile to note that hardwood such as birches have double the BTU value that would be available from poplars. The yields we are talking about are very large - 30-60 cords or oven dry tons per acre after 15 years for these hybrid poplars that I previously mentioned have been measured already, compared to approximately ten cords or ten oven dry tons per acre after the same time for normal healthy wild poplar. After 15 years, the owner still has the option of growing even larger logs, or harvesting several different products from his crop at that time. He has the option of logs, pulpwood or fibre. In addition, if complete tree harvesting is developed, an additional 15-30 cords per acre may be harvested in limbs and branches. This is so that you can directly compare these figures with the first ones I gave you for short rotation wood. Now, we are talking about almost 100 cords to the acre after 15 years. This is a massive amount of fibre; it is not only massive but it has been genetically shown that these particular hybrids have different capabilities for utilizing the sun's energy - these plants are particularly efficient at it. They are doing the job for us already. Cost of establishment and care, relative to pucker brush farming, would be reduced substantially, and any silvacultural operations required could be more easily coordinated with typical farm and woodlot management practice.

Dramatic breakthroughs have been made for particular hardwood species such as birch. Geneticists and breeders have been able to produce strains that exceed average growth rates by 40 to 100%. Everybody is concerned when investing in trees and tree improvement with the time span between generations. With faster-growing softwood 10 to 20 years are required for each generation of improvement. With

Dr. Manley (continued):

birch, using intensive tree farming methods and small breeding orchards, the time span between generations can be reduced to three years, in some cases even two years, making it possible to consider second and third generation gains in one continuous reasonably short period.

In all our talks today we have yet to consider the quality of the soils that are available on the Island. Besides being very favourable to agriculture, they are very unique compared to the forest soils in the northeast. With these quality soils available for forestry, it should be possible to produce 8 to 10 inch diameter birch in 15 to 20 years and I have mentioned that birch has also double the BTU value that poplar has. Including branches, yields after this time could be as high as 75 oven dry tons or cords to the acre, 50 cords or oven dry tons exclusive of branches and tops. Those are probably the best the geneticists can do right now; you can approximately double that if you are comparing the birch and poplar for heating value. Birch is probably very close to coal. Should the price of oil drop because of competition from alternate energy sources, the early-maturing genetic strains would be very easily turned into a variety of commercial wood products or could be carried on to maxi-rotation. There is no problem to market a real quality wood product. High-yielding genetically improved trees should serve to foster a renewed interest in tree farming and silvaculture for energy, domestic use, or for economic development. Unlike many forms of economic development, tree farming can be promoted with the knowledge that the labor force on Prince Edward Island already has the basic skills required. With proper management, elite trees have the potential of becoming another important crop for the Island farmer. As in agriculture, silvaculture is labor-intensive. More intensive use of forest land for energy and improved wood products would serve to reroute the dollar we spend on overseas oil to help alleviate the unemployment in rural areas right here in the province. Thank you. I will try to answer any questions.

MR. MCINTYRE: I was wondering, Dr. Manley, where you got that figure of 100 cords per acre; doesn't that appear high?

DR. MANLEY: The figure of, I believe 30 to 60 cords an acre has actually been measured in stands in Ontario. The poplar breeding programs in Ontario were begun by Dr. Heinberger as long as 30 years ago now so some of his work is coming into fruition.

MR. MCINTYRE: Has this been measured on Prince Edward Island? In comparison to Ontario?

DR. MANLEY: No, it hasn't. We don't have anything of that nature here.

MR. COMPTON: I think the best we have seen here is about 43 cords to the acre. Well, I have heard of higher than that but that is the best I have ever seen.

MR. MCINTYRE: You seemed to be leaning quite strongly towards birch; is this something the Department has in mind for the coming year?

DR. MANLEY: Well, the choice of species is up to the Department but it would seem to be a very wise choice. When we are talking about yields that are so high, it is wise to consider that the price of wood, let's say landed in the Maritime Electric yard, not very competitive with coal now but very similar, say you could get $35 per cord. If you were able to grow the wood ten times as fast, I don't think there is very much question that you could produce it much more economically.
MR. MCINTYRE: What is the time span now between time of planting and time of harvesting?
DR. MANLEY: Approximately the same as the well-spaced native forest, I would say, about 50-75 years, maybe longer.

Thank you.

MR. MIDDLETON: Thank you, Dr. Manley. As I indicated this morning, considerable interest is being shown on the part of major corporations and minor corporations, worldwide, in renewable energy developments. The company that, for example, perfects the low cost mass production techniques for photovoltaic cells (solar cells that make electricity out of solar energy) it is said, will be another Xerox, another IBM in terms of the profitability of its products and the advantage that that company will reap. Well in the area of bio-conversion, the use of organic material, there is also a certain amount of interest by large firms. Often, bio-conversion has the image of digesters for live stock waste on a small scale but there are some larger scale approaches that may end up being very interesting indeed. To talk about them we have invited Mr. Joseph Kennedy, from Canadian Industries Limited and he will speak about his company's activities in this particular field. Mr. Kennedy.

Renewable Resources

MR. JOSEPH KENNEDY: Thank you, Peter. Members of the Legislature, and guests, it is a privilege to have this opportunity to speak to you today. You are to be congratulated for your perception of the complex problems we are facing. Canada has traditionally regarded itself as some kind of resource cornucopia. The fallacy of this thinking is rapidly becoming recognized. The newly created Institute of Man and Resources promises to be a valuable agency in leading Canada from a throw-away society to one based on conservation and efficiency.

My brief deals with the utilization and the development of renewable resources. The renewable resources include the municipal and agricultural wastes, some categories of industrial waste and biomass material, such as wood. A brief review of the various technologies available for utilizing these materials will be made and CIL's activities in this field will be described. Also, some suggestions for energy production from renewable resources generated on Prince Edward Island along with conceptual cost estimates will be given.

Mr. Kennedy (continued):

Waste organic materials contained in municipal, industrial and agricultural wastes are limited to some extent in supply. However, biomass in the form of plants is perpetually renewable and its production continues at a constant rate which is greater than that of the exploitation by man. At present green plants are the only reasonably secure solar energy converters.

How can we take advantage of the enormous quantities of energy which are stored in renewable biomass and organic wastes? These organic materials are difficult at best to convert because of their varying and unpredictable qualities. However, possible alternatives are that they can be used directly as a solid fuel and converted into thermal energy by combustion, or they can be converted to a more concentrated fuel by a number of chemical or biological processes. Conversion of organic materials may also lead to the production of useful chemicals. The conversion method applied depends on the physical nature of the material.

Direct burning of material such as wood has supplied a large portion of man's heating energy requirements to date. Direct burning of municipal solid waste producing steam and/or electricity has been common throughout Europe and Japan for several years.

Crop residues, such as leaves and straw, and waste material, such as sewage sludge, manure, and canning wastes, all contain energy but do not lend themselves to convenient or efficient direct combustion. Extensive research and development work is presently being carried out to find economically feasible methods by which these renewable materials which are unsuited for automated controlled energy release by direct burning can be converted to solid liquid or gaseous fuels.

The first step in the basic technological process involved in energy and chemical development through the conversion of renewable materials is the collection and preparation of the materials before they can be fed to the conversion process that is to be used. An effective transportation or collection system is, therefore, of first importance. Preparation generally involves removal of any inorganic material and size reduction to facilitate handling and processing.

Direct burning is by far the most advanced of these technologies. Energy recovered from a multitude of renewable materials is demonstrated at facilities around the world. These facilities consist of various types of combustion chambers and different designs for recovering the heat from the hot combustion gases to produce steam and/or electricity.

Recently, there has been a thrust toward the development of pyrolysis and gasification processes. Pyrolysis and gasification processes are chemical processes in which the decomposition of organic materials is greatly accelerated through the application of heat with insufficient air or oxygen to support complete combustion. This process is similar to the coal gas produced many years ago. The product gas from these processes is combustible and is also the building block for other fuels and chemicals. There are several types of pyrolysis gasification processes being developed. Depending on the type

Mr. Kennedy (continued):

of gasification process used, the fuel gas may have a medium or low heating value and will contain varying amounts of tars and dust.

Anaerobic digestion, a form of bio-conversion, is the conversion of organic material into methane or natural gas through the action of micro-organisms. The reaction occurs naturally in the absence of oxygen. Bio-conversion of certain organic materials to produce methane is practised widely in India and Southeast Asia on small scales. However, it is felt to be impractical on a large scale because of the long retention time required for the decomposition to take place.

Hydrogenation is the addition of hydrogen to the organic material during its conversion to an oil. The reaction requires high temperatures and pressures, resulting in high capital investment and difficult operating conditions.

Another basic technology, hydrolysis of cellulose, or wood with acid and the fermentation of the resulting sugar to produce ethanol or ethyl alcohol, was practiced during World War I in a few locations in the United States. These reactions are sensitive and must be finely controlled. The process suffers from an inherent expense of acid addition and the ensuing problems of acid disposal. Production of ethanol from wood in North America terminated some time ago because it can be more economically and conveniently made from other sources. Besides being a popular beverage, ethanol is a very acceptable fuel. In South Africa it is blended with gasoline for automotive use. With the recent increase in petroleum costs, economics of producing ethanol from wood may have improved and it may be a viable process.

I will now go into some specific technologies appropriate to this discussion which CIL is developing and marketing. CIL, or Canadian Industries Limited, is Canada's largest chemical manufacturing company with a total sales of approximately $600 million per year. One of the business areas within the company is the Environmental Improvement Business Area, known as the EIBA.

The EIBA was formed in 1972 with the objective of bringing under one management group all of CIL's activities in the environmental field. In addition to the central staff of the EIBA, there are three operating companies - Tricil Limited, J. D. Lee Engineering Limited, and Eco-Research Limited. The EIBA and its associate companies, with a total staff of over 500, have concentrated their efforts on municipal and industrial solid and liquid waste management and the sale of engineering services and technology.

The management of waste is carried out by Tricil Limited, which is a major waste handling and disposal company active across Canada. Tricil owns and operates several municipal solid waste collection and disposal systems and three central solid and liquid industrial waste treatment plants. Tricil also owns and operates a waste transfer resource recovery plant that processes all the solid waste generated in the city of Kingston, population 65,000. This plant has been

Mr. Kennedy (continued):

operating about six weeks now and there are still some finishing touches to be put on it. The basic function of the facility is to receive waste from small collection vehicles and compact these wastes into large transfer trailers for bulk haul out to the landfill site, which is a 33-mile round trip. The use of the transfer depot drastically reduces the hauling costs. The unique design of this facility permits the accommodation of resource recovery. The EIBA is just completing construction of a pilot plant to investigate new approaches to solid waste processing and energy recovery from organic materials. This work will be done in the back portion of this facility. The waste processing section of the pilot plant is full scale. The energy conversion of the organic material is carried out on a semi-commercial scale. The prepared organic material from the processing section of the plant is introduced with a deficiency of air into a fluidized bed gasifier where a granular solid, such as sand, is maintained in a fluidized condition by the inflowing air. By combustion of a portion of the organic material, the remainder is broken down by heat to produce a low BTU gas which includes hydrogen, carbon monoxide, and methane.

Figure 42 shows the process flow sheet for the fluidized bed gasification of organic material. CIL is developing this particular technology because of several inherent advantages compared to other pyrolysis gasification technologies. We in CIL reviewed the technical and economic merits of the various schemes and settled on one which produces a minimum amount of tars, important if the gas is to be piped, is very stable operationally, and can be adapted to the manufacture of chemicals. In addition, it is one of the cheaper processes to operate and has a low pollution index. A wide variety of organic materials, including municipal and industrial wastes, sewage sludge, agricultural wastes, and wood are expected to be gasified to produce a combustible gas. With minor changes this gas, as produced, can be fired into existing boiler plants to produce heat for steam and electricity generation, or it can be used for process heating requirements for cement plants, saw mills, etc. It can also be upgraded to a substitute gas or methane, or converted to a chemical feed stock to produce such chemicals as methanol and ammonia.

The experimental gasifier is scheduled to go into operation within the next two months. It is becoming clear to us that such processing plants should be operated on a production basis, just as a factory, in which the raw materials, refuse and other organic material, wood, and agricultural waste, and so on, are processed and converted into various products in response to the market demands. There are a number of products which can be produced and the market may demand one product over the other. This energy industry, if you want to call it, would provide substantial employment, as it is labor intensive for the material collection and preparation segments.

PROCESS FLOW SHEET

C-I-L RESOURCE RECOVERY PILOT PLANT

KINGSTON, ONTARIO

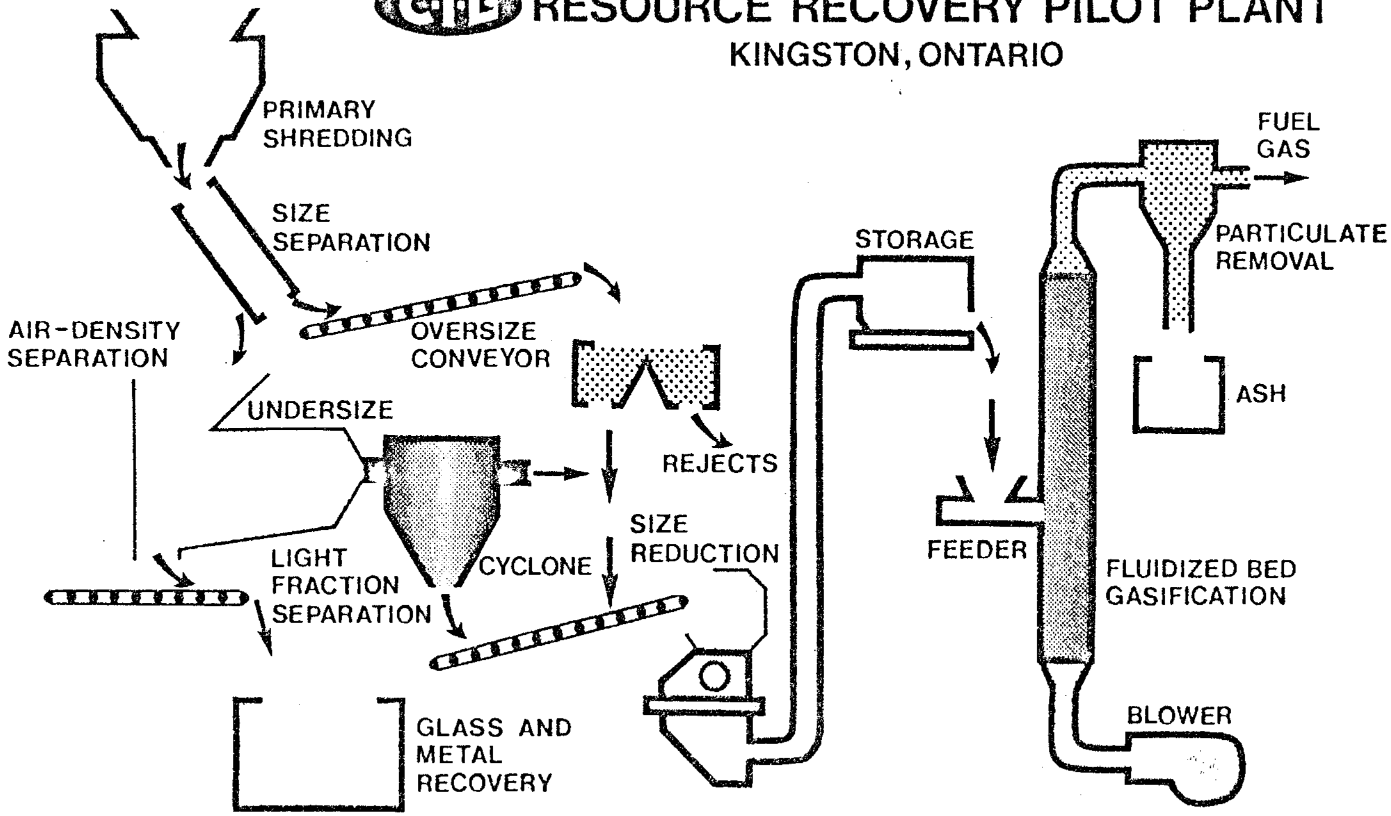


FIGURE 42

Mr. Kennedy (continued):

An alternative energy technology which the EIBA is marketing is the SWARU system. The EIBA has carried out evaluations of all existing technologies for the recovery of energy from mixed municipal wastes. The SWARU (solid waste dispoal-resource recovery system) was identified as the world's most advanced waste disposal materials reclamation and energy recovery technology. This technology is a Canadian innovation and is demonstrated at the 600 ton per day plant in Hamilton, Ontario. This is the first and only plant of its kind and has been operating since 1972. A number of municipalities in the United States are now planning to install similar systems to recover the energy from their municipal waste. Through an exclusive agreement with the design engineer, the EIBA has acquired the know-how from the Hamilton SWARU, and is marketing this technology on an international basis.

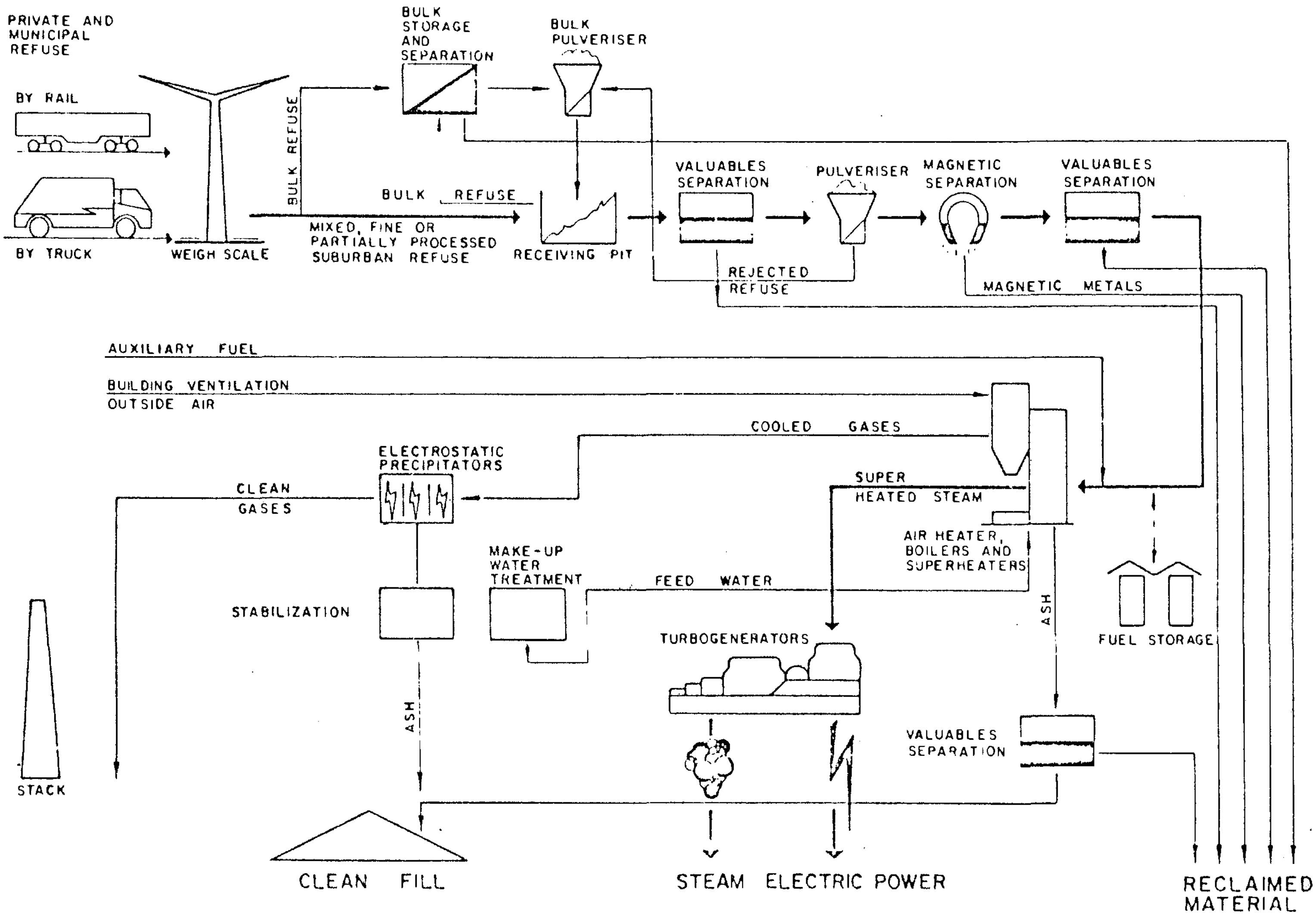
The SWARU (solid waste disposal resource recovery process) is a comprehensive system which can accept most kinds of waste. The system employs modern incineration and materials handling technology which facilitates resource and energy recovery and insures high thermal efficiency.

Figure 43 is a schematic diagram of the SWARU system. It involves size reduction of the waste materials, conveyor belt handling, material reclamation before and after combustion, and semi-suspension burning of the shredded material in a water-walled boiler to produce steam and/or electricity.

The type of boiler used in the SWARU system is especially designed for these low grade fuels, such as wood and garbage. The semi-suspension burning of material such as bark, wood, bagasse, and coconut hulls in spreader stoker boilers to produce steam has been practised for many years. Also, you may note that a number of reclaimed materials, such as metals and glass, can be recovered. Also for optimal thermal efficiency of the total process, low pressure steam for heating or industrial use is produced along with the electrical generation.

The heart of the SWARU system is the boiler. This is where 75% of the capital costs are. The prepared material is fed into the boiler through air-swept distributor spouts. It is picked up by the stream of air and blown into the boiler where material is flash dried and combusted in suspension, or the more wet and heavier material lands in a thin layer on the travelling grate at the bottom of the boiler to complete its burn out. In this manner, materials with up to 55% moisture content are successfully burned to produce energy. Conventional fuels, such as oil, gas, and coal, can also be fired into the boiler. High efficiency results from burning substances in suspension. Suspension burning requires the automization of liquids and the pulverization of solids. For the same reasons that oil is automized and coal is pulverized, the SWARU system requires that solid wastes, wood, and whatever be shredded prior to energy recovery.

Process Flow Chart



Waste Disposal - Resource Recovery System

FIGURE 43

Mr. Kennedy (continued):

The EIBA is involved in four major projects dealing with the SWARU system. In consortium with Consumers Gas Company and the Ontario Paper Company, preliminary engineering has been carried out to provide electricity and process steam to Ontario Paper Company, in Thorold, Ontario. This system will recover energy and resources from all of the solid wastes generated in the Niagara Peninsula, which is about 1,000 tons per day, plus any of the waste generated by the Ontario Paper Company. Coal will also be fired into the boilers along with the prepared waste. It generates some 25 megawatts of electricity and close to 700,000 pounds of steam per hour. Similar projects are also being planned for the city of Ottawa, 1,600 tons per day; city of Detroit, 3,000 tons per day; and Adelaide, Australia, 1,400 tons per day.

Now, what can be done in Prince Edward Island? An introductory survey completed by us through long distance telephone calls and whatever information we were able to pick up from newspaper clippings and so on, indicated that the following readily available renewable materials generated on Prince Edward Island were available for energy recovery. Under current levels of forest management, the annual allowable cut is 160,000 cords, which is roughly 320,000 tons of wood per year. If forest management practices were changed somewhat and were directed towards straight fibre yield by short term rotation, it is assumed that 320,000 tons of wood per year would be available for energy production without affecting present pulpwood exports. Also, the mixed municipal refuse generated by the Island residents along with that generated by the more than 600,000 tourists who come to this Island every year, amount to approximately 80,000 tons per year. There is also potato waste. In 1973, the production was 430,000 tons; we have assumed a 10% wastage which would amount to 43,000 tons per year. This brings a total of renewable material available to approximately 443,000 tons per year. The inherent energy in this material is equivalent to approximately 25 million gallons of oil. Because of the nature of these renewable materials, the process efficiencies for recovering the energy are approximately 15% less than energy recovery from oil; therefore, the actual oil equivalent is more than 25 million gallons or about 20% of the Island's total annual energy consumption.

Using proven direct burning technology, one alternative is a SWARU system. This would be the most effective way to recover energy from wood and mixed municipal refuse. It is suggested that the SWARU burning facility could base load the superheated steam to the existing turbo-generators for electricity generation. The existing thermal station fired by oil would be used only for make-up capacity. The SWARU system would supply steam to generate approximately 22,800 kilowatts per hour, at a cost of about 3¢ per kwh, plus the cost of operating existing turbo-generators. This rate of 3¢ per kwh is based on the following data: capital investment of the SWARU plant

Mr. Kennedy (continued):

is $24 million or amortised over 30 years at 10% interest rate. A garbage disposal fee of $5 a ton is charged at the gate of the plant. The cost of wood delivered to the plant is $7 per ton. Therefore, 400,000 tons per year of wood and refuse is converted to energy to supply an average of 228,000 pounds of superheated steam per hour for electrical generation.

These eonomics of a SWARU system would be much improved if post electricity generation heat could be used. For example, when fuel is burned for electricity generation, only one third of the calorific value of the heat is actually converted into energy and the other two thirds is wasted energy. Thus if a revenue could be obtained for this wasted heat, electricity rates would be less.

Getting on to the gasification side, from the evaluation and the potential situation in Prince Edward Island, we have estimated the following cost for fuel gas production at three capacity levels: 300 tons per day, 600 tons per day, and 1,200 tons per day of mixed organic material containing refuse, wood and potato wastes. These would be in the same proportion as stated in the inventory. The cost of gas per million BTU for the three levels of production, 300, 600, and 1,200 are $1.41 per million BTU, $1,18 per million BTU and $1 per million BTU with an investment of $3.6 million, $6 million, and $9.5 million respectively. This compares very favourably with the current bunker cost of $1.90 per million BTU, assuming petroleum is $12 per barrel. Therefore, annual savings for the respective three gasifying plants would be half a million dollars for the 300 tons per day, $1.4 million for the 600 tons per day, and $3.4 million for the 1,200 tons per day.

It should be reiterated that the capital investment for this technology is quite low and that the gas can be utilized in existing oil fired plants.

An alternative use for fuel gas produced by gasification is the manufacture of chemicals, for example, ammonia for fertilizer, methanol as a liquid fuel or petroleum intermediate, and methane. The manufacture of ammonia, methanol, and methane are similar in many respects, including processing equipment and the fact that the production cost is primarily in capital investment and fuel price.

For comparison purposes, a cost of producing 1,000 tons per day of ammonia has been estimated. Very similar cost relationships would hold true for both methanol and methane. Fuels selected were Bunker C at $12 per barrel; wood at $7 per ton; and municipal waste at a disposal fee of $5 per ton. Corresponding capital investments for 1,000 ton per day ammonia plant were $78 million, $80 million and $90 million. The resulting production costs were $1.61 per ton for ammonia from Bunker C, $1.28 per ton from wood, and $98 per ton for refuse. Obviously, both wood and refuse are choice feed stocks. The difference between $98 per ton for refuse and $1.28 per ton for wood and $1.61 per ton for Bunker C is very significant. This amounts to approximately $23 million a year for the difference between wood and oil and $12 million per year for the difference between refuse and oil. This is why CIL is getting into this business area because it can foresee that this is a very economical way to generate chemicals. CIL along with other chemical companies is actively working on this problem and it won't be long before wood and refuse will be used as chemical feed stocks. Thank you.

MR. MIDDLETON: Thank you, Mr. Kennedy.

Our next speaker is Mr. Rex Mellenger, a consultant from Saint John, New Brunswick and he is going to deal with the small scale production of gas from biomass material.

Gas from Biomass Material

MR. REX MELLENGER: Mr. Premier, gentlemen, Members of the Legislature: I came here today to justify three propositions that I have put forward on three different phases of power generation, with the known cost of production in each case.

The first proposal was for the generation of power by a modern diesel engine fuel plant in which the lowest heat rate has been achieved. Since you are definitely stuck with oil whether you like it or not for some time to come, why is it worthwhile to consider what is the best equipment available for the generation of that power?

That proposal needs no airing I think at this time because the purpose of my request to be here was to discuss the generation of electricity by wood gas.

Some 50 years ago, several of the big engineering companies in the world - like Crosleys, Campbell Power Gas Company, the Power Gas Company of England, Clockner - developed an extensive wood gasification plant and shipped their equipment all over the world. Many of them are still working and still available. We know from experience that for every pound of green wood in the world, there is one kilowatt available and we know the cost of generating it.

Such a plant today, in units of five megawatts, costs about $300 a kilowatt or less installed and it utilizes the wood which is available immediately in the neighbourhood of the plant because you wouldn't have built the plant in a neighbourhood that had no wood. Now with wood at $25 a cord and on an OD basis of 3,100 BTU per pound of wood, you can generate electricity today on a 90% load factor for about 1.07¢ per kilowatt. I think that a great many of the wood producers, the woodlot owners of the country, would welcome the market for their wood and since there is a great deal of wood available that has no merchant value (I speak now of the beeches, and the scrub maples, and the scrub poplars, and the white birches) I think that if you use a figure of $25 a cord, you get a bargain.

The wood gas producer is a simple device which burns wood in an insufficiency of oxygen and in the process creates CO and H^2 which burned in the internal combustion engine is a very efficient fuel.

Mr. Mellenger (continued):

It is not a bad fuel if you burn it in a furnace but because of its extensive hydrogen, it is best burned in internal combustion engines. The engine is of the low compression variety; any four-cycle engine is convertible, whether it is built as a diesel or a gas engine. If it is spark ignition, then it is of the order of 7-to-1 compression ratio and if it is diesel engine, it is used as a duel fuel engine, in which 7 or 8% of the oil is used to inspire or spark the charge. The other aspect which I put forward was the gasification of coal by the MacLaren-Mellenger system which is used in the city of Glasgow and has been used there for the last 15 years. There are 64,000 cubic feet of gas to the ton. It can be used either industrially as gas or within the transmission distance of let's say one municipality, because it is a low calorific value gas - in the neighbourhood of 200 BTU per cubic foot - and it doesn't warrant the long distance transmission that natural gas with 1,000 BTU does. In the production by the MacLaren system as it is distributed in England,there are two other by-products, coke or smokeless fuel. (I can't agree that solid fuel is not distributable within such an area as Prince Edward Island.) The other by-product is some 36 pounds of ammonium sulphate which takes care of the sulphur in the coal and if you go for Sydney coal, gentlemen, you always have a considerable sulphur problem; that is one of its worst enemies because they keep all their good coal for their coke ovens and sell the rest where they can which is very good business. Anyway, in addition to the ammonium sulphate, there are some 26-27 gallons of coal oil and that is the by-product of such a plant.

Now, I asked your energy chief here a while ago if he would take a look and see what the market for solid fuel in the form of coke was here on the Island. You have got to have fuel here on this Island, that is for sure and you have insufficient wood to justify a complete change-over to wood gasification, much as you would like to. So, your alternatives are either oil or coal and you definitely have a lot of potential for energy from wood gas, perhaps even 21,000 kilowatts. I don't know, because I have asked for figures on the availability of wood but I have not got them yet. But in a 3-megawatt station, you have three cords of wood a day, and that is three cords an hour, 72 cords a day, and that should be available every day in the year because the plant, much as it would like to, can't run without wood. So, I still wait with interest the availability of wood for the generation of electricity from wood but there is one thing for sure, that if you charge yourself $25 a cord, you can generate power for fuel only at just over 1¢ per kilowatt hour. Currently, steam generation, such as you have here, has a heat rate of about 12,400 BTU and therefore, it has a cost for fuel only of 1.7¢, apart from the capital charges and other charges. Those are the irrefutable facts of life.

To revert to the modern diesel station, the advantage lies first in the extremely low heat rate which is stated by one of the world's principal engineering companies to be 8,100 BTU per kilowatt. Recoverable heat was 26% of the total heat in the fuel for heating such as

Mr. Mellenger (continued):

your university campus, or for other forms of heat. In the case of the steam generating station, that heat is rejected to condenser and helps to warm up Northumberland Strait, but it does not do any good to the community.

I have said, I think, gentlemen, about all that is necessary on the subject at this time. I was limited to 20 minutes and I hope that those 20 minutes have been worthwhile.

PREMIER CAMPBELL: I didn't realize you would be leaving; would you answer a question before you go, sir? You referred to the possibility of a relatively small generating unit, a wood burning unit, and in the Prince Edward Island context, I suppose we are talking about units of five megawatts, or smaller. Are such units manufactured and available today?

MR. MELLENGER: Yes, they are available at about three or four months delivery. For instance, there is a plant that the United States Army has just abandoned up in Goose Bay which could be very well installed here as a duel fuel plant on 92% wood gas. It was abandoned by the United States Army when they abandoned Goose Bay. So you could be in the wood gasification business here in about three months at low cost and the rest of the gasification equipment could all be built in your own shipyard down at Georgetown; it is only cylindrical plate, and brick work.

PREMIER CAMPBELL: Have you done some calculations, I think the Institute has, as to the number of acres of woodland which would be required to fuel the generator each year?

MR. MELLENGER: No, sir, I haven't; I left that to the Forestry Department in Maine and Nova Scotia and I asked for it here. But we have done some extensive work with Seven Island Land Company in the State of Maine and all we need for a three megawatt plant is three cords per hour in any form at all, so long as it is wood. It could be round wood - it all has to be hogged - but it could enter the plant as branches, limbs, or trunks. It all passes through the hog and it all goes into the gas producer where it is gasified very efficiently. For instance, the Government of Sweden, three years ago, placed an order for 100,000 mobile gas producers for vehicles because during the last war they were caught short - Sweden has neither coal or oil - and her only means of transport was her extensive wood. Now Sweden, during the last war, had just over 66,000 licensed wood-burning vehicles on the roads and the only oil that she ever got in was when some of her visiting homecoming ships slipped a little bunker oil ashore, like they used to black market liquor. Sweden, being determined not to be caught again, placed the order with Volvo and I have had the good fortune to acquire the drawings since they are not patented. I wouldn't advocate the use of wood chips for running around; 120 pounds of wood chips is good for 100 miles in a 2-1/2 litre vehicle. But it does have a nuisance value whereas in the power generating plant, wood has no nuisance value; the only emission is the exhaust from your engine which is CO_2, H_2O, and N_2, none of which are objectionable gases and much less so than those emitted from the gasoline engine.

There are a couple of remarks that I would like to make. The use of methanol as fuel is a dream. I was manager of the Grey Chemical Company of Roulette, Pennsylvania, in the last days of its existence before the West Virginia Pulp and Paper Company brought it out and we made methanol and acetic acid and grey acetate of lime. In those days the by-product principally was charcoal and methanol had very little value then, as it has very little today, because of the synthetic methods of producing it. Secondly, it is lousy fuel compared to ethyl alcohol which has a much higher thermal efficiency. But in the experience, we had a yield of 16 gallons of 98% methanol per cord, and those were 50-inch cords, in those days, gentlemen, not 48-inch cords. We used to make a little money out of our acetic acid until Shawinigan, with their synthetic chemical process, cornered the market on acetic acid. But methanol, as I told Governor Longly and he, I think,has taken the heat off the project, is only a dream.

Another thing that is being vastly aired is the municipal garbage and bark. Now, OD bark is a wonderful fuel, it is 9,400 BTU to the pound. But bark is usually wet and it is imperative, since it will not support combustion, to burn oil in order to ignite the bark. When the cost of oil was $4.50 a barrel, you could afford up to 38% by weight of oil to incinerate bark and that is exactly what it amounts to. Bark has a nuisance value and it has to be got rid of, so there is much talk about it. But there was a paper given last week at the University of New Hampshire on the subject by an eminent gentleman who has for 40 years been power engineer for the Warren Corporation and they have to give up burning bark because they cannot afford the oil to inspirate it. And the same thing generally applies to municipal garbage - on its own, it is incombustible.

DR. MALONEY: In the generation of electricity from the gasification of wood, is it competitive if you don't use the heat by-product?

MR. MELLENGER: Yes, I gave you the figures on no-heat recovery. There are about six pounds of steam per horsepower at 30 pounds pressure recoverable from any internal combustion engine with a reasonable heat recovery. In some cases it is much larger, where you can afford to go into extensive heat recovery equipment, but such plants, for instance as English Electric, Rust and Hornsby, put out in the 1,200 horsepower in the 1,000 kilowatt range. They all have heat recovery and it is very highly developed because the diesel locomotive, as such, has given ample practice for the generation of recovered heat. Most trains of course, are heated by the exhaust from their diesel engines. When you get up into very large engines, it becomes a little more efficient because you can practise the better means of combustion in the recovery boiler. But that is a premium, sir, the heat recovery rate of duel fuel engine is about 8,200

BTU per horsepower hour and for a gas engine about 9,000 BTU per horsepower hour. Those are accepted figures and have been for the last 100 years. So there is very little purpose in recovering the heat from a 3-megawatt station that you would have located through the country here, outside of heating the building itself, unless you want to have a greenhouse there or a fishpond to heat. It is a very small quantity of heat, 12,000 pounds, which isn't big enough to put in a recovery turbine.

DR. MALONEY: Well it makes a difference to an industrial plant, you know; you don't have to have a very big plant today before the heat alone would be $5,000.

PREMIER CAMPBELL: Did I understand you to say that it had to be green wood?

MR. MELLENGER: No, in the process of gasification, Mr. Premier, you would have to have 30% at least of moisture in order to hydrogenate your fuel. Now, in coal gasification, we use 40% by weight of steam to coal, sprayed into our fuel bed, to get the necessary gas. Wood, however, already contains about 20% of hydrogen, so therefore it requires less water to hydrogenate the fuel. Wood gas runs about 23% CO and about 16% H_2. It is pushing up around your gasoline which is C_6H_{16}, or H_{18}, but the moisture in the wood is an imperative.

MR. MIDDLETON: Thank you very much, Mr. Mellenger. We have dealt quite extensively now within the time available, with a range of renewable energy resources. I hope that the message that has come through is not so much that there are no feasible alternatives but that it is a question of choosing among these alternatives, a question of determining which ones are appropriate for Prince Edward Island - which ones are appropriate for the Island now, which ones may be appropriate in the next five, ten, or 20 years. Obviously in a field like this which is just opening up, there remains a fair degree of controversy as to what works and what doesn't and what the economics of this one versus that one may be. But I believe personally and I think you have seen some evidence of that today, that there are a large number of serious organizations putting a considerable amount of money and time into answering some of these questions. In general, I believe that Canada possesses significant reserves of non-depleting energy resources within reach of existing population centres and energy distribution networks. A number of renewable energy technologies were proved to be technically and economically viable for certain applications in the next couple of years; indeed, some of them are now. These include solar space and water heating, small and medium-scale wind generators in certain applications, pyrolysis, incineration and anaerobic digestion systems for organic wastes, and wood furnaces. Providing that certain cost reductions can be achieved, a second group of technologies will considerably increase the percentage of Canada's energy demand that can be supplied by renewable energy. This group includes photovoltaics, the solar cells that Professor Hooper talked about briefly this morning, and integrated systems for production of methanol, ethyl alcohol or ammonia from wood and other organic wastes. As in the case of nuclear power, the degree to which

Mr. Middleton (continued):

Canadian governments lead and support the development of renewable energy resources will determine their ultimate potential. In the last analysis, however, we have no choice but to view renewable energy resources as an important part of our future energy mix. The question is how soon we will mobilize ourselves to maximize what may be considerable benefits. As I said this morning, this involves government commitment and involves commitment by industry as well; it involves the demonstration of the feasibility and the economies that are promised; it involves public education and training of the technical people to make it happen; and it involves a serious implementation program. As I also indicated earlier, looking at our energy problems from the source end alone really isn't going to solve all our problems. It is currently believed, even by some of the relative optimists in Ottawa, that no matter how we go, no matter what projects we get underway in large scale pipelines in the North, tarsands, nuclear, whatever it may be, we are still going to be producing less energy that we are going to be consuming for the next few years, for the foreseeable future, in fact, although those optimists do tend to see that as just a transitional period, following which somehow we will find solutions, so that it will all be alright again and we can maintain some of that growth. It will be up to historians to determine who was right and who was wrong. It is clear though, that we have to start also at the other end, at the demand end of the energy picture, and to this end we dedicated two sessions today, two sessions that aim at exploring what changes can be foreseen in two sectors of great importance to Prince Edward Island: agriculture and transportation.

Our first speaker, then, looking at it from the other end is Dr. Clair Rennie, who is the Executive Director of the Research and Education Branch of the Ministry of Agriculture and Food in Ontario, and who has been involved both through the Institute of Agrologists and through his Ministry in developing a comprehensive program to try to pinpoint the various types of changes that can be expected in the field of agriculture that we should be trying to bring about as soon as possible. Dr. Rennie.

Renewable Energy and Agriculture

DR. J. C. RENNIE: Mr. Speaker, Honourable Members of the Legislature, members of the press, ladies and gentlemen, it is indeed a distinct honour to be with you here today and to be afforded this opportunity to discuss with you certain aspects of the energy situation with respect to agriculture. Being an employee of the Government of Ontario, I would be very remiss if I didn't bring greetings, Mr. Premier, from my Premier, The Hon. Bill Davis, and particularly from my boss, the Minister of Agriculture and Food, Mr. Newman. He asked me specifically to bring greetings to his many agricultural colleagues here on Prince Edward Island.

Dr. Rennie (continued):

I do not intend today to talk about energy sources as I feel this is really out of my terms of reference, as Mr. Middleton has already explained. Whether you build or supply nuclear power of your own or bring it in from other sources, will be a decision which will lie with you and possibly those who may follow. In spite of this statement, however, I fully realize, as I will mention later, that new forms of energy must be found that are acceptable to and useable by agriculture in the long term. In my presentation here today, I will be looking at what I call the total agriculture food system, not just the production phase. I feel that when we talk about energy and agriculture, we must consider the energy costs of getting food from the fields or from the greenhouses or from the barns right to the consumer. Also in my presentation I am working on the assumption, and hence building my thesis on the premise, that agriculture in this province will remain as a major industry even though certain shifts in production marketing and other technologies may occur over time. Now from the various background papers which I have received and reviewed prior to this special session, it became very obvious to me that as a government you have already made considerable study of this topic and have available a fairly comprehensive inventory of total energy requirements for agriculture in your province. I want to take this opportunity to commend you for this forward action and for the excellent data which have already been generated. Because of this previous work on your part, it is unnecessary for me today to spend much time on such general topics as the dependence of agriculture on energy.

The dependence of agriculture primarily on fossil fuels in the production, transportation, and processing of food was made abundantly clear as we all know, during the energy crisis of not many months ago. It became very clear, not only locally, but on a national and international basis, that the crisis was not solely energy but one involving an interdependent mix of land, energy, and food supply. We know that accelerated development of agriculture in the advanced areas of the world is essential if adequate food production is to continue and moreover, and unfortunately, a massive injection of energy for mechanization and fertilization is needed if the developing world is to meet the food demands of exploding populations. It is now realized that this expansion of food production can be based on increased use of petroleum fuels and derivatives only if agriculture is to be given high priority in receiving these fuel supplies. New forms of energy must be found that are acceptable to and, as I mentioned earlier, usable by agriculture in the long term. In both the short and long term, techniques for minimizing energy requirements for food production and processing must be developed.

Now, in the past the emphasis in both food production and research has been on the useful output per acre, per man, or per unit of investment. Now a new emphasis must be inserted into the equation

Dr. Rennie (continued):

and that is useful output per unit of energy input. It also appears that agricultural production must be considered not only on the basis of energy ratios but also in relation to the probability of a reduced availability of petroleum products and/or high prices for them. This, in return, implies that the best or full use must be made of all components in the food production chain from the standpoint of efficient use of energy.

Now one of the key components is the relationship between land quality and energy efficiency. Energy efficiency in crop production is much higher when the energy is applied to highly productive land. For example, one soil type may produce a crop which is 25% larger than another with the same amount of inputs. For this reason it is essential that as much as possible of class one, two and three land as classified in the Canada Land Inventory, as well as special crop lands suitable to fruit and vegetable production, be reserved for food production. It is imperative, therefore, that long term energy and land use policies be developed concurrently.

Like all western societies, the energy requirements of the Canadian society are high. It is estimated that energy and agriculture production to the farm gate is 2-3% of the total energy used in Canada. All phases of agriculture require some input of external energy. The major needs are three really: natural gas for nitrogen production, petroleum-based fuels for machinery operation, crop drying and transportation, and various forms of energy for the fabrication and construction of machinery and buildings.

Despite the external energy inputs necessary for agricultural production, agriculture remains the major means of producing food and fibre through utilizing the sun's energy and this point has already been made today by previous speakers. The total energy used to get food on the table represents from 12-15% and I have taken 15% here as the upper figure of total national energy consumption. Production of food on the farm, however, accounts for slightly less than 20% as you will see in Table 29 of the total energy used to place the food on the table ready for consumption. And that is why I have taken the approach today of considering energy and agriculture in the total food system, not just the production phase, because when you are looking at it solely in the production phase, you are going from 18% for agricultural use, but only 2.5% of the total amounts used in the food system chains. Processing and packaging account for 32%; transportation and distribution, 20%; and then household preparation, another 30%.

Now, on the basis of energy input versus energy output, agriculture in North America has been reasonably successful. This was possible over the past number of years through high utilization of the relatively inexpensive energy accompanied by capital investment in mechanization. The future now, of course, is quite different. Agricultural crop production is in general efficient in energy terms. Most plants are net energy producers; in caloric terms of input-output, ratios fall in the 3:2, 5:1 categories for such crops as potatoes, corn, and grain. In other words three out, five out, for one in - tremendously

ENERGY REQUIREMENTS FOR FOOD PRODUCTION*

PERCENTAGE OF NATIONAL CONSUMPTION 12-15%

STAGES	% OF AGRICULTURAL USE	% OF NATIONAL USE
Production (to the farm gate)	18	2.5
Processing and Packaging	32	5.0
Transport and Distribution	20	3.0
Household Preparation	30	4.5
		15.0

* Reference: Ontario Institute of Agrologists Statement on Energy and Agriculture

TABLE 29

Dr. Rennie (continued):

energy efficient ratios. Many vegetables though, such as beans, have ratios of less than one to one; animal products generally speaking, have ratios which are less than one to one, with the dairy cow and poultry being the most efficient.

These ratios, although very interesting, cannot be taken on face value for a number of reasons. All crops require purchased energy in one form or another in order to get them produced, so we can talk about agriculture being the greatest user of solar energy because photosynthesis and so on. We still need an energy input in order to put those plants and animal products on the tables of consumers in this province and throughout the world. Now, animals, on the other hand, produce manure which is of considerable value in the total energy picture. Also our ruminant animals utilize considerable feed made up of the materials which do not normally make up part of the human diet. Further, to the degree that cattle and other ruminants graze on land that is not suitable for economic food production, they are converting energy in the form of forage which could not otherwise be available in the food chain. It is estimated that some 60% of the world's ruminant livestock population grazes on land that cannot be economically cultivated for direct food production for human consumption. Another consideration is that animal products are important in the human diet as a source of protein. It is apparent to me, therefore, that in spite of the low energy ratios for some animal products, animals will and should remain a significant component of the agricultural industry in most if not all regions of Canada and might, in fact, outlast certain high energy plants in the long term.

I fully appreciate that the theme of today's special session is energy alternatives although Mr. Middleton has explained why the last two presentations here are somewhat different. And when we talk about alternatives, this implies energy sources other than traditional. This I accept but I feel there is another interpretation to this which, both short and long term, can play a significant role in energy efficiency and I call it "technology utilization". I am prepared to predict that through maximum utilization of the agricultural production technology today - marketing, transportation and so on - through knowledge, technology which is available to all of us, we could realize a saving of up to 25% of current energy consumption. To me the first step we must take in agriculture relative to energy is an improvement in our energy efficiency. One of the alternatives we have, therefore, is the full use of technology which will reduce or in fact eliminate energy utilization.

On the matter of energy alternatives: I fully realize that many people feel that there are far more exciting and possibly more newsworthy topics when we are talking about developing energy sources, such as solar, wind and thermal. However, I feel that there are other aspects that we must look at. Number one: we have got to get

Dr. Rennie (continued):

people to apply the available technology which will reduce energy consumption; and two, to utilize and follow very strict energy conservation measures. I am convinced that one of the first measures that all of us should consider in the energy situation is that of making, through these two measures, the best utilization of the energy we have today as well as what will be available in the years to come. I know that you have already launched on an energy conservation program in this province and I commend you for it. I walked into the hotel room last night, switched the television on and the first thing I heard was one of your government slogans on energy conservation.

PREMIER CAMPBELL: I thought you were going to tell us the television wouldn't work.

DR. RENNIE: No, it worked fine. There are many situations we could discuss today with respect to energy efficiency and utilization, conservation, and so on. I picked out about ten here which I will run through very briefly. The first one, and of course one of our most expensive energy components in crop production, is that of fertilizer utilization. I think that we have to do more here with respect to optimum fertilization application related to soil test analysis. We have the technology to actually analyse soil and make fertilizer recommendations for all crops. Firstly, this testing should be utilized widely, more so than it is today across the country; and secondly, fertilizer applications should be held to the optimum. No longer can we follow the philosophy that if 100 pounds appears to be adequate, then 125 will be 25% better. That luxury, or waste, as it is more likely to be, must be eliminated. I understand that you already have a project started here on Prince Edward Island with respect to fertilizer response on your various soils and that is highly desirable.

Secondly, in the area of plant breeding, plant breeders across Canada are constantly producing new and better strains of plants. Agronomists should select and recommend and producers should utilize those new varieties that have high yield, short maturity, make maximum use of the growing season, and require minimum energy consumption during harvest. And it is amazing here - I think we could get upwards to 20% reduction in our energy utilization if we were to capitalize on all of those particular aspects. We talk about developing plants that will make maximum use of our growing season. Our plant breeders are attempting to change the shape and position of the leaf in order to make the greatest use out of solar energy, the same type of thing as we were talking about this morning, we try to position solar units to collect the most sun.

The third point is minimum tillage systems. The amount of tillage required for any one crop will vary from any one region to another because of such factors as soil type and climate but it is essential that minimum tillage system be used, coupled with optimum herbicide use. A realistic combination of tillage, seeding and

Dr. Rennie (continued):

pest control operation is essential. Cultivation methods which minimize energy consumption for unit of production, such things as reduced depth and number of cultivations, reduced depth of seeding, fertilizer placement, elimination of soil inversion and so on, should all be used in order to conserve energy in this tillage operation. I would estimate here that we can have an energy saving of between 20-40% if all of these were put into place across the entire agricultural industry.

I am going to talk very briefly about grain drying, another area where greater energy efficiency is possible. There is considerable work going on at the present time on efficiencies in the grain drying system. Savings of up to 20% are possible through improved air exchange systems and grain flow systems. We have become very wasteful in this respect: I am not sure we have to dry nearly all the grain that we do today across the country. We have high moisture grain storage systems using organic acids, like propionic, which will do a good job as far as the livestock feeding operation is concerned and which don't use any energy at all in the grain drying operation. In fact, it wouldn't surprise me if we would have a lot of saving if we even built a better corn crib and I think that is a possibility.

Another area which I think holds tremendous potential, short and long term, is the use of nitrogen-fixing crops and appropriate crop rotations. It has long been known that legumes have the capability of fixing nitrogen. Unfortunately legumes cannot be grown in all areas of the country but it is essential that we utilize these crops to the maximum because this is truly an energy alternative. Use of these nitrogen crops, such as alfalfa, in rotation with those lacking in this capability will result, without question, in considerable energy saving, granted it be indirect. One of the biggest research breakthroughs for future agriculture, which I am very optimistic about, is in developing strains of grasses and corn that have this nitrogen fixing capability along with specific management practices. Some interesting work came out of Brazil not long ago; certain strains of corn there are fixing considerable nitrogen, just like alfalfa. Now our climatic and soil conditions in Canada may be that much different that we could have some difficulty here long term in applying this technology, but I am optimistic. There is a lot of work started throughout the world in this area at the moment and we should watch it very closely.

The next point is what I call "once over operations". It may be possible to practice zero tillage in some cases but the most likely situation will be minimum rather than zero. Many farm operators are producing efficiently today with one or two tillage operations, compared to the two, three or four a few years ago. In other words we are getting up to 50% saving in energy utilization in that particular tillage operation.

Another example in this area, which is not really a once-over operation, but a reduction in number of operations, is in the area of

Dr. Rennie (continued):

monitoring. It has been proven that the number of spray operations for certain horticultural crops can be cut in half by utilizing and combining data on climate and insect infestation on a day to day basis.

Another area is machinery operation and maintenance. Real savings can be brought about through the proper maintenance and tuning of power equipment and through the proper balance of unit power with power requirements for specific jobs.

In the area of building ventilation and insulation, current studies are showing that farm building ventilation systems can be far more energy-efficient, and here we are talking primarily electricity, through greater attention to fan size and speed relative to air space, coupled to proper insulation. This could be a significant factor in the electricity requirement in the agricultural industry.

Somewhat related to this topic is the matter of energy savings in the tobacco kiln drying operations. We just finished one of our studies in Ontario and I just got the report the other day before I came down. We have found that we can get a 10% reduction in fuel utilization through the proper sealing and construction of tobacco kilns. This amounts to about two million gallons insofar as the Ontario tobacco industry is concerned, at a very low cost as far as the producer is concerned.

Use of long term energy-efficient species can result in savings: to some extent the most energy-efficient species of animals should be stressed in regions where energy supply is short and costs high. I would anticipate only minor savings in this area because major shifts in animal populations are extremely difficult.

Poor lands should be optimally used. One of the former speakers was talking about wood production and if we can use some of our poor lands for this and do it effecitvely, then there can be considerable savings. I think that the production of animals which can best use pasture land should be promoted; the use of class four and five land for pasture will release our better land for crops which can be consumed directly by humans. This is one of the types of production shifts that, as I was saying, we may have to look at in our agricultural system long term.

I have left until last the subject of energy management for greenhouse production. I think one of the most critical areas, energy-wise, within the agricultural industry in Eastern Canada, is that of greenhouse vegetable production. Studies are now underway in various locations to investigate various energy conservation techniques, such as temperature variation day to night, and various soil warming systems. I am optimistic about the possible savings in this area. In addition, and relating back to some of the discussion this morning, I can visualize in the future a real possibility of heating our greenhouses for commercial vegetable production through a combination of soil-warming techniques, solar heating and conventional

Dr. Rennie (continued):

energy sources. Some of the work underway at the moment is in what I call stage one, in which we are looking at the agronomic aspects - the growing of vegetables in greenhouses through soil warming techniques. The combination of solar and other techniques later will be stage two and stage three.

Let us now look at energy efficiency in food processing, packaging and distribution. Preservation, processing and distribution systems have been developed to provide the mainly urban population with agricultural products throughout the entire year, independent of seasonal cycles. Preservation techniques are also used for mass produced convenience foods, with packaging not only for product protection but for sales promotion as well. These techniques all place additional demands on the energy supply and the situation may arise in which it will be necessary to decide whether to provide energy for food production or for special processing and packaging. In the meantime, I think it is possible to use energy more efficiently in the food processing, packaging, and the distribution systems, including, three particular areas. In food processing, some recent advances include more efficient washing and peeling operations that use less water, and better sterilizing techniques are available and are much cheaper from an energy point of view. In the area of packaging, energy conservation measures could include minimizing the number of sizes of packages, increasing the size of individual packages, and eliminating unnecessary packaging which I am sure we have all noticed from time to time. And in the area of transportation, energy savings should be possible in transporting between the farm gate and the consumer. In some cases it would require better organization to eliminate duplication of movement, including to and from storage, to and from auctions, and so on. Similarly, duplication of handling and transport between processer and retailer must be avoided as well.

Now I look at planning for the future in three stages - the immediate, the short term and the long term. The various topics which I have discussed to this point basically fall in the immediate category. And they are related to the more efficient management and utilization of our present energy supply without a reduction of our food production. Although this approach may not seem very sensational as compared with developing new energy generating systems like solar power, it is nevertheless, in my mind, extremely essential. It is imperative that within the agricultural industry, we utilize every energy-saving technique possible to conserve current supplies and maintain cost efficiency in the food production system. In addition, this approach should buy us some time and I am serious when I say that, which I feel will be needed to effectively develop new alternative sources when current supplies of fossil fuels and other energy sources become scarce or cost-prohibitive. To effectively implement this phase, active producer, processer and consumer educational programs will be necessary and should be put into place as quickly as possible; I think you are well along that way at the present time.

Dr. Rennie (continued):

Another phase of an immediate plan is the implementation of a combined land quality and energy efficiency policy and program, as I explained a little earlier. There is no question in my mind that if we want to produce food and be energy efficient in agriculture, we must do our very best to have most of our foods produced on our class one, two and three land where we know we get a greater output per energy units input.

In the short term (I am talking about upwards to five years): from the resource papers I have read it would seem to me that as a province you have made a creditable start in this stage and you have had a tremendous amount of excellent data presented to you at the session here not so many weeks ago. The main features to be considered in a short term plan, I am going to summarize as follows:

A. Continuation of policies and programs which I discussed under the immediate plan, that is energy management, energy education and energy conservation, along those various means that I discussed earlier.

B. Development of an energy budget for agriculture. The basic data for such a budget you have already generated although it applies solely to the current situation. In studying the data on the present situation supplied to me and which all of you heard a short time ago, an energy budget over the next five years should be developed. What will that energy budget buy, what will the energy requirements be in agriculture five years from now? Such a budget could take into consideration possible shifts in agricultural production. Can the savings through the application of energy-saving techniques which I talked about and the application of new production and processing technology bring about a 2-3% savings in energy per year? I think so.

C. Establishment of an Energy Management Research Program. Fortunately, considerable research is already underway across Canada in the broad area of energy, including such significant projects as you have here in the Prince Edward Island Ark. For example, just last week I received a list with some 17 projects spread across Canada which are underway at the present time on waste heat utilization alone. Because of limited funds, no one institution or government is going to be the main researcher on this topic of energy nor should any of us attempt to be. I am convinced that to get the answers when we need them, it will require an effective pooling of all of our efforts across the country and across the world. I should add here that in Canada now, we have the Canadian Agriculture Research Council - I personally am involved in that - which will have published very shortly a list of all agricultural research in Canada, both public and private. This will be updated annually; it will be available to all governments and agencies and this should be a tremendous help to all of us in keeping up to date on what is going on across this country.

Dr. Rennie (continued):

A short term plan, and I feel that consideration should be given to the establishment of a resource team of specialists who can: a) keep well informed on the major research efforts in energy throughout the world; b) translate the results of such research into application technology for your own situation here; and c) identify those ones that are peculiar and highly significant to Prince Edward Island, for further research and testing should be done right here in your own area to really see if it is applicable. One of the speakers this morning referred to the use of public funds to support certain programs. It is very possible here that for such a team of resource people or specialists on energy management this is an area where public funds could very well be justified, because it would be of benefit to all producers and consumers within the province.

The long-term program up to the year 2000 would subsume, naturally, those features which are identified in both the immediate and short term programs. In addition I would like to suggest for your consideration the following:

A. The development of an energy budget for agriculture over the next 25 years. Again, as in the short term plan, such a budget must consider a possible shift in the agricultural production patterns. That will be a good problem for your Minister of Agriculture because that is not easy to know, what production shift will take place, but you have a pretty good idea. Such a budget must include effect of utilizing new production and processing, transportation and marketing technology. Also, it must include the priority which you as a government will give to agriculture with respect to energy, and the effect of continuing energy conservation techniques.

B. Along with this, I think the long-term plan should continue; you should continue monitoring energy research results on a national and international basis. And I do stress international here because the energy problem is international and there will be some tremendous research done in other countries of the world. We would be very remiss if we didn't utilize it here in Canada insofar as agriculture is concerned.

C. The continuation of energy management research and development programs would include two parts insofar as your province is concerned: a) testing under Prince Edward Island conditions of certain energy alternatives developed elsewhere and I think this has to be done from time to time; and b) the actual establishment on a continuing basis of a research program, such as the Ark. I would hope that whatever area of research you might select could and would become an integral part of the national thrust on energy research. We must avoid if at all possible unnecessary duplication because it is expensive. For example, and I hope I won't be criticized for pinpointing one particular example here, I would not like to see you starting research on methane gas production from animal waste because there is presently considerable work underway throughout North America, and also in Europe.

Dr. Rennie (continued):

There is a lot of work being done at the University of Manitoba in Winnipeg. We are not doing any studies in Ontario at the moment but we are looking at it and I know that we have looked at it from the standpoint that it doesn't look economic until up in the early 1980s, taking into consideration the supposed increase in other fuels at this point in time. I am just using that as an example of the type of thing that should be monitored to see whether or not it might have application here in Prince Edward Island, both short and long term. I have not attempted in this presentation to outline in detail a specific blueprint for energy alternatives in agriculture in Prince Edward Island. I do hope that I have been able to present to you ideas and some concepts worthy of consideration which may evolve into policies and programs suitable to your province, both short-term and long-term. Thank you very much.

PREMIER CAMPBELL: Sir, I think you ended with the best advice of all and that was to warn Prince Edward Island not to try to undertake original research in all fields of energy matters. One of the things we would like to do is demonstrate research as it may apply in some practical way to farming in Prince Edward Island and you mentioned a list of research projects and papers to be published. Did you refer to the National Agricultural Research Council?

DR. RENNIE: Canadian Agricultural Research Council, called CARC, established under CASC.

PREMIER CAMPBELL: Would that list, updated each year, give us a pretty good idea of what is going on around the world, or within Canada?

DR. RENNIE: Just within Canada. We will have a dry run of it presented at the CASC meetings in Ottawa next week, and then it will be printed shortly after that and be available to your government.

PREMIER CAMPBELL: How are we keeping in touch with research projects which are underway? You made specific reference to methane gas, I think that is a good illustration. How do we all inform ourselves as to what is going on at a particular moment in time, or what work has been done in the specific field?

DR. RENNIE: I don't think we are doing as much as we should be really, however, we have more and more diesel tractors, which I think is desirable. Some work is going on, I think at the University of Saskatchewan, developing a meter which would not be expensive to fit on tractors which tells which gear you should be in for the proper load, in order to get the most energy efficiency for a particular type of operation. I think that was what I was talking about here a little bit, balancing power of the unit for the job to be done. There are the, I think they call it, Nebraska tractor tests where they do rate all tractors with respect to their power output and these are fairly reliable. I think these are some of the maintenance things that we would have to look at more and more.

MR. STEWART: Are manufacturers moving toward a motor that will consume less energy per horsepower?

DR. RENNIE: They might be, I don't know of it if they are, sir. I would expect they are looking at it.

MR. MCINTYRE: I was wondering, Dr. Rennie, about something mentioned earlier, with regard to three phrases in your presentation: "energy budget for agriculture","the greatest user of energy", and "high priority for fuel for agriculture purposes". Were you suggesting here that there should be some restrictions on other areas of fuel consumption?

DR. RENNIE: What I was getting at there, sir, was that the data already presented to you by Dr. MacLeod, contained a tremendous amount of material which gives you a good picture of energy requirements for agriculture in Prince Edward Island today, and that's basically an energy budget of 1976. I think we should look down the road and develop an energy budget for 1985, and year 2000 as best we can, to see what our real energy requirements will be, taking into consideration these other things and any land use policy you might have in this respect. Also, I think we must utilize all these energy-saving methods, the application of technology, in order to make sure that agriculture is energy-efficient, and then somewhere along the way we have to decide, and I am not referring just to you people here, but to all of us in the various provinces, what priority we might give to agriculture with respect to a limited energy resource.

MR. MCINTYRE: I am very interested to hear that comment. It seems that this has been a theme during your presentation and I was quite pleased with that. The other thing I probably disagree a little bit with was your reduced cultivation for agricultural purposes; I am wondering what the saving would be in this area.

DR. RENNIE: Well, I think it could be up to 50% because every time you go over the field with your tractor, assuming about the same draw or load, you are going to use about the same amount of fuel. Some of our good operators I was talking to some just last week, some real top flight operators down in the Southwestern Ontario region, had been down to one operation but have gone to two, which is still much better than the three and four previously practiced. This is mainly for corn. So, in other words, they are sticking to two operations for their total seed bed preparation and seeding and herbicide application, so you are talking 33% to 50% saving basically in this sort of operation. Now it is going to vary from crop to crop so it will have to be looked at on a crop by crop basis. On some you may not be able to save at all, sir.

MR. MIDDLETON: Thank you, Dr. Rennie.

I think the one thing that is abundantly clear from this presentation is that we are not dealing with simple answers; we are not going to find the universal fuel that we are looking for this morning. Rather it is going to be through pretty complex changes throughout our whole system, our agricultural system, and our other systems, that are going to result in our being able to maintain a sound economy, and a decent standard of living. Some of these changes are going to be relatively easy to make - minor adjustments in management; some of them are going to be major. Perhaps we are still thinking in terms of how things are, and were. I suspect that today we have only hinted at some of the great changes that are going to come about in the next 25 years. There is no reason to believe that the next 25 years aren't going to see as many changes in agriculture and in any other field as we have seen in the last 25 to 50 years, and that is a hard thing to grasp when you are really sitting down to plan. If we can anticipate some of those changes, as difficult as it may be, then we are going to be in a lot better position than if we try to plan for the future assuming a pretty static present. The final speaker today is Roderick MacDougall, from IBI Group, Transportation Consultants, and his presentation, as might be expected, parallels in many respects to Dr. Rennie's. He is going to deal with prospects for changes in the way we conduct our transportation.

Transportation Alternatives

MR. RODERICK MACDOUGALL: Thank you, Mr. Middleton. Mr. Speaker, Mr. Premier, Members of the Legislature, and ladies and gentlemen, it has been a long day. You have been bombarded with information from all sides, and about all aspects of energy. Dr. Rennie is a hard act to follow and I will try to keep my remarks brief.

Just as an overview and review, the energy issues in Canada and in Prince Edward Island are briefly as follows: Canada is currently a net importer of petroleum. The imports themselves amount to approximately 40 million gallons, just under a million barrels of petroleum daily, and these imports are subject to inflationary pressure, as you've certainly experienced in this province, and to policies established outside this country. Therefore, the security of the supply is not completely guaranteed.

As to the domestic supplies, it is quite incredible to consider that we have already consumed a high proportion of petroleum energies in proven reserves in Canada in a matter of a few decades, primarily since the last World War; and that as our consumption increases, the investments required to bring this petroleum on scene are massive, in the order of $10 billion and up. And these massive investments, while perhaps in the short-term maintaining the supply of petroleum energy in Canada, do not in any sense of the word assure a long-term potential for continuing increasing petroleum supply. We are talking of generations in the future and we certainly don't have proven or even potential reserves which can supply those generations without very significant capital inflow. Maybe that is the most significant aspect of finding future petroleum energy, and that is the potential dislocation to the economy of the country, and the economy of its provinces, that such investment in development of new reserves will create. Therefore, the question of management of demand and conserving demand for energy becomes a very important part of any energy program.

Mr. MacDougall (continued):

Focussing now on transportation energy, which is the subject of my comment this afternoon, approximately 25% of all Canadian energy consumption is by the transportation sector and fully 50% of all petroleum energy is consumed by the transportation sector. Further, the transportation sector is very heavily, in fact, virtually completely dependent on petroleum: 99% of the transport demand is met by petroleum currently and there are no innovations emerging at the moment, except for the comments of a previous speaker about wood-burning automobiles, to significantly change this dependency on petroleum. Therefore, more than in any other sector of energy consumption in Canada, it is important to efficiently utilize petroleum resources in the transportation sector.

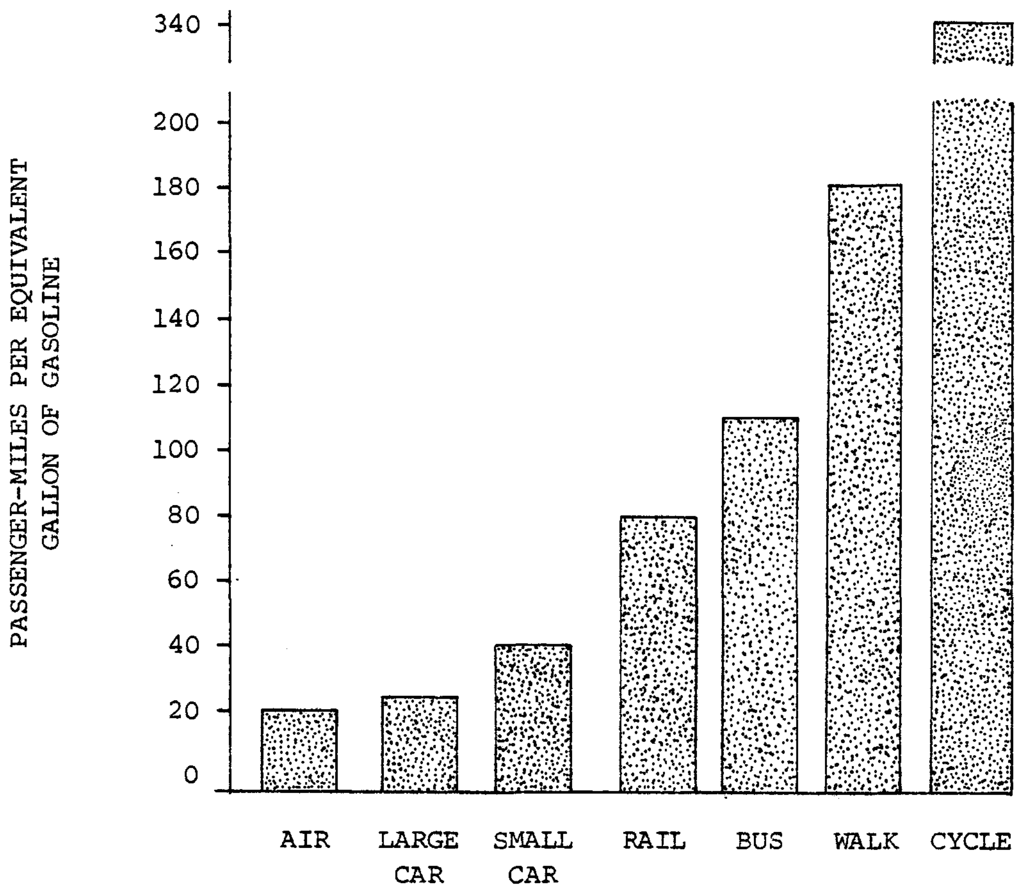
Now, coming down to the issues in Prince Edward Island, and primarily those related to passenger transportation, the first is that there is no public transportation system, except taxi services in Charlottetown and Summerside, available in Prince Edward Island. The rail passenger service was discontinued almost a decade ago, the bus service that was operating on the Island is not operating any more, and therefore the only alternative for most trips beyond a normal walking distance is the automobile. There are some congestion and parking problems in Charlottetown and these are exacerbated by the summer tourists. Turning to the automobile itself, there are approximately 40,000 currently registered automobiles in the Island and they consume about 25 million gallons of gasoline each year. That's about 625 gallons per vehicle, and if you consider that approximately 60% of the trips are within communities or urban, and 40% are inter-urban or between communities, then you can get some impression of how much travel is created by automobile in Prince Edward Island to consume that 25 million gallons of gasoline. Figure 44 gives a brief glimpse of fuel efficiency of alternative modes in passenger miles per equivalent gallon of gasoline. Some of these modes, in the case of air, do not consume gasoline. On the right hand side of the chart are shown the walk and bicycle modes which don't consume liquid fuel - they are human resource modes of transportation. But you can see that, for example, the bus load, that is an urban bus load, is at about 110 passenger miles potential per equivalent gallon of gasoline, as compared with a large automboile and an airplane which is down about 20, so there is about a five to one ratio between those two modes which are readily available for passenger movement - bus and automobile. Of course, the most efficient mode of transportation in terms of energy consumed - it consumes no petroleum energy - is the bicycle and if we got everyone to cycle, they would consume less energy and become more fit at the same time.

MR. MCINTYRE: How long would it take to get to Montreal?

MR. MACDOUGALL: Well, it depends on what kind of physical shape you are in. Don't do it in the winter.

I am covering in my comments four areas that offer opportunity for energy saving. One is more efficient use of existing vehicles

FUEL EFFICIENCY OF PASSENGER TRANSPORT MODES



NOTE: Relative efficiencies relate to a given load factor.

FIGURE 44

Mr. MacDougall (continued):

and facilities, such as automobiles. The second is the introduction of new, more fuel-efficient services. I think that at the present time in Prince Edward Island, and in fact in any other province or state in North America, the automobile is the most convenient mode for virtually all travel. It is a multipurpose vehicle that is used for work, shopping, pleasure, recreation, what have you. I anticipate we will see, with the squeeze on energy supplies and the consequent increase in price of energy petroleum energy, that the automobile will become a much more special-purpose travel mode - you will use it for particular purposes but not for all purposes and it will be replaced by other modes which are more fuel-efficient, albeit perhaps not quite as convenient.

A third area which offers promise of significant energy savings is more efficiently engineered vehicles - that is the basic automobile itself.

And the fourth is the reduction in overall demand by eliminating unwanted trips or by converting some of those trips to other than automobile method of travel.

Dealing with the first of these - more efficient use of existing vehicles - we can talk of, for example, much more extensive use of shared taxis and I understand that on an informal basis now, the taxi companies operating in Charlottetown and Summerside do provide multiple ride services. I don't know whether they give you a reduction as a traveller for that service but often you find you are sharing a cab with someone else. There is nothing wrong with that; the level of service is a little lower, perhaps, but the fuel efficiency is significantly higher and presumably if the legislation provides it and establishes a guideline for the taxi companies, you can also save money as a passenger in using such services.

One other method of increasing the efficiency of the automobile is trying to encourage car pools. Now this is not very practical for dispersed trips with not too many people travelling between two given points, but in urban areas, or in the main corridors of travel of Prince Edward Island, it may be possible. And again, it requires a more detailed analysis to come up with a good estimate of the potential savings involved and it would also require a pretty significant educational program to convince people it is a good idea and to provide a framework and a basis for car pooling.

Table 30 translates in a general way the potential savings in Prince Edward Island as compared with the 25 million gallons of gasoline presently consumed each year if we look at car pooling and shared taxis. For example, we can see 1.9 million gallons of gasoline saved per year, if you get a fairly extensive network of shared taxis operating and some encouragement for car pooling.

Now the second measure shown is the reduction of speed limits and Figure 45 shows the average consumption of gasoline in miles per imperial gallon, by automobile and by average truck, with speed, and you can see that the line reaches a peak for the automobile of just under 40 mph and thereafter the fuel consumption goes down. If you

MORE EFFICIENT USE OF EXISTING VEHICLES AND FACILITIES

	POTENTIAL SAVING (MILLIONS OF GALLONS OF GASOLINE PER YEAR)
CAR POOLING AND SHARED TAXIS FOR URBAN TRAVEL	1.9
REDUCING SPEED LIMITS BY 10 mph FOR RURAL TRAVEL	1.2

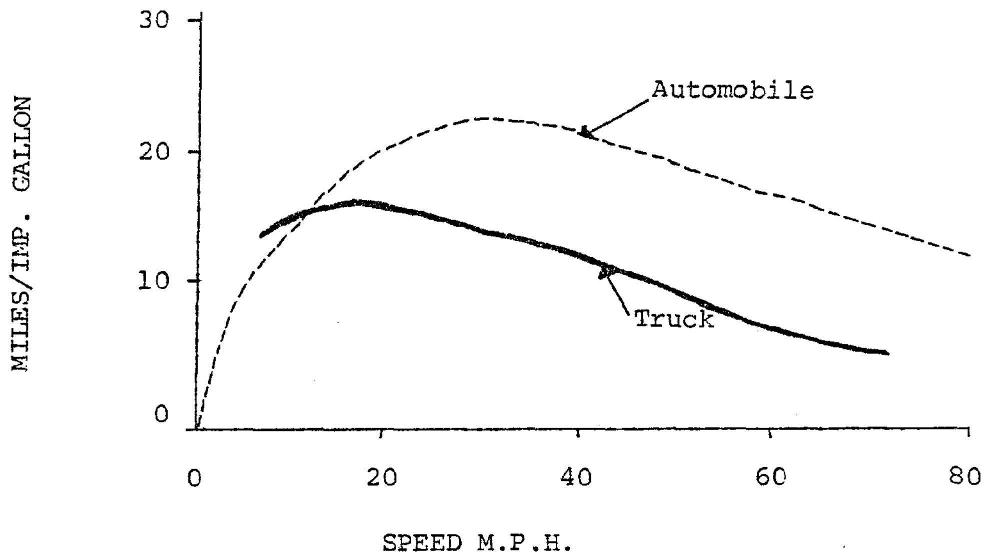
TABLE 30

INTRODUCTION OF NEW, MORE FUEL EFFICIENT SERVICES

	POTENTIAL SAVINGS (MILLIONS OF GALLONS OF GASOLINE PER YEAR)
RURAL BUS SERVICE TO CAPTURE 5% OF PASSENGER MILES	0.3
URBAN TRANSIT SERVICE TO CAPTURE 25% OF URBAN TRIPS	1.5

TABLE 31

AUTOMOBILE FUEL CONSUMPTION EFFECT OF SPEED



Source: Highway Research Board Report 133

FIGURE 45

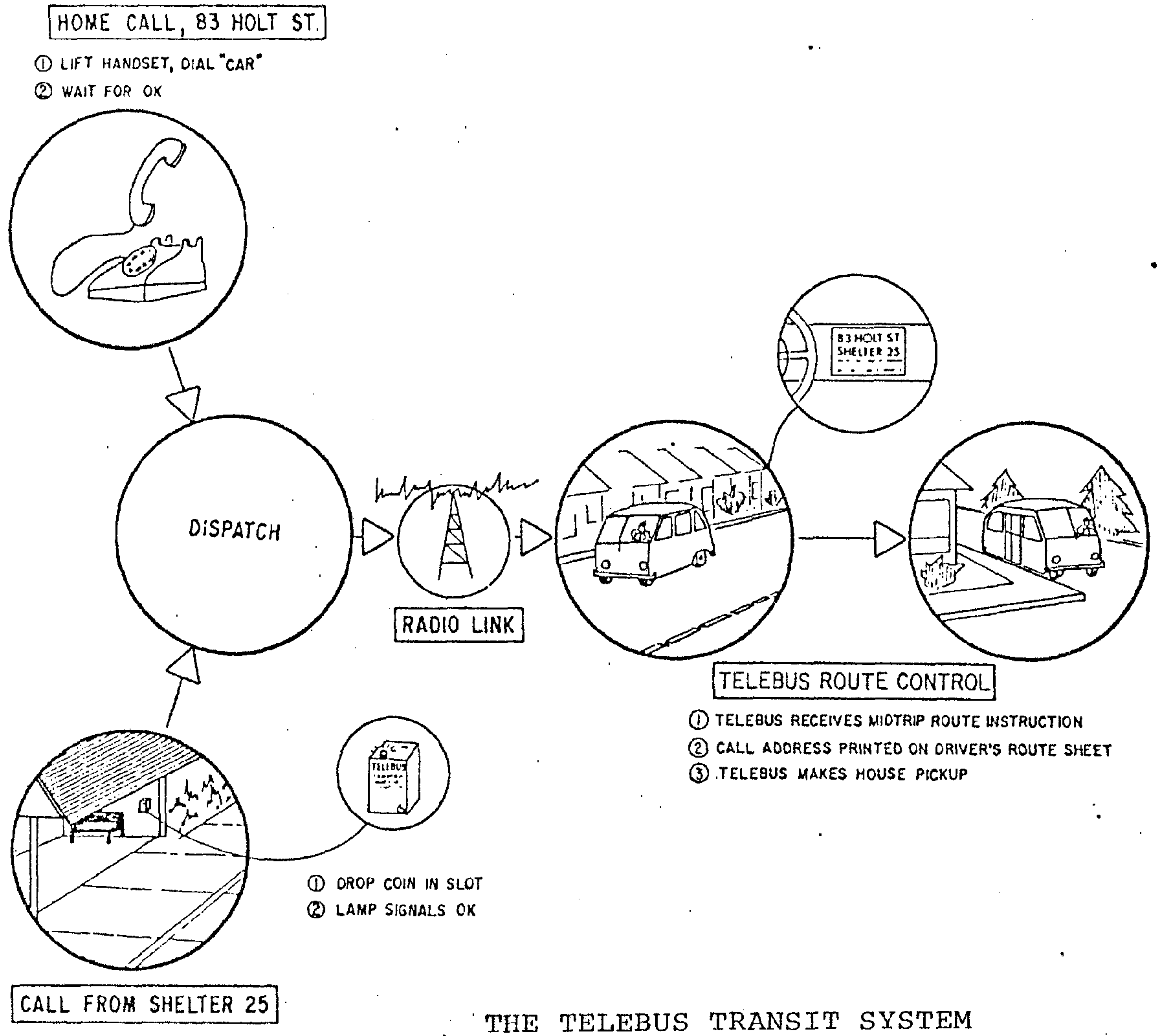
Mr. MacDougall (continued):

consider the slope of that line, it says that for every 10 mph reduction in speed, that is moving from the right to the left, from say 50 to 40 mph, you get a 12% saving in fuel, or 12% higher fuel economy. If you translate that into rural travel in Prince Edward Island, the potential is in the order of 1.2 million gallons savings per year, if you effect a 10 mph reduction in average speed on the rural road, for rural travel.

One other possibility, as I mentioned earlier, is the introduction of new, more fuel-efficient services (see Table 31). The first of these I have shown is rural bus service and the estimate here is that if you have a decent rural bus service, inter-urban, you can perhaps capture up to 5% of the inter-urban passenger miles. You might ask why only 5%? Well, one of the reasons is that the population of Prince Edward Island is pretty dispersed in small communities and spread around the Island. By the Statistics Canada definition, Prince Edward Island has about half the population in urban centres that the average of Canada indicates, something like 40% in communities 1000 or more, the remainder being in rural communities and it is very difficult to serve that kind of travel between small communities with a good bus service that will attract people. So we have assessed a 5% capture of that travel market to rural service and a potential savings of .3 million or 300,000 gallons of gasoline per year, which is what is consumed now by 5% of the passenger miles in rural travel in Prince Edward Island.

Now, one has to look very carefully at this kind of service because if it isn't designed efficiently, that is to say it doesn't capture that 5%, it could cost you in public subsidies a lot of money, well in excess of what the fuel would cost to the automobile driver. That applies to any kind of public transit, not just inter-urban. Now, we have also set a target of 25% of urban travel in essentially Charlottetown and Summerside, as being a market which could be captured by more fuel-efficient public transit and that would have, if you achieve that goal, a savings of a million and a half gallons of gasoline. That takes into account the trips that are made by automobile now and the fuel consumed by the urban bus system to carry those same people as a net difference.

Now, one way of providing a very attractive system to people who are used to using the automobile and might not be too inclined to using public transit, is the dial-a-bus service. (Figure 46). It is called here telebus. It involves someone who wants to travel to another point in the community telephoning a dispatcher, the same as one telephones a taxi now. The despatcher organizes the calls in a logical route and gives the passenger an estimate of when he will be picked up. The despatcher then communicates this information to the driver of the vehicle who travels around on the assigned route of that particular trip picking up the persons and dropping them off. It can be a door to door service, or it can be what is called a mini-to-one, where you are picked up at your home and taken to one



THE TELEBUS TRANSIT SYSTEM

FIGURE 46

Mr. MacDougall (continued):

central point, such as the central part of Charlottetown. Then when you want to come home, you can go to that same point and pick up the bus which will take you to your door. Now this has proved in other communities of Canada to be a very attractive first-phase or supplemental phase public transit system. In a community of somewhat the same size as Charlottetown, a suburban community of Metropolitan Toronto called Bramalea, which had no bus service, the dial-a-bus service was an immediate overwhelming success. One thing about dial-a-bus service, it is a low density service. The service in Bramalea was swamped, it was killed almost by its own success, but now they are going from dial-a-bus into a fixed route service with larger, more efficient vehicles, so it is one way, one strategy, if you will, of entering the market of public transit and providing a more fuel-efficient service to members of the community.

The third area of potential for improving fuel efficiency is more efficient automobiles themselves (Table 32). While this is outside the capability of the Province to legislate, it is interesting to note that there are a number of things that can be done to the standard automobile to make it more efficient. First is weight. Now, about 60% of all vehicles on the Island are full-size vehicles. If it were possible, for example, to achieve a decrease in their size over time as a result of attrition and replace them with smaller vehicles, a 2.1 million gallon savings per year is possible. Just as a rule of thumb, an automobile consumes about 1.4 times its weight in fuel every year so there is a direct correlation between the weight of the vehicle and the fuel consumed. If all presently automatic transmission vehicles were converted to standard gear drive transmissions, there would be another substantial saving as a result of a more efficient transmission of power inherent in a standard transmission engine and you are looking at another saving here of 2.2 million gallons per year, based on the number of cars that are registered at the moment. Then, there are various other supplementary benefits you can get through more efficient fans for cooling, alternators for charging and running the electrical power in the car, more efficient axle ratios (you then sacrifice performance for better fuel economy), there is another approximately three million gallon savings per year. As I'm sure you all know, the result of emission control devices to curb or reduce pollution produced by an automobile, is to reduce mileage as well. I am not suggesting this, or advocating it, but if you went back to the 1968 fuel emission standards, you would save 1.1 million gallons of gasoline per year.

The fourth area is to try and encourage people to walk more and ride bicycles more. That is hard to do, perhaps in the winter, but it is not so hard in the summer. The major means available to do this is public education, convincing people it is important to walk for their good health and also to participate in the conserver society which Prince Edward Island is laying a foundation for now.

ENCOURAGEMENT OF MORE EFFICIENTLY ENGINEERED VEHICLES

	POTENTIAL SAVINGS (MILLIONS OF GALLONS OF GASOLINE PER YEAR)
A 500lb DECREASE IN WEIGHT FOR ALL FULL SIZE CARS	2.1
MANUAL INSTEAD OF AUTOMATIC TRANSMISSIONS	2.2
MORE EFFICIENT FANS, ALTERNATORS, AXLE RATIOS	3.0
IF ALL CARS LATER THAN 1973 HAD 1968 EMISSION CONTROLS	1.1

TABLE 32

Mr. MacDougall (continued):

There are other methods, including investment in pleasant walkways and bicycle paths and through the design of communities, which are now focussed on the automobile. People have to make most trips by car because they can't walk. Communities are generally fairly low density, with community facilities centralized. If they were dispersed more, closer to the fabric of the community, people could walk to them more often than to have to drive to them. If 10% of urban trips were converted from the car mode to walking or bicycling, .8 million gallons of gasoline could be saved annually.

As a summary then, the measures that I have talked about briefly today are summarized in Table 33. They are not in order of priority. On the right hand side is shown the measures which the province needs to consider in implementing these various opportunities. In the case of urban transit, the first thing to do, obviously, is to design the service; then it is important to provide a good level of public education which will establish why the service is being provided, what trips it is important for, and generally to try to encourage people to use it. And then there is the very important part of co-ordinating your transportation policies so that public transit, if you do install it, can play an important function in the community - you do not offer free parking downtown at the same time as you are providing public transit, for example. In the area of shared taxis and car pooling, again one of the primary emphasis here in implementation is public education. Also, you might consider giving priority parking or priority access to such vehicles, multiple-occupancy vehicles, or shared cabs, and legislation is perhaps required in the case of shared cabs, to provide the basis for and the agreed rate structure for shared cabs. In the area of walking and cycling, again the primary emphasis is on education. The reduction of speed limits requires legislation, education and policing. In the case of rural bus, again it is service design, and the possibility of considering a vehicle mileage tax. This is a car pricing if you will and would be a disincentive to people taking their car for long trips as opposed to going on the bus. And in the area of increased efficiency of vehicle design and engineering, with the largest single cumulative savings, you are talking about mainly senior government action to implement those changes, but there is a big component of public education for the residents of Prince Edward Island to understand the energy implications of those big cars they are driving around. And one novel idea, you can drive up now to a gasoline pump and they will give you different premiums of gasoline at different prices; one thing you could consider - and I am just tossing this out as a top of the head suggestion - is that instead of dialing for increased price for higher premium gasolines, you dial up the dial for the big car or the big gas consumer and you dial down the dial to the same quality of gasoline but a different price for a smaller vehicle. And then there is the question of progressive taxation of licencing for larger automobiles as opposed to smaller automobiles. Now, while all of these add up to something

POTENTIAL ALTERNATIVES	POTENTIAL SAVINGS IN MILLIONS OF GALLONS/YEAR	IMPLEMENTATION MEASURES
URBAN TRANSIT	1.5	Service Design Public Education and Demonstration Co-ordinated Transportation Policies and Pricing
SHARED TAXI/CAR POOL	1.9	Education Priority Parking, Access to Multiple Occupancy Vehicles Assistance and Incentives
WALKING/CYCLING	1.5	Education Investments in Facilities
REDUCE SPEED LIMITS	1.2	Legislation Education Policing
RURAL BUS	0.3	Service Design Vehicle Mileage Tax
INCREASE EFFICIENCY OF VEHICLE DESIGN AND ENGINEERING	5 - 7	Senior Government Legislation and Guidelines to Manufacturers Public Education Government Tax Incentives to Industry and Researchers Registration and Tax Incentives to Small, Light Vehicle Purchasers Gasoline Taxed Progressively

TABLE 33

Mr. MacDougall (continued):

like 12 to 14 million gallons per year, about half your present consumption, there are overlaps. Also some of the benefits can only be achieved in the long term, for example, if you are changing the vehicle mix, you have to go through the cycle of attrition of the present vehicles before you can introduce a substantial component of smaller vehicles. So if you are looking at a realizable target program you might be talking about more like 25% of the present gasoline consumption as a target savings. As Dr. Rennie suggested earlier, and as this table also points out, there is no single solution, just as there is no universal energy source. The savings in gasoline consumed in Prince Edward Island will result from a number of co-ordinated program changes which will effect the mix of vehicles, the way people travel, and the general awareness of the population that energy conservation is mandatory in the future in Prince Edward Island. Thank you very much, and I am now open for questions.

PREMIER CAMPBELL: Thank you very much for your contribution. Are you aware of such schemes as progressive registration fees for automobiles so that the bigger the car you buy, the more you pay to have it registered?

MR. MACDOUGALL: No, but most provincial license fees are graded according to weight, engine displacement. But there is a progressive licensing of vehicles at the present time, with the larger, more energy-consuming vehicles having to pay a higher license than the smaller vehicles. This is also true in Prince Edward Island. One must bear in mind, though, that the license fees are a small proportion of annual costs, something like 2 to 3%. So unless you consider a very significant escalation in those license fees, it won't be a major deterrent to purchasing large, fuel consuming automobiles.

PREMIER CAMPBELL: Well, I am aware of national legislation that limits the size of the car in some countries to let's say a Volkswagen or an Austin, something of that size, and in other countries to the size of an intermediate car. But the registration fees that apply in North America go up to $45.00 for the biggest car on the road, and that from a person who had paid perhaps $640 sales tax to buy it, so that is not much of a disincentive at all.

MR. MACDOUGALL: No, peanuts, it really is. The Minister of Energy, Mines and Resources, a couple of months ago introduced a program of fleet average performance, which for a given automobile manufacturing company, will establish by 1980 what their sales-weighted average fuel consumption must be. It is, from that point of view, a legislated mileage performance standard, which will affect all Canadian sales and affect the mix of the vehicles that the manufacturers are putting on the market. But license fees of and by themselves unless they are drastically increased by a factor of perhaps ten, won't have much impact on the mix of vehicles that are on the road.

DR. MALONEY: Do you think one could justify emission controls as a national program? In other words what I am saying is a town like Los Angeles which is in a bowl and very hot, etc.,may require strict controls. But in the Maritimes, for instance, where it is blowing all the time and with no high population density and considering how inefficient our emission controls are, it is hard to justify each person not taking that off his car as soon as he buys it, isn't it?

MR. MACDOUGALL: That is right. I would agree with you. The Canadian emission control standards are less severe than the American and the California emission controls standards are the most stringent. Certainly in Prince Edward Island I don't think there is any real need for them because there are no significant clusters of population and there are no climatological conditions which suggest that it is important that you have them. Every day is a clear day.

PREMIER CAMPBELL: Many people in high places have suggested that air passenger transport is by far the most efficient means of transport but your graph has indicated that it is the least efficient from an energy standpoint.

MR. MACDOUGALL: I'm not sure to whose remarks you are addressing yourself, but for long haul air travel, certainly the airplane is the most convenient. I think there are lots of opportunities for substitution of surface, either bus or rail, for short and intermediate travel, which are more energy-efficient. Now the graph that you saw was, is effective at 100% load factor or it is effective at a 50% load factor, but it doesn't reflect the present use. If you are comparing rail with air, you will find that by virtue of the low load factors on the passenger rail service now in Canada, the air service is more efficient today because it gets higher load factors. In fact, the rail passenger service in many parts of Canada is less efficient than the automobile, just by virtue of the fact that it doesn't attract high load factors. So to make that mode more attractive you have to consider major capital and marketing improvements to attract people to the service so as to replace air travel for short and medium distance travel.

MR. MACPHAIL: You spoke of introduction of new, more fuel efficient services: well, over the years one has heard from time to time about fuel saving devices that have been patented and perhaps the suggestion has been that oil companies or others have bought these patents and as a result these have never become available to the public. Is that a problem?

MR. MACDOUGALL: I tend to think not. About a year ago there was a developer in the United States who had come up with a magnificent new carburetor which could give twice the mileage on a standard car just by being installed - that was his claim. It was tested by the Environmental Protection Agency and various motor companies and found wanting. In other words, there is a lot of hot air in some of the claims. I don't believe, particularly in today's environment where governments are intervening so strongly in the automobile industry to encourage and promote more efficient automobiles, that the automobile companies or the petroleum companies would hide these from the public. It would just destroy their credibility completely. As an example, the North American automobile industry is investing something like $20 billion, a phenomenal sum, in re-tooling and changing the whole mix of their cars and within five years or so the standard size automobile will be a small proportion of what they sell every year.

MR. MCINTYRE: Following Dr. Maloney's remarks a few moments ago and also, sir, I think your remarks, that cars coming into the Maritimes would not need pollution control, do you see a possibility of a recommendation from the Federal Government to the car manufacturers that cars would be made available to the Maritimes without these controls?

MR. MACDOUGALL: Of course, it is pretty difficult for the Federal Government to do that because you might buy a car in the Maritimes and move somewhere else. The other thing that encourages standardization is the automobile companies themselves - when they have got it on the line and it is a standard component of their product, it costs them more to take the emission control device off that it did to put it on in the first place. You are almost strapped in to a national standard for those two reasons.

MR. DINGWELL: From all this discussion today, it is apparent that technology has kept abreast of, or ahead of the demand of the day, and I suppose we can foresee this in the future in regard to new technology for energy and power. I was wondering how we control this technology. As time goes on it seems to me the more technology that we discover the more dependent people become on society in general. Is there any possibility of managing new technology on the basis of an average person's need, so he won't become a dependent creature on society and the rich won't get richer and the poor get poorer, as often has been the case in the discoveries of new technology?

MR. MACDOUGALL: Well, certainly you painted a very clear picture of the way society has evolved in the past decades, and is headed in the future - that with increasing technology to advance our standard of living, we become increasingly more dependent on others to get along. Fifty years ago we depended largely on ourselves with the help of the local blacksmith and maybe a neighbour once in a while to sow our crops and reap them and so on; but now as we become more urban and more specialized, by virtue of the technology that we are developing, why we become more dependent on others and that is an unfortunate fact of life that I don't see any real way around. I think your comments alluded to the fact that instead of having automobiles which allow everybody to drive around and be independent, here we might be introducing things like public transit, so that they have to depend on someone else, and society as a whole, through government. Government financing becomes responsible for that service and it is just another one of the proliferating range of services that is available to the community by government. But, having said all that and summarized your comments very well, I don't have very much to offer in the way of a suggestion.

MR. DINGWELL: Society in general can take advantage of those techniques, rather allowing such a built-in profit for the few.

MR. MACDOUGALL: Well, again, if you are going to be buying things in the marketplace, like an automobile, bus or bicycle, you become automatically dependent on others, and it is almost a fact of our way of life, and that is the way we have to go to maintain our standard of living.

MR. DINGWELL: I am wondering in this context if this should not be our problem for the future, rather than that technologies don't keep ahead or abreast of the need of the day. They have, since the discovery of the wheel, but how to control that technology by society in general should be the prime subject of our discussions.
MR. MACDOUGALL: Oh, indeed, there is no question about it.
MR. WELLS: Mr. Dingwell, you are going to completely preempt tomorrow's program.
MR. MACDOUGALL: I think he just set the tone for it.
MR. DINGWELL: I am not a socialist but I believe in social justice.
MR. MCINTYRE: I was wondering something else. Regarding manufacturers, it seems after the war there was a car came out, I think by the name of Kaiser, and it seemed to be recommended in specifications that you run it in overdrive after and above 40 mph which seemed like a fairly economical idea. Has this ever been thought of or discussed with the car manufacturers in recent years?
MR. MACDOUGALL: Well, certainly many, particularly smaller automobiles have the standard gear shift transmission and do have overdrive, or fifth gear. That is one of the things I meant by increased efficiency of design, through better axle ratios (you are reducing your axle ratio), sacrificing some performance, but getting better fuel economy as a result of it.
MR. MCINTYRE: What are the manufacturer's views on this?
MR. MACDOUGALL: The tendency has been in the design of automobiles to go for more power in the engine, rather than more power through better gear ratios, and that is why a fifth gear, or an overdrive, as you call it, has only been on small cars, because they don't have the performance in the engine. But if you squeeze the performance in the engine to reduce fuel economy, then it makes sense to put in the fifth gear.
MR. MCINTYRE: You could still use this on the open highway, on straight driving where you don't require so much power. I don't see why it wouldn't be a sensible move to conserve energy.
MR. MACDOUGALL: It is eminently sensible, and the only reason it hasn't been maintained as a practice is because fuel has been cheap and there was no real interest in fuel efficiency. Therefore the idea of the overdrive, which you say came in after the war and has been around for some time, has never been maintained. And for the same reason, you went from a standard transmission to an automatic transmission, because you don't have to do any fiddling with your hands but you sacrifice fuel efficiency by going that route.
PREMIER CAMPBELL: You didn't indicate the feasibility of battery-operated automobiles.
MR. MACDOUGALL: No, I didn't, because the research and development in this field has not come up with a good battery at this point in time, and there is nothing on the horizon to suggest that a very efficent fuel cell will be developed in commercial operation in the near future. You have to go through two sort of sets of fuel inefficiency to get a battery performing: you have to generate the power somewhere, transmit it through normal transmission systems, and

then generate the battery which then has to deliver the energy to the car. At the moment the only battery operated vehicles are extremely heavy and very inefficient in their conversion of electrical energy into direct drive power.

MR. WELLS: Thank you, Mr. MacDougall. That concludes today's discussions. I would like to thank the speakers, and especially Mr. Middleton, who helped assemble this comprehensive program. Tomorrow we will examine some political, social and economic aspects of energy.

April 13, 1976, A.M.

7. ENERGY FUTURES

MR. ANDREW WELLS: Good morning, Mr. Speaker and Members of the Assembly. Today, our final day of Energy Days, we look at Energy Futures. We will attempt to examine some of the social, economic, and political questions surrounding the whole matter of energy. At the end of the formal presentation this afternoon, we are going to have all of our participants engage in discussion among themselves and with Members of the Legislature, on the matters which they presented to the House today.

Our first speaker is a Canadian of some considerable background and reputation; it's almost impossible, without taking some considerable amount of time, to list his many activities and achievements; I'll just go through a few of them. Mr. Ronald Ritchie, in 1974-75 acted as Principal Assistant to the Official Leader of the Opposition in the Federal House, Mr. Robert Stanfield. Prior to that he spent many years with Imperial Oil Limited on the Board of Directors as Vice-President and, in 1971, as Senior Vice-President. Prior to that he was with the Wartime Prices and Trade Board, Ottawa, and prior to that he lectured in Economics at the Ontario Agricultural College in Guelph. Among his many activities are membership in International Institute of Applied Systems Analysis in Vienna and the Club of Rome. He is on the Advisory Committee of the Institute for Northern Studies in Saskatchewan. And of course, many of us will best remember Mr. Ritchie as the founding father of the Canadian Institute which is now operating and is known as the Institute for Research in Public Policy. So with that brief and somewhat inadequate introduction, I would call on Mr. Ritchie.

Energy Options for Canada

MR. RONALD RITCHIE: Mr. Speaker, Mr. Premier, Members of the Legislative Assembly, it is an honor for me to be invited to appear before you, in what really is an innovative project you have been engaged in. Although the theme for today is Energy Futures, I am going to spend more time talking about energy past and present because it seems to me that if we want to understand the future in almost any field, and certainly in this, we need to understand where we are and how we got here. If, for instance, people had understood where we were and where we were going, perhaps there would be fewer people on this Island and in Nova Scotia heating their homes with electricity at this very moment because what has happened was predictable, but it wasn't being predicted to the right people. Therefore the exercise in which you are engaged today occasioned by the so-called energy crisis is very important indeed; it may help us avoid errors in the future. Let me then talk about three or four things that, it seems to me, are very important in explaining our present position and very important as a foundation for our thinking about the future of energy.

Mr. Ritchie (continued):

First off, why is energy important to us? An elementary question but it is one worth thinking about at least for a moment because it is a fact that, for most human beings who have lived on this earth, the kind of energy we are talking about has not been important. The human species has not used mechanical energy, if I can use that phrase, very extensively for very long. We all know that most human beings have been dependent to a large extent on their own limited human energy for what they could produce. But the key is that they were only able to produce more or, in another sense, to raise their standards of living, by more and more extensive use of outside sources of energy. It is hard to say which came first, animal power or wind and water power, but through most of human history those were the chief aids that were available. As a matter of fact, it is not so long ago that they were still pretty important. I grew up on a farm in Ontario, and at that time we had no tractor; we had horse power and human power. We weren't very large users of energy. But agricultural productivity in this country and elsewhere has grown apace because of the rapid introduction of energy, not just in mechanical forms, but also in the form of fertilizer, for instance, which is a form of energy.

Now, we all know that this period of big independence on energy is a relatively brief one in the span of human history. Until about 200 years ago, when industrialization began in the United Kingdom and Western Europe and North America, there wasn't much use of energy and that, of course, touched only a small portion of the world's population. But beginning with industrialization, we have learned that we can multiply our output substantially, raise our standard of living, to use other phraseology, by introducing as supplements to the traditional forms of energy, new forms of mechanical energy. And we have increased the demand for energy at a very rapid pace, in the industrialized world particularly.

Throughout this century the demand for energy throughout the industrialized world has been multiplying at percentage rates which, when you consider that they are exponential, become impressive, if not alarming. A lot of this has occurred since World War Two, because since World War Two, we have seen not only a continuation of rapid economic growth in North America, but also a rebuilding and tremendous growth in Western Europe and in Japan. And we see that two-thirds to three-quarters of the world which still uses very little energy has as one of its chief aspirations raising its standard of living, its productivity to something like our level. Therefore, the demands on energy, by the world as a whole, potentially are tremendous. It is interesting to note, I think, that when the Club of Rome produced its first report, one of the reactions of the developing world was that this was a conspiracy of the industrialized, imperialistic Western world to keep them in permanent subservience because, in effect, that report, to the extent that it was believable, said, "There will not be enough energy for you, the two-thirds of the

Mr. Ritchie (continued):

world that doesn't now have much beyond a subsistence level of living; there will not be enough energy for you ever to achieve our present levels." They didn't like to believe that and maybe they shouldn't. In any event, it was a very sad message for them, if true, because it meant that the thing that they are most concerned about, which is raising the material level of well-being of their people, might be just a dream. If it is a dream, I think we would all agree it is a very important political fact for us in the advanced industrialized world because it means that our world will be in a state of tension and conflict for as far ahead as we can see.

Let's look at the supply side of this energy picture. When the industrialized world first began to use energy to improve productivity, beyond wind, water, and animal power, it used wood and it used coal. It is not so long ago that wood was fairly important. Again to go back to that Ontario farm, when it came threshing time, I can remember a steam locomotive fed with wood; we had to get wood and fuel that threshing machine while we were threshing, and that is only a few decades ago. But through the last century and in the early part of this century, the chief reliance for the industrialized world to meet their growing demands for energy was coal. A hundred years, or let's be more cautious and say 125 years ago, if you had asked anyone who was concerned about the world's energy supply to talk about the inventory of what was available, they would not have mentioned oil because the first oil well had not been drilled. And yet today when we think of energy, we think chiefly of oil and, to some extent of natural gas in some areas, because in this century oil began to displace coal. It began to displace it in North America and we can all remember ways: it began to push coal out of the heating of homes, it began to push coal out of the generating of electricity in some cases, it pushed coal out of the railroad transport field. This process began in North America and advanced rapidly, except in, for instance, Western Europe, because well into the late fifties of this century, coal was still predominant in Western Europe. It is not today. Now, there are reasons for this. For many purposes oil is more convenient; easier to handle and in some cases, of less by-product nuisance value. But one of the chief things was cost, because oil was cheaper than coal, substantially cheaper. The more wages and the general economics of the industrialized countries went up, the relatively cheaper oil became, because there is a high labor content and a very unattractive labor aspect to coal mining as we have known it. And so, oil was displacing coal and that meant that a very large growth in total energy demand was more and more focussing on one part of the potential energy supply and this had expected results. The United States was the chief producer of oil and a substantial exporter in the first half of this century. In the early fifties it ceased to be an exporter and rapidly became an importer, despite strong policy efforts to minimize its import dependence. In fact, the whole of the Western Hemisphere became an importer in due course despite the fact that during this

Mr. Ritchie (continued):

period Canada was achieving something like self-sufficiency in oil, if not in energy as a whole.

The result of this was, in due course, that the whole of the world's rather high growth in energy consumption, or almost the whole of it, was focussed on one small area of this world. You can narrow it down if you like, by 1970 or thereabouts, to Saudi Arabia, one country. Now, a lot of people saw this happening and there were a lot of people who knew the inevitable results of it happening. For instance, people in the oil industry were quite calmly looking forward in 1970, a time when, if I recall correctly, Saudi Arabia's production was not much more than two million barrels a day, to a decade later when they said it would be 20 million barrels a day. That didn't make much sense. There was never any reason in 1970 to assume that Saudi Arabia would find it in its interest to produce 20 million barrels a day by 1980, because for Saudi Arabia, that oil is its major resource to which it must look forward to support its people for a long time to come. In the kind of world we live in, piling up foreign currency of some sort or even making foreign investments, is not the wisest and safest way to protect the future incomes of a nation. But more than that, the oil-producing countries of the world of which Saudi Arabia was marginally the most important, hadn't been very happy with what they were getting for their oil. What we call today the OPEC cartel was at work long before 1972-73, when we began to feel its real impact. That group of nations, added to here and there by those with new discoveries such as Nigeria and Libya, had been trying to band together to improve their share of the revenue, potential or actual, for oil for more than a decade before 1973 but their efforts hadn't been very successful. There were good reasons for them not being successful and good reasons to foresee that they would in due course likely be successful. The real reason that they weren't successful in the sixties was that oil was still in surplus supply; there were more places to turn to than just Saudi Arabia for the final barrel. But as that decade progressed, for the reasons I have already suggested, more and more there was no recourse for the industrialized world. Therefore the potential power of the oil producing and exporting countries to band together, the potential power of one member of that group to ensure a better, from their standpoint, share of the potential revenues was more and more achievable. And so, it came at a time when the world had put itself in a position of relying for the next decade or so at least, for its growth in energy demand to be supplied by one small area, an area where there was lots of oil for the time being, but still one small controllable area.

Now, what have the OPEC countries done with this control? What is its significance for us? Well, one thing it is safe to say and worthwhile saying, is that what they did was give us an early warning of what was going to happen and what some people knew was going to happen anyway. There were investments already underway which were premised on the assumption that energy was going to be more costly and therefore more valuable in the future than it had been. Investments, for instance, in things like the Alberta Tar Sands, in the

Mr. Ritchie (continued):

search for Arctic oil, in the search for North Sea oil, in more intense discussion about things like shale oil in the States. This was going to come anyway, and it was going to come very quickly, because of the rapid rate at which the world's current, so-called conventional, supply sources of energy were being drawn on by increasing demand. The OPEC countries gave us, perhaps, a needed warning; in any event, a very dramatic one, because while I say that a lot of people knew that this was going to happen down the road, it is evident from the reaction of the public all around the world that the public didn't know it was going to happen. And in that way, perhaps, although painful, it was a salutary early warning. We are still struggling with what we do about it but at least we are thinking about it now in ways most people weren't thinking about it before.

There is another thing that can be said about the action of the OPEC countries. They have multiplied the price of crude oil internationally. They have multiplied it by several times in a very brief period and it is necessarily a shock to any economic system to have an essential ingredient multiply in price several times. Now, we've experienced this before in other products, on not quite as extreme a scale. Minerals traditionally go up and down in a cycle by substantial amounts, copper for instance. But we know that that happens and we have learned how to live with it; we adjust. We were unprepared, most people were in their thinking, for this very rapid multiplication, and the effects are therefore more startling and, more important, the adjustment is more demanding, because this looks like being a continuing state of affairs. Because if we look at what the OPEC countries have done, we have to give them some marks for wisdom, I think. Basically, they have raised the price to somewhere near, or even a bit below, the cost of all the major alternative sources that we are going to have to bring in, in due course, as a supplement and finally as a replacement, for Middle Eastern oil.

Now, there are, from the standpoint of the industrialized world some real risks in this situation because it is conceivable that, if the industrial world proceeds fairly rapidly in committing large sums of capital which is required in almost every instance to developing alternative sources of supply, it is conceivable that over the next decade or decade and a half the OPEC countries collectively, or some of them individually, could undercut the costs of these new alternative sources of supply. That is a risk and, like essentially commercial risks (I think in this case more commercial than political, but that is arguable), it is a risk that has to be assessed. Because the OPEC nations, from their standpoint or from the standpoint of an objective observer, have handled themselves pretty intelligently and in a pretty commercial manner heretofore, and because it is difficult to see that their interests are very well served by departing from such a course, it may be that the risk is not very great. But time will tell because it is clear that the

Mr. Ritchie (continued):

industrialized world cannot afford to wait until 1990 or the year 2000 to bring in, or work on bringing in, substantial new energy resources.

What I have said so far is the simple, self-evident truth that our level of productivity, our standard of living, depends on energy consumption. That has been reflected in a tremendous growth in the world's demand for energy over a relatively brief period of human history, and much of that growth has really taken place in the last three or four decades at a pace which probably could not ever continue and perhaps doesn't need to continue in the industrialized world. But for the future of the remainder of the world who are more numerous than we, it is essential that it continue in some form if they are to have any hope. As a result of this we are now paying a price for oil, internationally at least (not quite true in Canada at the moment), which is probably representative or certainly not higher than the alternative sources of supply which the world is going to have to develop and we should be laying our plans for the future on such an assumption.

Well now, if that is a relevant foundation, what are some of the things that can be said about the future outlook? First of all, one thing that I think is important is that because energy costs the user more now, we are going to find important ways to use it more efficiently. When energy was cheap, we used it like something that was cheap; we used it with carefree abandon. Now that it means more to our pocketbooks as consumers and as industrialists, commercial operators or agriculturalists, we are going to have much more incentive, we already have much more incentive, to find ways to economize. It was a very interesting fact that in the winter of 1973-74, I guess it was, when the United States felt that it was going to perhaps be physically short of oil, industrialists and business people generally found that they could save quite a bit of energy consumption without changing any technology. If you asked a typical senior businessman in most industries five years ago what his energy costs were, he wouldn't have been able to tell you. He could have told you what his labor costs were, his depreciation costs, but he wouldn't have known what his energy costs were because it didn't matter very much, it was a small cost. Well, in that winter it began to matter because it wasn't just a matter of cost, it might have been a question of continuing to operate and the savings that people found they could make just by ordinary business care were significant. If this is a continuing state of affairs, as we must assume, we will develop technology and changed habits which will significantly reduce our energy consumption. That is the kind of conservation that I think we can count on, without exhortation. It is an inevitable response. Ten years from now we will, on average, even if no one passes legislation, have cars that give better gas mileage - smaller cars; that process may be hastened by legislative direction. Twenty years from now we will have better insulated houses and office buildings so that less energy will be used both winter and summer. New technologies will be developed to save energy because there is powerful economic reason for doing so.

Mr. Ritchie (continued):

You'll hear today, I am sure, a suggestion that conservation should go much beyond that, that there should be a conservation ethic. I wouldn't argue that there shouldn't be but I think the reasons for it are less clear cut and less reliable than the kind of conservation that is going to come because energy costs more and is going to keep on costing more.

Now, just a word about where we should be looking, or where we are likely to look, for energy in the future. There is a great deal of speculation in this field; I can speculate like other people. It does seem to me that for the next three or four decades at least, liquid fuels will still be the predominant source of energy. They will be supplemented, I have no doubt, as they are beginning to be, by nuclear fuel; they will be supplemented, or perhaps added to in supply, by more use of coal, although it is very interesting that the early hopes of the last two or three years for a rapid expansion in coal supply and demand are not so far coming to pass. In the United States they plan to double their coal production by something like 1980. At the moment it is hard to say there would be a market for twice the coal production in the United States by 1980. Even the demand for oil and gas has been less world-wide than would have been expected, partly because we haven't known in the past what the real effect of price increases would be on demand for energy. We are still learning about that but secondly, of course, because we have had something by way of a world recession and it is difficult to separate the two factors in terms of their impact on energy demand. But we do know that among the fossil fuels, even if we take into account the likely recoverable liquid fuel from things like tar sands and shale oil which have environmental and other difficulties, cost difficulties, as does coal for that matter. But coal gives us the promise not only of use in the ways in which we have done in the past, but it gives the promise of liquid fuels and gas from coal. In fact, there is the possibility that coal which was not of value in the past can be of value in the future, not only because energy values are higher, but because if you can turn it into liquid form or gaseous form at the site and avoid a lot of transportation costs which killed certain low quality coals in the past, those coals can become useful and valuable.

Nuclear power? You will hear some debate about that today I am sure. There are a great many people who look at that as the answer to the gradual displacement of fossil fuels. It is an answer that itself runs out in due course, unless we can move on to the fusion process which is not technically established as yet. But there are debates about nuclear fission energy which I happen to think myself are of some importance. They are the kind of debate which can't be solved by an arithmetic solution but they have to do with risks, political and otherwise, for the world. And that debate I think will continue; it may mean that nuclear energy comes in on a smaller scale than is being looked forward to by some people. It is of course already at a much smaller scale than was freely predicted twenty years ago. That underlines one fact of great importance which is that all of the alternative sources of energy now not only cost a great deal more than the kind of energy prices we were paying in the last decade, but also have very long lead times and usually a need for very substantial commitments of capital. So what we are looking towards, in addition to a great deal of risk and cost, is a process by which new sources of energy phase in; and they must begin phasing in before our present sources phase out. Thank you very much.

PREMIER ALEX CAMPBELL: Mr. Ritchie, we thank you very much for your contribution. The nature of your discussion is not one that lets us zero in on detail by any means. Perhaps by way of initial general reaction, do you think that when you made the comparison, arising out of the paper before the Club of Rome, between the under-developed nations of the world and the industrialized nations of the world, little hope was held for the non-industrialized section of the world catching up because of the lack of conventional forms of energy? What about the industrialized portions of the world: is there a fairly good chance in your view of our maintaining our position and improving it at the rate of development and the materialistic mentality that has become part of it?

MR. RITCHIE: Mr. Premier, in that comment earlier, I was reporting a reaction, rather than giving necessarily my own view of the likely prospect. There is no doubt that what has happened recently to the cost of energy has been tremendously important, has been a terrible shock to some of the immediate growth prospects of the developing nations but I am not sure that it means that they, over the longer-term future, don't still have some prospect of doing something like we have done. For instance, they had fallen into the habit, just as we, of relying on an easy source of supply. Take a country like India: it had come to rely, to a significant extent, on imported oil. But India has a lot of undeveloped coal, a lot of undeveloped hydro power, and in the present situation, although it would take time, India may turn to its own sources more than would have been worthwhile as long as energy was cheap. Beyond that, and this applies to both the developed world and to the developing world, I find myself in what I would call the optimistic side of the picture. I don't think that the industrialized world needs to keep on adding to its energy consumption for very long at anything like the past rates. There must surely be a ceiling some time in terms of how we want to spend our time and energy. I'm not quite sure where it is, but we are a lot nearer to it than the developing world, that is for certain. One can, taking the long span of history, foresee some ceiling of total consumption levels quite a bit larger than the world's present consumption level, not just because supplies were limited but because people didn't want to consume more energy and the world's population had stopped growing, as it must if we are to survive in any decency. In one sense energy is not limited at all in this world or in this universe, because matter is interchangeable with energy and the energy we use doesn't really disappear. The convenient sources, as our present technology knows them, may disappear and so I am on the side not of those of who predict a technological fix but of those who predict a continuance of what we have always done, by discovering new methods of getting what we want. That doesn't mean we don't have some very painful times for some decades or longer, from time to time. The world may go through these, perhaps in the next two or three decades. But there is really no shortage of energy even in the world at this moment. In fact, by very short-term standards, there are some surpluses. And so my own view, which I would be hard put to justify with any particular evidence, is that if we want to expand the consumption of energy in the world as a whole, a lot beyond its present levels, we can do it over time.

MELVIN J. MCQUAID, MLA: I would judge from your closing sentences that you are apparently of the opinion that we are a long time away from being able to take advantage of the various alternative sources of energy, is that a correct assumption? It is not quite in line with some of the presentations we have heard in the past few days: they have indicated to us that, for example, wind power and solar power may not be too far away.

MR. RITCHIE: No. I talked about phasing in and I tried to stress that. I think that wind and solar power are already used in some places and I'm sure that we can begin to use them almost immediately much more than we do. But in terms of displacing adequately our present sources of supply, I don't think that will happen overnight. We are talking in most cases, either for economic reasons or for reasons of technology development necessary, about decades of development while we continue to use present sources as long as they are more economically competitive. It takes a lot of time. Let's take the tar sands. There were a lot of ridiculous things said and forecast about how fast we could produce huge amounts of energy in Canada from tar sands. In fact when we got into it, we found out what, in terms of dollars and physical effort, just a massive and expensive job it is. We know that it will be decades before the tar sands are a huge contributor to Canada's energy picture, let alone the world's. So these things take time.

HON. GILBERT CLEMENTS: What would you estimate is the supply of oil that we have now, how long would it serve at our present consumption rate with known reserves?

MR. RITCHIE: Well, you have to make a supposition about growth rates and my own assumption is that growth rates are likely,at least in the industrialized world, to be a lot less than they have been in the past. You are guessing to a large extent. We know less about how much gas and oil there is in the world to be discovered andproduced than we know about coal, for instance, but it seems to me that conventional oil and gas will be important contributors to our energy needs for up to 50 years in the future, anyway. But they will be increasingly complemented by other sources of supply; which may be unconventional sources of liquid fuels from coal or from shale oil, as well as things like nuclear power, solar power and so on.

MR. CLEMENTS: But assuming that we don't come up with alternative methods of producing power, what would you suggest might be the period of time that we could rely on oil at any price?

MR. RITCHIE: Well, if we can't come up with alternatives, it's a very sad fate and it wouldn't make much difference, but I think that we would be fairly safe on oil for 30 years.

HON. T. EARLE HICKEY: Over that period is it likely to be more costly or will the competition from other sources keep it level?

MR. RITCHIE: Leaving inflation aside, these are very hazardous kinds of speculation. I would think that it needn't be much more costly than suggested by present international price levels.

PREMIER CAMPBELL: But if we just proceeded as we have been, full out for the next 30 years, every single industry, and every single job, and every single pleasure in life - car, boat, ski-doo, and warmth in the home - is fully established and based on the oil truck coming next week. In the 30th year the oil truck doesn't come and the lights go out and society collapses. Listening to you, Mr. Ritchie, I gather that you have an abiding faith in necessity being the mother of invention and in the industrialized countries compensating, probing, finding alternatives and moving into a "new society" as a matter of natural evolution rather than governments anticipating, studying, probing, and trying to define some limits within which industry and society generally move through this next 30-year period. Or do you see an interplay.

MR. RITCHIE: I am not at all against governments probing, monitoring, and even finding ways that seem to be constructive to help new supply sources come in, to adjust or even, because it looks as if it's wise, to enforce conservation rules of various kinds. There are a lot of reasons besides economic for doing that including the security reasons and so I am not at all against it. In fact I think it would be in today's world ridiculous to argue that governments should not be involved in doing some of the things you are suggesting. On the other hand, it is also possible for governments with the best will in the world to get in the way of constructive things which might happen because of the forces at work. This, I think, is a real risk and more so for a country like Canada than for some other countries because we appear to have alternatives. We can play with the idea of self-sufficiency; for instance we can, for a time at least, play with the idea of somehow trying to keep our energy costs lower. We have more alternatives, therefore we have the possibility of getting in the way of the process in the sense in which government of a country with no indigenous resources can't, and most of the world is nearer the latter situation than ours. I guess my real answer, beyond that, is that I think the physical resources to keep the world supplied with energy, for a long, long time as far ahead as we can see and further, are available. I suspect our incentive for finding ways to make use of those resources will be great enough that we will probably find ways to do it but we are really looking a long way down the road. The things that we have to do in the next 50 years or so are pretty self-evident; even the technology, except for fusion power, is more or less available. It will be improved, no doubt, but it is more or less available.

PREMIER CAMPBELL: Would you care to comment on what you, or perhaps the Institute for Research in Public Policy, foresee as the role of rail in national transportation requirements during the next 50 years?

MR. RITCHIE: I can't speak for the Institute because I haven't been a part of it now for about two years. I wouldn't want to be very categoric except that it seems to me that in a country like Canada, rail is bound to continue to be very important because it should be a relatively efficient way of transporting over long distances for many purposes, but not for all.

HON. A. E. (BUD) INGS, DVS: Mr. Ritchie, you mentioned the large amount of coal deposits that are available. Would you just enlarge on what areas you feel that coal research should touch? I'm thinking of gasoline production. How many years are we behind in coal research as an alternative source?

MR. RITCHIE: Well, the technology is known today but the economics aren't as attractive as one would like them to be even yet. I'm not technically qualified to respond to your question, so I can give you only the layman's impression. My impression is that the coal gasification is nearer as an economic proposition than coal liquification but that we know enough about both of them that both are very likely over the next few decades to become significant. I believe that in both cases the costs, as we currently know them, are a little bit higher than what we now are paying for energy and, as in most things, once you get into them, you find ways to reduce costs; but initially it is a hurdle.

VERNON MCINTYRE, MLA: I was wondering, Mr. Ritchie, back in the mid-sixties I believe the United States were large exporters of oil and I am wondering now, ten years later, that we seem to be solely dependent on Saudi Arabia. Just what has happened to this surplus of oil that was in the United States some ten years ago?

MR. RITCHIE: Well, I think you would have to go a little further back, let's say 25 years. I think it was in 1952 or 1953 that the United States ceased to be a net exporter of oil and became a gradually increasing net importer. Well, two things have happened. One is that the demand for energy in the United States, growing something like 5% a year, has grown a great deal. You get it doubling every 14 years or so at that rate of growth. If you had an exportable surplus in 1950, it is easy to see why you might not have one in 1970. The second thing is that for quite a few years now, I believe, the United States has been discovering less new oil than it has been consuming from its own sources each year, so that the established reserves have been going down.

MR. MCINTYRE: What has caused the crude oil price to multiply so much in recent months?

MR. RITCHIE: Internationally, it has been a cartel. The OPEC countries, in effect having collared the key supply, have banded together and said "We want such-and-such a price" and they have gotten it. It happened that the price they have charged is pretty much what we would have to pay from major new sources of supply anyway, so the two together advanced a process that was more or less inevitable.

MR. MCINTYRE: I am wondering one other thing, Mr. Ritchie; just what you were referring to when you said, "use oil more efficiently". Were you talking about conserving oil in our homes and industry, or just what were your thoughts in this respect?

MR. RITCHIE: I was really talking about using energy more efficiently including, at the moment, chiefly oil, I suppose. But there are a lot of industrial processes where energy consumption can be reduced by the application of new technology and of course there are even more where you can switch from oil to some other fuel such as coal. But in terms of all of us as men on the street, we can drive smaller cars. It is even conceivable we might drive less. We can switch to public transportation in certain cases; we can insulate our homes. There are a whole range of ways in which we can make significant differences to our energy consumption. I think it is not unreasonable to suggest that as compared with a base year, let's say 1970, before we had this incentive, we could cut our energy consumption by as much as about 30% over time without hurting any real standard of living at all. Energy was so cheap that we didn't have to worry about how wastefully we used it (how lavishly is a better word for an economist to use). Energy has now become, by past standards, pretty dear and we now have a real incentive to use it effectively and efficiently.

MR. MCINTYRE: You also mentioned coal for development of liquid fuels; do you feel this is economically feasible?

MR. RITCHIE: I believe it will be yes, and should be worked at now, as it is.

MR. MCINTYRE: You say, will be. Are we talking next year or ten years from now?

MR. RITCHIE: I would expect it would be making a significant contribution by ten years from now. I don't mean 80%; you'll begin to be getting some value from it.

HON. BRUCE STEWART: Mr. Ritchie, everybody is interested in how high the price of oil might go. What do you see as the contributing factors to the world price of oil in the future, bearing in mind that there isn't any real competition in the energy field for oil? When do you see a point where these other energy factors of atomic energy, coal and wind power and so forth, will in fact be real competitors for oil? What do you see in the future for the world price for oil, bearing in mind those things?

MR. RITCHIE: Well, it is foolish to predict in some senses, but let us look at some of the factors involved. I have already said that most of the competitive sources of any significance that can be brought in will cost as much as or maybe a bit more, at least initially, than current energy values set internationally by the OPEC countries. The saving fact is that probably a number of them should not cost much more. On the other hand, they are not yet available. Theoretically, the OPEC countries could be charging a great deal more right now, because there is no alternative, except substantially reduced consumption, which is not an alternative that we could probably adjust to even in the very short term. So in a sense you could say that the OPEC countries could do almost what they liked at the moment. But that isn't true, really, because the OPEC countries are well aware that in the last year there has been a surplus of crude oil available in the world, even with the production controls that they collectively have. They are aware, maybe more than we are, of what higher prices seem to do to demand. Also, they have displayed so far, I think, some pretty shrewd commercial sense or else they might have raised those prices a lot higher. The Saudi Arabians perhaps have been a key to a large part to this commercial sense. Now, we don't know of course, what is going to happen to Saudi Arabia. It is an antiquated form of government, if you like, and it may be displaced at any time, and who could predict what a new government of Saudi Arabia could do? So there are lots of hazards here, but my own view would be that we should not give too much weight to the possibility, leaving inflation aside, of substantial price increases in energy over the next several years. Once we get some of these new sources of supply in; if they prove to be higher cost, not competitive with present world prices, then we might get a move up to that level.

MR. STEWART: With the amount of oil production from Saudi Arabia going up from two billion barrels a day to ten million barrels a day or more, surely they are cutting down the life expectancy of their reserves and their future security. Can you see the Saudi Arabians putting a halt to this kind of thing and saying to the industrialized world and the under-developed world that they are not going to produce oil beyond three million barrels a day, or something like this in order to guarantee our future security?

MR. RITCHIE: Well, Saudi Arabia has been producing somewhere between eight to ten million barrels a day and it has cut back more than other OPEC countries. But I think it is a fairly safe assumption that a drastic cut-back would be hard for them to adjust to. You can see it most clearly in the case of Iran, because Iran has put itself in the position of needing all its oil revenues at this point. Even Saudi Arabia is getting closer to that point; they have been importing more things than they were expected to import, for investment purposes and for consumption, so that the world's balance of payment situation, even with Saudi Arabia, hasn't been quite as bad as was predicted two years ago. I wouldn't expect a drastic cut-back, barring some brief politically-induced thing - another war in the Middle East - which might bring a very brief cut back.

DANIEL COMPTON, MLA: It has been reported that two-thirds of the world's known future reserves of oil are in the Middle East. Do you think this statement is fairly accurate?

MR. RITCHIE: If you are talking about conventional oil, I would have to check the figures, but it doesn't sound out of the way. Now, we are still making conventional oil discoveries and nobody knows quite how big they will be; for instance, many off-shore discoveries in the east coast of Canada and in the Arctic. China is reported to have, not only on the mainland, but off-shore, some pretty substantial potential. I don't know whether we really know how much the Russians have in the way of oil and gas. There are uncertainties. You see 15 years ago, and that is a relatively short time in matters of this kind, there was no Nigeria; there was essentially no Libya; Algeria wasn't really producing; Indonesia was much smaller than it is today. So it is not a field where certainty is great.

MR. COMPTON: Rumania, at one time was quite a supplier of oil.

MR. RITCHIE: Yes, it still has quite a bit of gas but it has exhausted most of its oil, I think.

MR. MCINTYRE: I believe you mentioned, Mr. Ritchie, near the end of your presentation, a certain amount of risk regarding alternative energy sources. Were you suggesting at that point that oil prices might level out or come down at some future time?

MR. RITCHIE: I think I was at that moment talking about the possibility that the OPEC countries might, some way down the road, choose to undercut new sources of supply. That is a risk. I myself would not place it very high. But it is a risk that has to be thought of because for another 15-20 years they certainly could do so.

MR. WELLS: In that respect, Mr. Ritchie, I would like to clear a comment on what position governments might take if, having decided to get into alternative sources, they found that they were being undercut by the OPEC nations because of the development of the alternatives. Would it be wise for governments to continue with the alternatives or take advantage of the cheap oil again?

MR. RITCHIE: I don't think you can give a generalized answer to that. You would have to deal with it situation by situation. If you already had substantial sunken investment, I think there would be a very strong pressure to continue using it, even if you had to charge your consumers more than for the time being they would pay elsewhere. On the other hand, if you were just about to start, depending on how much credibility you thought the lower prices had for the future, you might delay. So you would have to deal with that case by case,I think and, as I have tried to suggest, I think it is an, relatively speaking,unlikely prospect but you can't say it doesn't exist.

MR. STEWART: Up to the present time, Mr. Ritchie, we have been using hydrocarbons to produce electricity. Do you think in the future we will be using electricity to produce hydrocarbons?

MR. RITCHIE: That is not inconceivable or some substitute for hydrocarbons, such as hydrogen itself, as a carrier. I think that down the road quite a way, that is a real possibility; that you will use electricity generated by fusion or by some other means or maybe solar energy directly, to produce hydrogen as a convenient carrier for energy.

MR. MCINTYRE: Do you see a restricting of passenger car travel in the foreseeable future in regard to gasoline consumption?

MR. RITCHIE: I would think that gentlemen like you are in a far better position to say because it would be a political decision, as I see the prospect.

MR. MCINTYRE: When I asked the question I was wondering about stocks of gasoline in comparison to fuel oil and this type of thing.

MR. RITCHIE: Well, within reasonably broad limits, from crude oil or any liquid fuel you can get from a fossil fuel source, you can have more or less gasoline, more or less fuel oil. They are not interchangeable overnight because investments are involved, but there is no reason to expect a shortage of gasoline where there is an abundance of fuel oil, except for a very brief period.

PREMIER CAMPBELL: I don't want you to get away without having an opportunity to anticipate further discussion through the day, sir. You have left the impression that we have oil for 30 years and I suspect that subsequent speakers will make some reference to your forecast. Perhaps it would be well for you to clarify what you mean by that because without some clarifying statement I'm sure the stocks of Maritime Electric, on your very words, are going to go up today in the marketplace and people may react by saying "Well, what is all the fuss about?" If we have oil for 30 years, there is no urgency, there is no rush, there is no need to get exercised over the matter." So, in your own self-defense in the face of further speakers and much discussion I'm sure throughout the province, I wish you would have the final clarifying word on this statement.

MR. RITCHIE: Well, as you yourself pointed out, Mr. Premier, a little earlier if that's all there were in the energy picture, oil for 30 years, we would be in a very sad state, because either at the end of 30 years everything would come to a halt or we would have slowed it down drastically somewhere in advance of that period because of what was going to happen. When I say that there is oil for 30 years or some such period, I'm really talking in terms of the world picture of something like current levels of energy consumption, maybe even somewhat increased, in relation to reserves that are now known and some guess at reserves which might be proved up during that period. And as I think I have already made clear, I expect the place of oil in our energy supply picture during even that 30 years to become gradually less, because of new sources such as coal, nuclear, solar, etc. Therefore in effect I expect that oil will be supplied and be significant for much longer than 30 years because it will be spread out and also because, for all practical purposes, it doesn't make any difference to us whether oil comes from an oil well or is converted from tar sands, or shale oil, or coal. If someone had asked me how long I thought we would be using liquid fuels, it would be much longer than 30 years. Thank you very much.

MR. ANDREW WELLS: Thank you Mr. Ritchie.

Our next speaker is an individual whom I expect we will be seeing, in this province, a great deal more of over the next number of years. Most of us I'm sure are familiar with the activities of the New Alchemy Institute at Spry Point and the famous, or infamous, depending on your point of view, Ark project. We have with us today the founder of the New Alchemy Institute, Dr. John Todd. Dr. Todd, born in Hamilton, Ontario, received his B.Sc. in Agriculture at McGill University; his M.Sc. in, you correct me if I mispronounce this John, Parasitology and Tropical Medicine at McGill; his Ph.D. in Comparative Psychology and Animal Behavior at the University of Michigan; and he has taken graduate training in Oceanography. He has taught at San Diego University as Associate Dean of the College of Sciences and in 1969 he founded the New Alchemy Institute. In 1970 he established the Marine Animal Communications Research Lab at Woods Hole

Oceanographic Institution. From 1971 to the present, new branches of the New Alchemy Institute were established in Massachusetts, California and Costa Rica, and most recently here in this province. Dr. Todd calls himself a 'biological designer' and it is in that general area that we will be hearing from him today. Dr. Todd.

The Prince Edward Island Ark and Renewable Resources in Agriculture

DR. JOHN TODD: Mr. Speaker, and Honourable Members of the Legislature, thank you very much for inviting me. Today I would like to discuss the work and plans of the New Alchemy Institute on Prince Edward Island. I would like to particularly refer to its proposed and on-going work in agricultural energy research and I would like to emphasize at the outset that we are concerned not only with these but also the other vital support elements of society.

A little bit about ourselves: we are a small international research and education organization with a rather broad task of seeking appropriate solutions for the future of humanity. New Alchemy was founded by several Canadians and it has always been our hope that Prince Edward Island would become our Canadian home.

Today we are focussing on the question of energy and 'energy' - what a word! It is not just what Arab nations sell or what children have limitless amounts of; it is the stuff of society intertwined and embroiled in every act of our daily lives. It can create harmony and order or it can break us. It is complex and not easy to understand but an understanding of its many forms is necessary before wise political choices and decisions can be made.

Today, I would like to imply, perhaps even persuade you a little bit, that an exciting future is possible, one that is pre-eminently based on resources that we have in Maritime Canada. I should like to illustrate solutions that I think are far more intriguing than building giant nuclear plants, the technologies of which we can't understand, nor even participate in their building or construction to any great extent - that is usually left to outsiders and experts.

But before I get into specifics, I would like to take time to explain the guidelines, or perhaps the self-imposed rules, which my colleagues and I work under. This would give you some solid basis to judge us. Now these guidelines were originally intended to provide the skeleton of a new science, to steer us through unchartered waters and they were ironically enough, based not on neutral scientific criteria but on social, humane, and ecological precepts. I will very briefly list some of these.

First, that our research involves the basic functional units of society, that is the concern of the individual or the family or the small community, while at the same time trying to maintain some global or larger perspective. One of the reasons for our interest in this area is that the majority of science today is practised not for the benefit directly of individuals but for the benefit of large

Dr. Todd (continued):

corporations or entities. Most scientists tend to work in a larger realm than is absolutely necessary or useful to most people. In other words, in a sense, we are trying to bring science into our own back yards where we think it belongs.

The second guideline was that we invest our efforts in food and energy systems. We could see farther down the road when we originally began in 1969 some serious energy and agricultural crises in our lifetime. Modern agriculture is predicated on feedstocks from petroleum, the herbicides and pesticides and fungicides and nitrogenous fertilizers and what have you. These are all coupled to the politics of the Middle East. And so we thought the wisest thing for us to do would be to invest our efforts in food and energy systems and not just do that, but to try over the long run to reduce the amount of capital involved. In other words, if we could find ways of creating energy or ways of producing foods with less capital, then that would mean that a larger percentage of humanity could actually participate in providing the needs of society.

The third point, and this may be a little difficult to feel at first, is that we wanted to hitch all of the work that we do to everything else, in other words, to create a science of wholes. So while we were working on an energy question, at the same time we would have to work on its equivalent agriculture question, or shelter question, or even transport aspect, so that they would all be coupled together to create a new sense of whole; and this, we believe, can only be done really well on a small scale. Again, we would try to look for scientific solutions which would involve large numbers of society which I alluded to before. An example of what I mean by this: let's say we wanted to heat our homes here, we would conceivably purchase, for example, a nuclear generating capacity and we could install electric heating in everybody's house. Islanders would not really participate in this other than as purchasers and end users. An alternative to the same question of household heating that would involve a science directed more specifically on a human scale, would be to retrofit existing houses. This would involve such things as insulation, new design ideas, solar coupling, perhaps even alternative energy sources, new types of furnaces. What this would engender in society is in fact a new internal economy. All of us could participate; there would be new building; there would be new manufacturing elements; and all of them in this second scenario could actually take place right here in the Island. The end product would be living places which require little energy and all of us would participate in that particular future society.

The next point of guideline (these previous approaches are rather universal, but this one is more particular) was that, we would like to take a bio-regional approach. We tend to look at ourselves, wherever we are, as a region which does not have what somebody else has and therefore is at a disadvantage. Every region I have ever worked in has this same feeling about one thing or another but as we get to know more about what each region has in a positive sense, we learn of possibilities for the future which have simply been

Dr. Todd (continued):

undreamt of. For example, if one were to calculate what we have here, whether it is the sun, the wind, the good soils, or the ability to produce diverse tree crops as well as other agricultural crops, we would discover that we have all the bases of a complete society, including the brains and the expertise to couple the manufacturing associated with it. The society that we would create would be partly determined by what we had in the first place. It wouldn't be second class to anything or anybody else but it would be very, very different. And I think out of this bio-regional approach would develop a sense of diversity in the world and a sense of self-reliance and independence. It is my belief that only from an independent position can we then deal with other parts of the world in a more humane and equal way.

The next guideline is that we work primarily with renewable or long-lived materials. We assume these are the things that are going to be around tomorrow and the day after tomorrow: the wind, the sun, bio-fuels, and in the terms of materials, wood, stone, and others. The reason for working with these things which we have freely available is that there is less chance for mischief amongst groups in society; and also going further down the road, the conserver concepts and conserver societies will be dependent upon working with those things which are renewable, particularly the wind and the sun.

The final point, which I think will become clear as I show you some material, is that the Institute seek methods, which won't be a quick job, of fundamentally redesigning the vital systems which sustain human communities. Now to give you an example, most of our communities are presently sustained by engines and machinery, heavy hardware, powered by petroleum fuels. But we decided to look at the idea; would it be possible to substitute engines, machinery, and hardware that we presently consider essential to our society, with equivalent processes derived from living systems coupled in some new ways with appropriate technologies, powered by the wind and the sun, and perhaps controlled and integrated with micro-computers? In other words, the question that we were going to ask was: can we ask nature to help us make the transition into the twenty-first century and if so, how will this come about? I have some examples to make this point a little clearer.

You have all heard of the Ark project, a part of Canada's contribution to the Human Settlements Year to which you people have so kindly contributed. Many people at this particular stage see it as just another expensive house. That is what the Ark, a bio-shelter, is not. The project happens to involve seven different research programs in the areas of windmill energy production, solar heating, climate regulation, aquaculture, intensive greenhouse culture of commercial crops, architectural structural design, and a level of integration in houses and structures that at the present is unprecedented. The Ark is an ecological place for living, powered by the wind and the sun, and creating its own climates. Within, it is, instead of being a drain on society and using fossil fuels, a net contributor

Dr. Todd (continued):

to society both in the form of energy and also in the form of income for the people who live within. It is the antithesis of the modern house which takes away just about every dollar we have; this one will tend to create its own economy.

One of the important aspects of the Ark research program is the wind-driven power plant which I would like to take a moment to describe. We made the decision back in the fall of 1974 to design this plant. Around 1970 we had started building wind-driven power plants and we have built them in a number of parts of the world. They have been vertical axis (egg-beater) types like we saw yesterday; they have been horizontal windmills; they have been large water-pumping mills. We designed and built electric generating wind plants and in the late fall of 1974, when we were conceiving the Ark project, there was no commercial wind plant which was either economically interesting or large enough to, say, provide the power needs of three or four farms or the Ark for that matter or the Ark as it was originally conceived. We thought we should go ahead and try to develop a very advanced wind-driven power plant but because we were largely biologists and our training wasn't in wind technologies other than the experience we had gained over the five or six years, we assembled an engineering team to develop a wind plant for Prince Edward Island. The first thing we did, or the responsibility that fell on my shoulders, was to find a chief engineer and this was a man who was working at digital equipment. The reason why he was chosen was that not only did he have some windmill experience, but he was an ocean racing sailor and had experienced near hurricane force winds in a small ship at sea. I felt if anybody had been humbled by the wind, perhaps he was one. The other people were a mathematician and an electronic engineer. Interestingly enough, as we got going down the road a little bit, we decided that perhaps one of the key futures in windmill production was in hydraulics, using hydraulics as a transfer of energy from props to a power station on the ground. At that point we contacted the President of Research and Manufacturing Hydraulics, the largest such company in New England which had developed very difficult hydraulic systems in the submarine industry and the aircraft industry for the transfer of power from one place to another. He decided to join with the group in the development of a wind driven power plant for Prince Edward Island.

The wind plant itself is a three-bladed machine and on top of the tower is a hydraulic pump. It also has a pitch control mechanism for the prop. The energy is transferred through hydraulic lines down to a generating station on the ground. The plant on the Island is going to have 25 to 32 kilowatt capacity which is probably going to produce between three and four thousand kilowatt hours a month power at the Spry Point site. Within two weeks the first prototype will be tested on Cape Cod and after a period of about a month and a half or two months of intensive running, we will begin to build a full scale plant here on the Island.

Dr. Todd (continued):

I can't really report to you that it is going to revolutionize the windmill business but we think it is a very interesting and perhaps a very useful machine. I should make one point. When we went into the original design phase, I requested that it not only be able to stand the salt spray, which one doubts when you have a lot of aluminum around, and be able to stand fierce winds, but also be able to be scaled up by at least a factor of four. I also requested that it be designed in such a way that it could be manufactured in Charlottetown. We are now in the design of the Hydrowind twin which is the second generation, which uses a pre-stressed concrete tower, and after I finish I can show you how this whole machine operates, if anybody is interested. I have four slides to show you how that as the wind changes the props change, and how the mill deals with vagaries. So the Hydrowind twin, the second generation, is already on the boards and it would result in about a 40% decrease in cost per kilowatt hour. Hydraulics as an area is moving into mass manufacturing and the prices of hydraulics are going down, not quite as steeply as electronics, but I think there will be some similar deductions.

And so our plans are to establish late in the summer on the Island the Hydrowind, the 25 to 32 kilowatt system and test it next fall. If it is successful and doesn't blow off into the sea, we will try then to make a decision early in 1977 to begin manufacturing here. But none of this is sure, since the tests have not been completed.

The mill has a synchronous inverter, so that the DC power coming from that plant can be coupled to the Island's grid; in other words, as it is sitting on Spry Point this summer, it will be able to sell, we estimate at today's prices (if anybody would buy it from us, we may have to donate it) about $1,000 of electricity a year, at least $700 of electricity a year, excess of what the Ark project will actually use down on Spry Point. Again, that is just an early estimate.

Let's leave the windmill aspect of the Ark research project, which we can get back to if anyone is interested. The Ark itself is a solar and wind powered structure, pre-adapted to be coupled to existing farms or certainly existing agriculture.

There is some background research I would like to tell you a little bit about. We had to find a low energy structure and at the very outset we collaborated with a couple of ingenious architects calling themselves Solsearch. They had been trained to build banks and sky scrapers and became convinced that ours was one of the ways of the future, and have been very active on a full time basis with us ever since. There is a materials testing model for the Ark that was built on the Cape last year. It is south faced and made of arched fibreglass panels which let in about 90% of the available light. The structure is designed as a low energy system without any fossil fuels. The north face is highly insulated; its interior is reflective so that the plants and what have you within it get the same amount of light. Without fossil fuels or any other energy input we maintain tropical plants from Central America all winter

Dr. Todd (continued):

on Cape Cod. Within the interior over the aquaculture facility is a plastic membrane, a transparent long-lived material which has been invented by a couple of friends of ours, scientists at MIT. It lets in light but doesn't let much heat out. The structure stays quite warm all of the time. The inventors being strictly engineers, made one flaw though which I should mention to you. It is not a very strong material, so it is suspended inside fibreglass exterior. The squashes which we are growing punched their way right through the material and rendered it inoperable, that is just something that wasn't predicted in the computer labs at MIT. Nevertheless, it is a very interesting material and I think it is a direction which we will see, light-receiving materials which don't let the long wave lengths out.

Another very critical background piece of research that has been going on since last spring and very actively this winter, was the development of what we call the solar algae ponds. Now, this is what I meant earlier when I said that we looked for natural systems to do things for us in the future that are presently done by machines powered by fossil fuel. These solar ponds were designed to be inside structures where light would impinge on them. We were trying to find out if we could create from living material, in this case a green soup of tiny little plants called phytoplankton, a low grade heater. The plants would be the absorbers of the sun's energy and the water in which the plants were floating around in, the storage medium. At the same time that green soup, because we like to integrate things or make connections in accordance with the wholism that I spoke about, would also provide the basic feed stocks for our fish. We have fish in there that simply swim around like great blue whale and grow on that stuff. We had temperatures this winter down to -22°C and winds at that time were blowing 30 to 35 miles an hour. The solar algae ponds were sitting outside with a cap on them and a double skin in an exposed location. There was no reflective wind break at that time and at no time did the temperature of the water ever go down below 5°C. In other words, they were still acting during the worst conditions of the winter as solar heaters. Admittedly 5°C isn't what would keep you warm in a house. We put a solar reflector on in the middle of winter and immediately the temperature inside those things went up to something in the neighbourhood of 25 to 30°C, roughly around 80°F, and the fish we had within it grew like weeds, little realizing that it was wintertime.

Now 40 of these structures are going to be inside the Ark on Spry Point and they will be coupled together in the form of a river. I don't know exactly what fish we are going to be able to grow in them. This is a large question which I can't really answer but the ones that we have been growing in the past are algae-eating fish from Africa called the tilapia. They grow in about three months to an edible size. We can grow these; we showed in experiments

Dr. Todd (continued):

this winter, at about one per gallon, and that works out in the Ark facility at about 22,000 pounds per year of fish, with about 95% of the feed stocks being grown right in with them. If you want to work it on a per acre basis which is a terrifying thing to do, because I don't know if you would ever have an acre of solar ponds, it is several million pounds per acre, internally produced in eco-systems designed to raise food. Now, while this may not be applicable as a research program for a coastal area with its own unique resources, it has some applicability in other parts of the world, perhaps even more strongly than here. A fish from Israel also did very well. These fish this winter doubled in size without much extra feeding inside their ponds over the winter. Fish from China, the white amur, had the advantage of not feeding on the green soup like the other two, but on old wasted hay and by-products of vegetable gardens, or market gardens. So we just throw it in and the fish kind of sticks its head out of the water and eats these things. And these are not awful fish to eat, they are magnificent. Now whether any of these will be cultured in the Ark or not I don't know. None of them would survive in the wild here, incidentally; the tilapia dies at temperatures of about 10°C, so it would never survive in the wild. One of the reasons why we chose these species is that by working with tropical organisms, you don't threaten your own wild environments.

Well, I just wanted to point this out as one of the background research programs to the Ark here and point out how this is just a first possibility, an inkling of how we can find ways of doing vital jobs for society in ways that haven't been dreamed of yet. If we have the spectre of the waning petroleum era, as I believe we do, this is all the more reason to develop diversity of approaches to the future.

Spry Point, down on the eastern end of the Island where the Ark is situated, was surrounded by pack ice this winter. The pack ice is a great resource for us down there, believe it or not, again talking about bio-regional processes. The meteorologists have told us that 50% of the energy impinging on the Ark is light coming from that ice, reflected off the ice and that we can expect about 50% of the heat load coming from light bouncing off the snow. That is why our collectors are vertical, unlike Dr. Hooper's in Toronto, where if they have any snow it is pretty dirty as you know. This is very interesting for the Island because it basically means that you can put a solar collector on the side of an existing house rather than messing up the roof which makes me less pessimistic than Dr. Hooper yesterday. Although, I thought what he said was very good and very well said, I just don't agree that we can't retrofit; in fact, I think we will try some retrofitting experiments over the next few years.

But getting into the Ark itself. It derives its basic energy sources from two areas, one the Hydrowind power plants which I have already mentioned, and secondly from the sun. The solar system consists of the vertical collector and a hot water collection system. Whenever the sun shines, water is pumped through it and runs down and

Dr. Todd (continued):

into a 22,000 gallon chamber below the house, which will be at about 150-160°F. It will be very nice to walk around on your bare feet with the insulation between you and the hot water chamber. So that provides part of the basic heat load. The collector for domestic hot water, because you need hot water in the summer time, is slanted to take advantage of the summer's rays as well as the winter's rays. The vertical collector is an American design made by a man at Yale, and the reason why we chose it after much agony, was because it is the only one that has been shown to work, or one of the few that has been shown to work reliably, and the Ark has to work over a period of years. As for domestic hot water panels here, we have the solar collectors from Canadian manufacturers, so if they don't work, we will just have cold showers. The whole structure itself, (and this may be carried out in a collaborative research program with the Institute of Man and Resources and maybe the National Research Council) will help to evaluate collectors being made in Canada. I would like to push it one step further and maybe figure out who could make them right here.

The other basic heat collecting source, and this is something we really have to look at, is the greenhouse component that is over 2,000 square feet, and that is itself a collector. Most greenhouses open their vents and shoot their hot air out into the atmosphere. This one instead vents all the hot air down into another basement which is filled with rocks. Unfortunately we have found one of the most costly things about this experiment was rocks. There aren't any on the Island, so they had to come from across the way. Basically whenever the temperature is about what the plants like, heat will just be shunted down to a rock storage system.

We have done an energy budget for the Ark and just to give you a couple of figures, if you include the windmill as a heat source for November, December, January and February, we have a surplus. The worst month, December, has a 16 million BTU surplus. If we say to the windmill, "You have better things to do, lay off", we have a deficit of 8 million BTU in that structure in December. In November, we have plus 11 million. January is 5 million down; but by February, already in Prince Edward Island, we are back up generating in a surplus. So, we only have two months a year that we need to provide energy from other sources, which include a very elegant, interesting little stove designed in Denmark. As an emergency measure the windplant has a coupling to the household hot water fan coil heating which could be triggered in case of some internal threatened thing.

In the greenhouse area, there will be resistance coils under the soil so that we can match the temperature needs to the roots of the plant very, very economically with not an awful lot of energy. We are going to have a tree propagation unit in which seedlings and cuttings will probably produce somewhere between 10 to 20,000 high quality trees a year as a micro-economic unit.

Dr. Todd (continued):

On the south side, plans are that we will research commercial greenhouse vegetable production trying to tackle the local winter market which would be tomatoes and cucumbers primarily, grown in the fall for marketing in the winter here. Again the idea is to spend about five years, not only investigating the structure as a living structure, but also as a biotic entity which can not only provide its residents with a source of income, but perhaps link it to a larger farming operation, much the way as farmers here on the Island use greenhouses in tobacco and cole crops today, only this would be a little more tightly controlled, more tightly coupled with the household itself.

The living end of the Ark houses a research laboratory. There is going to be an extensive bio-environmental analysis system and we are collaborating with the government in working a micro-climatological station there. There is a family greenhouse and you can walk in and out of it from the living room, dining room, kitchen area. As a matter of fact, food plants can be grown right in the kitchen of this particular structure. It can be separated because at times we may want to run the house at 70°F and the greenhouse at 50-55°F. There is a composting toilet system which recycles waste and doesn't pollute. Developed in Sweden, it is called the Clivus-Multrum and it is cleaned out about every two years. What comes out is sterile, excellent fertilizer. Then there is a normal sized living area, for the average size household resident, or maybe a little larger, because we needed slightly extra space for people to meet and talk in.

Now as far as the aesthetics are concerned, the question was raised yesterday about the aesthetics, and I think it is going to be different; it is going to be highly landscaped, because it is through the planting of trees that one can extend one's growing season for sometimes two or three weeks by avoiding cooling winds and drying winds, and what have you.

I would now like to use the Ark and the Hydro-wind and the solar algae ponds and certain aspects of the Institute's attempted wholistic approach to the future, as frames of reference for discussion. I don't want to give the impression here today that this is our sole focus. I am very interested in the whole question of energy and capital in agriculture generally. I don't pretend to be any great authority. It is more of a gut reaction, so please forgive me for some of the errors that I might make. I think a goodly percent of agricultural research throughout the world, whether it is at the Rockefeller Foundation in South America or wherever else, it is directed toward greater yields on our farm lands. This is important, no doubt about that, but I don't think it is the whole story. These increases, as we all know, have involved infusions of fertilizers, agricultural chemicals, and a tremendous amount of machinery. I got a chance to burrow into the Island's agriculture statistics and discovered that, lo and behold, it is in the machinery sector that the costs have climbed out of proportion to the rest of agriculture. And so, trying to peer between the lines, one gets the

Dr. Todd (continued):

feeling from time to time that increased yields are not necessarily translated into net profits on the farm because the farmer is purchasing more to acquire these yields. He or she is paying interest in many cases on the increased capital necessary to operate today, to maintain what is expected to be maintainable. I guess the farm economy is more external and the people who are making the best livings, as a result of this, are very often not the producers but the suppliers of these products. It may be that agriculture is slowly being eroded because of this shift. I think, and here I am skating on even dicier ground, that the way of the future is going to be different (you are going to perhaps laugh at me), towards smaller farms using less capital and more information. That latter point I think is critical here.

Internalized economies (the Ark cost a lot to get going but once it is going, it is off and running for a long time), are going to have greater independence in agriculture and I think greater relative wealth. I think in this future, as Premier Campbell has articulated so well, there will be strains of the past but there will be much that is new. In creating agriculture more in tune with this biotic entity (Prince Edward Island has a wonderful gift of good soils and a good climate), we can create a new kind of agriculture that involves less capital but we are really going to have to work for it. I think we are increasingly going to have to learn to use nature and decrease our reliance on chemical or fuel companies to provide us with our power.

We set out to establish an experiment. We just asked ourselves a simple question which tends to be how all of these things start: could we make a farm, could we create a farm for $35 to $40,000, no let's say $30,000, could we make one that any one of us in this room could tend and make a living from, as compared with $100,000 or so which is the capital land costs of farms in the Island? Now, the way we would approach that problem here is slightly different than the way we approached it on Cape Cod where land just is not available anymore; the farms have disappeared in the last 25 years. But we decided to design, and it is just being built, so I can't give you any information on it as to whether this idea is going to be successful or not, a micro-farm. It had to be powered by the sun and the wind; it had to create its own climates; furthermore it had to grow stuff full out all year, because if you can do it in the winter time in this part of the world, you have got something. And it had to be interconnected with each element feeding the other, much the way nature does, so that the productivity would be so high and the external inputs, apart from its initial construction, would be so low that, even though its gross income might only be about $18 to $20,000 per year, its net income, after paying for itself, the bank mortgage could be $9 to $10,000; in other words, an acceptable system. We call it Bioshelter I. It contains an aquaculture region of the

Dr. Todd (continued):

type that I have described briefly, a vine tree crop experimental region, where we will experiment with the food crops that are most adapted to the conditions which are produced, and a commercial greenhouse production area. You maybe feel a little insulted that one calls something like this a micro-farm but everything goes on in here that goes on in a larger farm so that the amount of knowledge necessary to operate it is the same as if you were operating a farm elsewhere. There are some nine of the solar ponds that I mentioned indoors, and another 21 out in the courtyard, because we now no longer need structure for them, as they stay warm enough all year without structures. All of the sun's energy that impinges on that structure, even on cloudy days is blown down into a subterranean chamber where the heat is stored. We can compete with fossil fuel-type greenhouse management whose heating costs are over 60% of that now and we can afford to have smaller units to compete. I wouldn't be surprised if after a few years of really hard work on these things, people can build these bioshelters themselves. Some of our people who had never wielded a hammer were involved in the construction of ours. It is very dramatic in the way it looks and yet very attractive. I'll tell you one of the ways it gets productivity is that nutrients build up in these aquaculture systems faster than the plants can remove them. The plants are the primary filtering mechanism so that water, loaded with ammonium and other goodies that plants like, is irrigated down into the plants. In experimental plots, we managed to get over 100% increase in yields with shallow rooted crops like lettuce using the water from the aquaculture system. In turn, the wastes from the agricultural system are thrown back in to provide the nutrient base for the fish and the aquaculture. So, it is a miniature world and it is a world which is pleasant to work in, at least we find it is, and it is one way of answering the questions of how we can do things with less capital and a one-term investiture of money and still maintain the kind of food levels that we need in the future.

The way that we will approach this problem here on the Island, I'm not yet sure. There is an awful lot of debate as to which way we should go, and perhaps by listening to you people, the answers will come to us. Thank you very much for listening to me this morning.

PREMIER CAMPBELL: Thank you very much Dr. Todd, for the hope you hold for the future and for the insights and ideas. I spoke with a farmer a few days ago who had, through the Family Farm Program, installed a greenhouse on his farm in order to advance the start of his growing season and he was telling me that one of his winter energy bills was $600 per month and this is beginning to erode the profitability of his entire operation because so much of his returns are now having to be used up in energy. I just make this comment as a lead to a general question about your presentation. Yesterday we were left with very little hope for older established homes in the province and you have opened the door again which is helpful. And of course, the implications that this has for farming, or greenhouse aspects of farming are exciting. But what is your storage? Yesterday we were also told that we should be looking at year round storage, hence the conclusion that that answer was limited to big buildings. So could you explain now, on a small scale application in the family home, in the family farm, what your answer to the energy storage is?

DR. TODD: First of all I think all of you have to be suspicious of a single discipline ever approaching any problem which is why you got that approach yesterday. But if an architect and a biologist and an engineer and some other people are sitting side by side, what a terrible nuisance, even a problem, becomes an asset. To digress a bit before I get more precisely to your question. We wanted to make the solar algae ponds, we didn't want to truck them up from New England where they are made. They are very special they don't leak, which is a very unusual feat for any pond maker, and they have marvellous light transmitting properties, as I mentioned. It is the same stuff as the roofs of our buildings are made of. So we went to the company and we said, "We think we know a man on Prince Edward Island who can make them for us, how about giving us with the goods as to how to do it?" And they said, "No, it's proprietary, and while we wouldn't mind giving it to you, it would mean that the larger corporations would get it from us." So we came up and we talked to our friend on the Island and told him the sad news and he said, "Just a minute now, aren't you jumping a little to conclusions? Let me do a little work up here." So he called back, and he said, "Well, I tried to make one of those things, and I got hold of a resin and it didn't hold." A couple of days later, as I understand the story, he called again and he said, "Well, I got hold of another resin and I made myself a little model of those ponds up here, and I tried to tear it apart. Well, I didn't tear the bond apart, which was the proprietary interest involved, but I sure tore the fibreglass apart." So, what we have here is a man who worked out the technology because somebody asked him to, within a few miles of this building. The ponds are going to be built here because he took the time and the interest to go through that, to track down a solution when it was supposedly secret information. So, this is a question of linking between elements, and I think the kind of thing you see in the Ark, in the bioshelter, is more applicable on a farm. A farmer wouldn't have too much trouble seeing the usefulness of a greenhouse coupled to his house if he was dealing with a product that could give him a boost in season. I think the biggest area is retrofitting and the reason why it doesn't get talked about, is because there isn't a lot of profit to be made. Retro-fitting existing houses is not simply solar heating them but making them low energy houses, which may be cheaper than solar heating. For example, and Amory Lovins can tell you more about this this afternoon, the Danes, or

Dr. Todd (continued):

may be this was a Swedish experiment, found an exterior way of drastically reducing the heat loads of the house. They invented a way whereby they just put a second outside skin on the houses which any one of us could do in our spare time and which is very efficient, and got the job done right away. In other words, the Ark uses long term storage, the word yesterday was "annual". It was designed initially to run for a month without the sun because we assume that that sometimes happens unfortunately. Short term storage, little systems, are equally exciting with a tight house. We put a stove in which we tried yesterday and I guess, as Canadians, most of us are too close to the wood stove to really like it but this one stove was operating yesterday in that structure which isn't completed (it doesn't have any of its solar heating or any of its heat storage), and it warmed the whole thing. And there is an awful lot of exciting innovation going on in stove technology right now and although it may not impress nuclear physicists with the exception of Amory Lovins, it is really important and I think certain countries like Denmark seem to sense the importance of these micro-approaches to the future. So I think it would be possible for the New Alchemy Institute or Institute of Man and Resources or any group, to take a couple of houses and actually calculate the kinds of technology that would be necessary to make them snug and operate on very, very little energy. There are some houses, and one wonders at the fumes, the odours, that operate almost on no energy alone, but the appliances and the people. They are designed that well and while you can't retrofit that tightly, you can certainly come a long way closer. I think we are going to see a little renaissance in the way we deal with housing. Housing is such an exciting part of the Island's scene; I mean one of the things that makes this place most interesting is its architecture. It should be something that would be attractive to us.

The other thing I think we are seeing is a lot of activity, more in the Province than anywhere else, in windplants. We are not the only windplant people as you know; there was the Dominion Aluminum, it is an outside firm, but it is a Canadian firm and then John Garnham, I understand, is starting to manufacture small plants near Kingston. And there is another group or two who have been importing the Australian mills for a number of years here so that we may see a lot of activity that will actually have rather global ramifications, although it might not strike us at this time. There is a real growing interest in the creation of manufacture and technologies that can be developed indigenously. I know this is one of the things of great interest to ourselves and others. I think there is a lot that is going to happen and I know that as I look through the 1880 Atlas, the number of things that our forefathers did here, are probably more than we do I may be wrong but I think they made more things and I think they were a little more ingenious than we are. Unless I am mistaken even railway cars were made here on the

Dr. Todd (continued):

Island in the last century. So that I can foresee a lot of very interesting things happening. I think it has to be based on a strong agriculture because that is the basic premise upon which this society is based, so that it really begins, I guess, on how the farms are operating and how profitable they are for the family farmer.

A really interesting study was done recently in Missouri about small farmers who were successful (there are small farmers who are very successful); and the report was recently published. One of the things they found was that the successful people were really an interesting group. They were youngish, the mean age was 46; their capital structure was much less; they had figured out ways of operating their farms on less machinery. The acreages in many cases were around 80 acres so it was an interesting comparison. Secondly, there was a higher ratio of livestock on all those farms to other crops than in any other sector of agriculture. The third point this study revealed, which I find intriguing, is that during periods of very high prices the small farmers didn't sell off everything, and during periods of very low prices they didn't hang on to everything. They actually had a kind of stable basis, much less prone to fluctuations than the other elements in the agricultural sector. The State of Missouri was so impressed by this that they established an actual extension program operating out of their agricultural university exclusively for small farmers and it is the hottest thing in the State right now.

So again, I think that ultimately the question of agriculture is primal.

MR. MCINTYRE: I wonder, Dr. Todd, at this point in time do you have a figure of a cost per kilowatt of that 3 to 4 kilowatt plant that you mentioned?

DR. TODD: We are going to do an economic estimate this fall that you would be happy with. At the present time I can't give you anything that you would be happy with. The 32 kilowatt wind plant here is made up of four mills on towers each with a hydraulic engine. They all link by umbilical cords to a single generating station and a single hydraulic pump on the ground. If one should fail, the system only feels the other three because of the equalizing chamber in the hydraulic pressure; or if one should operate at a different speed, it is all compensated to deal with that. The way I will answer your question is if NASA was developing Hydrowind they would have spent well over a million dollars to get to where they were to develop a 32 kilowatt plant. We have spent around $100,000 because we have discovered very ingenious ways. People were less mercenary and would work for us to get the thing developed. And so if one talks about development ratios to actual eventual cost ratios we've, I think, somewhat narrowed the gap. The Island network can stand, the utilities people in Wisconsin tell me, for about one-third of the budget of the energy load which can be handled by things like wind plants with synchronized inverters. These things are being manufactured; they are not terribly expensive but that would be about a dollar a watt installed. That figure was chosen because that is what nuclear power

Dr. Todd (continued):

is going to be a few years if it isn't already. There are at least one or two studies in the western United States that suggest that it is already there, although the figures in the energy field are enough to drive everyone to total cynicism.

Hydrowind II, that I didn't show you but I alluded to, knocks about 30 to 40% off that price because it piggybacks and simplifies and uses a single tower for two elements. Then when one gets into manufacturing scales, the question you ask is: how much is an installed kilowatt per hour or kilowatt capacity, say at a production level of a hundred plants? And I hope by late fall or early winter I can have an honest figure there. The only thing we are hoping is that they are going to be competitive quickly with alternative sources. One of the advantages of wind plant which is rarely talked about, is that it is not an all-or-nothing situation. You can build capacity in as you feel confident to install it; in other words, if you assumed that there was a 2% increase in growth then you can say let's turn the task over to the wind plants to provide us with our 2% increase in growth. You are not investing all your capital in a single solution which may take years to get going and not operate or operate at a terrible loss from time to time, as they say the Pickering Plant has done. So that you can really proceed more carefully and you can have more control, because on the Island you would be manufacturing the towers, you would be manufacturing the plants. Even if your capacity for power production were greater (let's say for argument it costs more), what you have really done is keep all the profits you have created in the internal economy which is a strong one. There is the maintenance, the construction, etc. so that in fact you are not paying out to get a single entity back, you are paying out to incorporate a member of the society.

The wind profile in Prince Edward Island has to be as close to a fine a one as anywhere I know of. The winds are fairly steady, fairly constant, a source of great concern to most farmers as they see the soil being blown off into the sea, but nevertheless if wind plants are going to compete economically they are going to do it here, in Newfoundland,and in other areas of Canada which simply cannot be supplied by fuels readily.

I think that as for the technology, it has in some senses been second class and the reason is because there haven't been any great incentives to develop it. I mean if one compares the billions spent to make the atom useful for humans and the few pennies spent to make the sun and the wind useful, one tends to get cynical about the neutrality of science. I think there were simply more profits seen ten years ago in the nuclear business than in these other areas because these other areas, ironically, lend themselves to diverse manufacture, diverse design and diverse use. The way we use the sun on Cape Cod and here in Prince Edward Island is very different than the way solar people use the sun in Arizona. It can't be reduced to a single entity and that is why these things have been neglected and I think is the reason why the new Institute of Man and Resources can find those

Dr. Todd (continued):

areas that have been neglected because it was in the economic interest of others to neglect them. And I don't think that was a paranoic attitude. It doesn't pay, say, Ontario or Montreal where the people are, to invest a lot in wind energy if they control the nuclear technology. It just doesn't make sense. You won't push that kind of decision through. The only way you are going to push through the development of a new technology is when an area says, "We need it". Then I think you will get more per dollar than any other way.

Windmills, in a few years, are going to be one of the most sophisticated things and they are going to be really quite trouble free. We'll have to see a few go off into the sea first, I think. I hate to say that but it is because there isn't that much money, for example, on the Hydrowind; we only had enough money to prestress test three blades. That means to destroy under tension and determine how much tension it takes to destroy the blades. Now if it had been a fat research contract, I think we could have probably destroyed 20 blades. It would have been statistically more interesting, but there was a compromise between time and having the prototype operating by the end of April or the first of May so that we could have the full size plant operating on the Island by the end of the summer or early fall.

So if we appear a little simple and our technology appears a little crude, I think it is because they are ideas in embryo rather than second class ideas. Now that the umbilical cord is here, or almost here, maybe the power flow will go the other way some day. I think it might.

MR. MCINTYRE: Would it be fair to assume, Dr. Todd, from your answer, that we are looking at $1 per kilowatt less 40-45%, which in approximate figure would be something like 50¢ a kilowatt for 600 kilowatts, or $300 a month against now, say 5¢ a kilowatt, or $30. Is that a fair sample?

DR. TODD: No. These are costed over 20 years. I don't have the figures with me and the reason why I am intentionally not carrying them with me is that I don't want any false promises to go out. I think power on the Island is about 5¢ a kilowatt hour. I think that Hydrowind II is going to generate power costing over 20 years, at about 5-6¢ a kilowatt hour. I think so because of the wind you have. As they said yesterday, power goes up with the cube of wind velocity.

MR. MCQUAID: Did you say that you only had from $700 to $1,000 worth of power that would be able to sell after the Ark uses its?

DR. TODD: Well, let's say at today's prices, $700 to $800 a year, yes, which is a better alternative than paying out $700 to $800, in fact the difference is $1,600.

MR. MCQUAID: But it is not going to benefit very many people, is it?

DR. TODD: No. This is a prototype system. The original design idea was to have a system large enough to handle a dairy operation.

MR. MCQUAID: I was interested in your suggestion that your solar plant, you think, can be adapted to existing houses. The figure given yesterday for one of these installed in a new house was in the area of $10,000. What would you estimate it would cost to put your system into an existing house?

DR. TODD: I can't give you a figure at all. We may be able to get at this this afternoon when we have some of the others who are more experienced in this, when we have the round table. I think we may be able to prove that question a little more intelligently.
MR. MCQUAID: You do think that an existing house would be suitable irrespective of the shape of the roof or the slant of the roof and so on, and would this have the storage in it for storing this?
DR. TODD: Yes, but it wouldn't be the large storage that was talked about yesterday.
MR. MCQUAID: Well, it was suggested that we could put our storage out in the yard.
DR. TODD: Yes. Actually we don't have any unique system here. The solar collector that he showed you yesterday. Is that made in Israel? It may have been made in Israel. So there really was no new stuff shown there but it is possible to do it and fairly quickly, to come up with a series of designs which could be fairly readily incorporated. I think the costs are something in the order of \$12 to \$14 a square foot. I think they could be pushed down to that for solar capacity.
MR. MCQUAID: How do you propose to handle this terrible problem of insulation that this man pointed out to us yesterday; you know, your house has to be terrifically well insulated according to this man yesterday. And how do you propose to insulate these houses?
DR. TODD: In fact I think that is more important. That is a more important project than the solar heating itself.
MR. MCQUAID: And you think an existing house could be adequately insulated without tearing it all apart.
DR. TODD: I would like to say, and Amory can talk more about it this afternoon, that kind of problem is so readily solvable that you simply go into all the literature, which takes you a few months; you come up with the best answers and then improve on them relative to the climate here. And I think that one could come up with a prototype design, including building it, within two or three months. We would like to retrofit a house and I would like to do it outside, in other words as an external retrofit because then you don't make the rooms smaller. In most cases they are small enough. And secondly, if it is external you are not tearing up the house while you are putting a second skin on.
MR. MCQUAID: I'll let you try it on mine.
DR. TODD: I am amazed at the Ark! It is tight - a tiny little stove and we were all taking our coats off and sweating yesterday - and there is all that square footage; it's tight!
HON. JOHN H. MALONEY, MD: Tell us a little about the stove that you are moving to. Does it contain any new principles?
DR. TODD: No, it doesn't. There is nothing new about it at all. They say the most efficient stoves are the Norwegian stoves and they burn for rather a long time. You can operate them for 14 to 16 hours in some cases without refuelling. I think I need a forester handy to verify this. If you burn in that kind of stove slowly on a low grade wood, it would creosote up pretty quickly and there would be a

fire danger. This stove, because we have the solar capacity, in other words it is an adjunct, can lift up and be a fireplace. It is not as efficient but you have flames dancing around the room and it has warmth emitted from it which has a lot of emotional appeal. It closes down and becomes a stove. It burns a little faster and it will only operate about eight hours between loadings but in a house not dependent on it as a primary heat source, eight hours is a wonderful gain. I would say, a stove like that could be built here by any good steel maker; it has fire brick in it. You could put that into an existing fuel-fired house quite readily, probably in the chimney, and whenever you had a little extra wood you could run it when you felt like running it and operate your house at a relatively low base load from fuels. The costs in fuel would drop considerably.

The other aspect that wasn't mentioned this morning, and I guess it is about time to wind up, was that I have nothing against petroleum; I think it is a marvellous material that has produced some of the most interesting products that are really valuable things. I am not really happy with it being burned as a fuel because that is the least interesting way to use it. I much prefer to see, for example, the Ark use a sandwich material made of petroleum for its transparent roof which has little air-locks inside it so that the heat can't get out of the structure. That is a nice way; that is stopping fuel use and making it into a semi-permanent product. What wasn't mentioned this morning, perhaps because one shouldn't talk about these things, but I think one should, was the very vulnerability that we put ourselves in here in most of New England and Maritime Canada. We really have to dance to someone else's tune when it comes to Venezuelan politics. This is a new situation, I think for Eastern North Americans to be totally dependent on the whims of other people. In this particular day and age, with all the politics of petroleum, I think that is a pretty precarious position to be in. So any effort we make to have two or even three prongs to our fork that we call society is very, very important. In some cases, one can't even put a dollar value on it. Thank you.

MR. MCINTYRE: You mentioned earlier solar collectors on a home. Have you any idea of what the cost would be of installing one of these solar collectors on an individual home at this point?

DR. TODD: I think we are getting two collectors, one is coming from Vancouver; the other is coming from somewhere around Toronto, maybe Port Credit. I am not sure of the cost but I think they are about $12 to $14 a square foot and one might put 400-500 square feet on a house if one had storage capacity. So if one could do a quick calculation of that, it is $6,000 to $7,000.

MR. MCINTYRE: Would this be for completely heating a home?

DR. TODD: No. I don't think it is wise to completely solar heat a home. I think to go about 80% as Dr. Hooper suggested is the answer. I certainly think that would be a more valuable approach. You see, if you have 80% or even 60% of your load coming from the sun then it doesn't seem quite so ridiculous to have a little bit of baseboard electric heating in there when you have got a bad spell. Then you don't resent it to the same degree, or for those of us with a slight preference for wood back-up systems, it gives us a chance to get out and saw wood or something. That might not be the solution - obviously the city solution is going to be different from the country solution but, I think the intermediate stage and this is where Mr. Ritchie made so much sense, is that this is the transition period. It is not at this point in time on all-or-nothing situation. I alluded to the fact that it might become an all-or-nothing situation if we didn't have any alternative so I think I am being pragmatic there. Also, I wouldn't be surprised if on the Island that we had the talent to start making solar collectors right away and I think the talent could be found right now to start a few units anyway. The first few would not be as economically exciting as into the second stage and I think some of these small manufacturing concerns will need some management help because they tend to be, first, engineers and many of them not trained too well in management areas. Again I am optimistic that it wouldn't take a long time. If solar installations could be part of mortgages, could be added to existing mortgages, then I think it would go like that. If we could spread out the burden of it and put it in its true perspective. Thank you very much.

MR. WELLS: At this time I would like to introduce our next speaker, who has come some considerable distance to share his views and his experience with us - I am referring to Mr. George McRobie, Director, Intermediate Technology Development Group Limited, London, England. Mr. McRobie's formal education was realized at the London School of Economics. He began his work career in the coal mines of Great Britain between 1943 and 1946. He acted as a political and economic planner in London from 1948 to 1955 where he did economic research. For the last 20 years he has worked with E. F. Schumacher whom, I am sure, many of you will recognize as the author of what is becoming an evermore popular book on economics called "Small is Beautiful". He started with E. F. Schumacher in 1965 the Intermediate Technology Development Group and since that time has worked in various African countries over the last ten years. He started the Intermediate Technology Development Group Journal and publications from that group and also offers a consultancy service. He has left with me to pass around for your interest a copy of that journal which I will circulate as soon as Mr. McRobie has begun speaking.

So it gives me great pleasure to call on Mr. George McRobie.

Role and Potential for Intermediate Technology in the Future

MR. GEORGE MCROBIE: Mr. Speaker, Members of the Legislative Assembly, I thank you for the privilege you have extended to me of addressing you. My subject will be Alternative Technologies in Practice, and during the course of the half hour or so, I will try and give some examples drawn not only from our own experience but that of other people in the development and application of small scale and low cost technologies in different parts of the world.

Mr. McRobie (continued):

I think it is necessary before I do this to give some idea of what our Intermediate Technology Development Group is, and what it does. We are, in fact, a non-profit company and a charity registered in the United Kingdom. We were formed in 1965 with the object of promoting and developing small scale, low cost technology.

I think it is also true that until very recently, until the last few years particularly, there was a widespread assumption that technology could only move in one direction. That was up, bigger, more expensive, more complex; perhaps typified in the dreadful experience of Concorde, for instance, where one group of very clever men designed something, another group of perhaps less clever men insisted we must make it. We hope that in the United Kingdom in the near future we will have a government by cancellation, that is every time we cancel one of these projects, the popularity of the government goes up. It started working quite well.

I don't want to go into the things that might be cancelled but perhaps concentrate on the more constructive side of some of the activities that have started in the United Kingdom as well looking at alternative technologies, because six months ago we appointed our first research officer in the United Kingdom to concentrate on alternative technologies for the United Kingdom and we hope similarly to have groups in Scotland and Wales before too long.

Now this assumption that technology can only become bigger, more complex, more expensive was largely unspoken and it was enshrined, if that is the word, in an ideology of economic growth which has been with us until very recently. That is that growth of a particularly rapacious kind would be with us forever. No one ever said when the growth levels off, if it was ever going to level off! That was still with us when we formed the group in 1965. For the rich countries in the world the argument was 'the sky is the limit', and for the poor countries in the world the argument was, ' become as like the rich countries as quickly as possible and you too will become rich'. It was the great virtue of Schumacher that he challenged this idea and, in fact did this in India in 1963 when he put forward the concept of an intermediate technology which he defined (I think we would still define) quite simply, as a technology that lies somewhere between the sickle and the combine harvester in terms of cost and sophistication and complexity.

The sickle has reached the limits of its productivity; you couldn't do much more with the sickle. The combine harvester, if that alone was offered to the developing countries, was a prescription for their continuing underdevelopment because it was within reach of only a very small section of the population. If it did indeed generate more income, that income did not, as people would hope, percolate downstairs - it remained where it was. And Schumacher's approach, the basis of which is still the keynote of our activities, is that it is important to look at the cost per work place when looking at new technologies. Over most of Europe the cost of creating one new work place in a manufacturing industry is now in the order of 4,000 pounds excluding the cost of land and buildings, that is equipment cost alone.

Mr. McRobie (continued):

In most developing countries the cost of creating one work place, if it was to be 4,000 pounds, would assuredly mean that very few new work places were created and from about 1965 onwards we have concentrated, along with a growing number of other people, in trying to identify technologies which would lie somewhere between the one pound technology of the sickle and the much more than 4,000 pound technology of the combine harvester. In fact, there is a relationship between cost per work place and income per head which I don't have to go into in any detail, the main point being that there is some relationship between the income of a community and the capital equipment it can afford to purchase in large numbers.

It was then that we started looking very hard at large scale technology in its application not only in the poor countries but especially in the poor countries because it was there that the effect of large scale technology was most evident. First of all it is essentially a centralizing technology; it centralizes activity in large cities. Of course it was assisted in this by energy that was virtually given away until 1973, it was so cheap.

I was interested to get the impression this morning that the energy was so cheap, it was sort of an act of God almost, one felt. If so it was an act of God as the Scots would say, under very suspicious circumstances.

But at least man has now made energy less cheap and so it will remain. But assisted by cheap energy, the technology we have developed has become essentially a centralizing technology requiring large scale units of capital, mass markets, and then with that, the whole structure of the economy is determined. The minute you have a technology imposed of that size, the whole of the rest of the economy has to take its shape from that technology. And this is really, I think, one of the more interesting and more startling features of some of the work we have been doing.

It is now quite evident that the choice of technology is perhaps the most critical choice that any country can make, not only a developing country, but it is most evident in developing countries because on that choice depends who works and who doesn't. Where will work be done? Will it be done only in the city or will it be done in the rural areas? What kind of work is it? And work is the greatest former of people. It also determines what infra-structure you have. If the type of technology demands that you are centralized in one city, then the infra-structure will follow suit. It can even affect the type of social services you have. There are very few institutional decisions that are made in a country which are not influenced by the sort of technology that is adopted. And yet, surprisingly enough, until quite recently, we have thought of technology of all things as neutral. It is very far from neutral. It carries its own culture, for lack of a better word, with it and of that there is no doubt; many, many cases can be given.

Mr. McRobie (continued):

The characteristics of the technology that we have developed under the influence of the application of science to engineering and virtually free energy, very cheap energy, have been that it is very large, very complex and very capital intensive, or more familiarly, more labour saving. It would make a very interesting study to think of why we have always thought of labour saving but certainly in the future we must begin to think of capital saving. One of the reasons being is that capital equals energy, so I am picturing what I am saying in terms of energy in rather a broad way. But the fact remains that the technology we have developed requires vast quantities of energy to manufacture the technology as well as to run it.

Now in contrast with this, we said what is required by developing countries is a technology that is, instead of being very large, relatively small, so that it fits into small markets and small communities. But it meets the human need more and more expressed nowadays in the form of strikes and action that can only be explained by the fact the people are sick of working for large organizations. It meets the human need for smallness, for dealing with people and not being dealt with by machines.

It should be relatively simple so that you do not have a small core of highly elite specialists who make and maintain machinery but that you can spread the use of such equipment much more widely throughout society; for example, so the grandson and the grandfather can both have a hand in it as well as the highly skilled father. That too, I think many of us would recognize as one of the social necessities of the present time.

And thirdly, it would be capital saving instead of labour saving. And this implies too that it would use very largely local resources to meet local needs, at a capital saving. What we are really saying to scientists and engineers is for the first time in a 150 years, "Stop devising machines that are labour saving and start devising machines that are capital saving." If anything, this is a more challenging task to technologists than labour saving because it is not difficult to save labour if your capital is limitless, so it doesn't matter how much it costs, save the next 20 men. Instead of that, if you were to say now "Let's start saving resources", this then requires a more ingenious approach on the part of engineers and scientists than we have had in the past.

Well in 1965, when we started the group, we addressed ourselves to some of the technologies relating to rural development; rural development because the problem of poor countries especially resides not in the cities where unemployed people tend to make their appearance, but in the rural areas from whence they come, from which on the whole they are forced by lack of employment opportunities in the rural areas. Then we started looking at such things as agricultural equipment, water supply, building, building materials, small scale energy sources, power supplies, services such as rural health, transport, forestry and forest products, chemistry, chemical engineering

Mr. McRobie (continued):

and a range of small scale industries. And over the past ten years we have found the application of modern technology to many of these areas of activity can produce highly efficient but very small scale technologies.

I am not going to try and give any exhaustive account of what we are doing. I'll just pick a few particular cases that obviously may or may not apply in your economic environment, many of them won't, but to illustrate the principle that if you give a subject really serious attention you can find ways of making it small and efficient. Now, I don't think in many cases that you have to be taught this; you have already discovered it for yourselves. In economics one is taught, as far as I can remember, that there are three factors of production - land, labour, capital - and that these are very distinct and separate. But they are not in practice. In practice the distinction between labour and capital is knowledge. If you have the knowledge you can create your own capital equipment in your own time. If you don't have the knowledge you have to save up to buy that capital equipment. Now a very good example would be you either make your own fishing boats which fit into your own society, or you go outside and buy much bigger ones. I think in the case of Prince Edward Island you have chosen to make your own, quite correctly. What it does do is to avoid an enormous load of indebtedness, as John Todd spoke about in farming this morning. If you don't have to use your capital to go out and buy the knowledge from someone else, if you have the knowledge, you can make it yourself.

Now most of the pieces of equipment, not all of them but most of those I am referring to now, are of the kind where local communities can in one way or another modiblize the resources for self-help technology. In the field of agricultural equipment we have been looking at very small scale mechanized, animal operated equipment and, of course, a whole range of simple water supply, simple pumps and simple building materials. Let me take the simple building materials, the most obvious example. The modern brickworks can produce in the order of something like two million bricks a week. We have shown it is possible to operate a brickworks making ten thousand bricks a week at the same unit cost. If it were possible then to provide some of that power by means of wind power or methane this would make it even more attractive.

Cement is another very interesting case. A modern cement plant operates around 12,000 tons a day. It is possible to make plants produce around 150 tons a day, at rather lower unit costs because the technology changes as you redesign the plant to make it smaller. In the field of building too it is not only a matter of scaling down large scale technologies, you can bypass the large scale. For example, in work that we have done in India, one of our engineers, Robin Spence, has shown that you can produce a very satisfactory cement, mortar rather (one mustn't call it cement because the cement manufacturers get angry about it; call it a cement alternative or mortar), made of

Mr. McRobie (continued):

lime, brick dust, gypsum and one or two other easily available chemicals and it can put up buildings up to two stories high at a very small fraction of the cost required if you used conventional cement. And, nowadays I would ask who wants buildings much more than two stories high? Certainly not in developing countries.

It is when we turn to forestry and forest products that I think we find the most interesting, potentially productive developments. Not long ago the head of I.C.R. research wrote an article in Chemistry in Britain in which he said the future chemical plant in the United Kingdom will be relatively small, will be widely dispersed in different parts of the country, and will be based largely on wood. And he went on to say that the chemistry of wood had been pretty well ignored for the past fifty years; in fact the whole chemistry of cellulose, the cellulose chemistry. And we have already heard of the potentials that lie in timber. It really does now require these to be spelled out in practice to discover exactly what can be done on a relatively small scale.

In the field of small industries, we have a growing body of experience. For example, you can get a foundry now - the most modern foundry will cost between 20,000 and 50,000 pounds, highly automated - but you can also get one for 2,000 pounds and not long ago we asked the foundry industry in Britain to help us to develop the smallest foundry that man could devise. They hunted around for a bit and did quite a lot of work on their own and then they finally came in triumph with a foundry costing less than 100 pounds which they informed me that I could build in my back yard any time. Quite true. You can have a foundry for less than 100 pounds and it would operate on a very small scale. It has also the advantage that it would use not only coal or coke, it could also use charcoal as a fuel whereas the larger foundries don't. One often finds this is actually scaling down the technology, in fact totally redesigning the technology, the requirements for specialized raw materials or fuels tend to diminish. So in my cement case, the mortar, the cement substitute, the sort of stuff the Romans built most of their buildings with, a bit up-graded, can be made from oil, coal, coke or wood, whereas cement cannot be made from wood as a fuel. It requires the very high temperatures that you can only get from oil or coal, up to 1,500°F.

When we come to other small industries, we have been looking at industries such as glass, paper, paper/pulp, papier mache, equipment, machines and, among others, one that is not likely to be of immediate interest to you but the principle is of interest to you, sugar. I think in all of these cases, every time we have started to look at the subject, we are assured by the manufacturers of the big machines that there is no possibility of making it small and efficient. That is their instant reaction.

We were asked some years ago by Zambia to produce a small-scale egg packaging - a machine for making papier mache egg trays, the industrial kind, fairly large flat ones - and we thought we could probably identify a small manufacturer, but we couldn't. The large manufacturer who is an American multi-national company based in Denmark,

Mr. McRobie (continued):

for reasons no doubt best known to itself connected with tax, immediately assured us that it was physically, technically, and economically impossible to produce a small machine. The smallest one they made cost 250,000 pounds and produced a million egg trays a month; not much use to a developing country which required a million egg trays a year maximum. So we were lucky enough to find a few people to help us and we designed a small machine and put it into production, the machine costing 9,000 pounds instead of 250,000 pounds, and this has worked very successfully ever since. So much so that the big companies have come to us since and said, "Look chaps, you know we don't make a small machine", we said that we knew but they are getting so much demand for small machines, they asked if we would make it, they would sell it for us.

We are hoping to do the same with glass in the very near future, to produce a very small-scale glass works and equally a small-scale paper manufacturer. The absence of small-scale units in both these cases has so far prevented the effective development of a recycling scheme for both these industries. By effective, I mean one which means all the available waste glass, waste paper than can be found, not just some of it.

Now all of this was done very largely, not entirely, with the developing countries in mind. Strangely enough, it was another initiative from the east coast of Canada that brought us quite fully into the area of looking at the technology of rich countries.

In 1968, a group of young people at Memorial University of St. John's, Newfoundland, took the initiative in bringing together people from what they called the Middle North - Scotland, west of Ireland, north Norway, north Sweden, Iceland, Greenland, northern Canada, Maritimes, Appalachian Mountains. The only one they missed out was southern Italy, which you really couldn't call the Middle North. All of these have one characteristic in common and that is that they are peripheral areas on the edges of rich communities, large scale metropolitan centres. They all suffer from the same problems. They are on the outside looking in. Their level of income is low. They sporadically tend to suffer from migration to the mainland main centres. They are not getting a reasonable share of increased economic activity. They are in fact very much treated as the rural areas of developing countries in that they are the suppliers of raw materials to the metropolitan centres who then process those raw materials, turn them into (very often) rubbishy consumer goods, and sell them back to the raw materials producers at enhanced prices. That is always a prescription for continuing poverty or low levels of income.

In all of these areas, one would need to pursue the idea of maximizing the value added by work at the point of production. What do you produce, how far can you process it before it is sent anywhere else for consumption? In fact, one would go as far as to say all these areas that I have mentioned have very strongly the characteristics of colonies, if you define a colony as an area where the main economic and social decisions affecting that area are not made in that area but outside it and, I would add, in parts of the world which produce

Mr. McRobie (continued):

what they don't consume and consume what they don't produce. And basically, the need in all such areas is to maximize the self-sufficiency of the locality. This runs against a great deal of orthodox economic teaching; so much the worse for orthodox economic teaching. Because in reality the idea of this large scale international division of labour is a guarantee of impoverishment for very large areas of the world surface. It is always worth remembering that the theory of free trade was developed in Britain by economists who were invariably the lick-spittles of the rich at a time when it suited Britain to have free trade. You could multiply that in many other cases. The theory that supports particular activities generally is derived by economists looking at what the rich are doing and then saying "This is the theory that supports it."

So in all these cases, we would argue, one requires a new look at technology to say "Let us devise a technology that is appropriate to our social and economic conditions." Generally speaking, it will have the characteristics I have mentioned: it will be smaller, it will be less complex, it certainly will be cheaper in terms of capital costs. I would like to give you an example which illustrates the case (although you are unlikely ever to use the technology itself), in the case of sugar refining. I mentioned this one because the principle is so extremely interesting. I have been told very vehemently and with rage by makers of sugar refining equipment that there is no such thing as a small scale sugar refinery. It doesn't exist. I have feebly countered by saying,"Well, there are 600 of them working in India and I have seen maybe 200 or 300 of them." The argument is then put forward, "As far as we are concerned, they don't exist." It is a different argument but you are going to see the point.

Now, this is a technology that was developed quite deliberately over a period of the past ten years particularly by a very remarkable North Indian economist called Gar. He set out to take a traditional technology for making sugar which is rather inefficient, an open pan sulphation method, and steadily upgraded its technical efficiency so it is now within reach of the large scale technology in terms of technical efficiency alone. But if you take technical efficiency only, you don't really get the full picture because this small-scale technology has social and economic advantages that go far beyond the purely technical efficiency of the plant. For example, speaking from memory for the cost of one large-scale plant you can have 50 small-scale ones which means you can have them widely distributed in different parts of the country, generating new income and starting the possibilities of capital accumulation outside the centre. Instead of employing 900 people for the large plant, you employ 9,000 for the small plants, affecting income distribution very considerably. Total amount of sugar refined: large plant, 12,000 tons; the 50 small plants, 30,000 tons. Cost per work place: large plant, 1,500 pounds; each of the small plants, 150 pounds. The only respect in which the large scale is superior to the small is the amount of sugar derived from each ton of cane brought into the plant. In the case of the large plant, it is

Mr. McRobie (continued):

about 90% extraction; in the case of the small plant, it is about 80% extraction. In terms of the economics of operation, of course, this is much more than made up for by the short transportation hauls.

This has very many interesting applications because one can begin to see industries in our own societies which will be moving in the same direction because of the increased costs of transport and the costs of energy required in the process. The most obvious ones are those where you have a high energy input in the process of manufacture and high energy input for moving the stuff; for example, bricks would be a very good case, so would cement, so is brewing. Even the brewers in the United Kingdom, not notorious for their acumen in other ways, have realized suddenly that it doesn't pay to have highly centralized breweries because, since beer consists of about 80% water, what you are doing is paying through the nose for carrying vast quantities of water.

There are other more complex cases which may need looking at. For instance, I have frequently stood on the motorway in the United Kingdom looking at lorries going from London to Glasgow carrying biscuits and lorries going from Glasgow to London carrying biscuits. Now the only logical, rational explanation for this is there is something in the nature of biscuits that requires them to travel 500 miles before they are fit for human consumption. That is the only rational explanation. There are no other explanations. Yet to each individual manufacturer it makes sense because of the marginal cost of producing biscuits and the hope of expanding your market somewhere else.

So we live in a society where individual decisions, the total sum of individual decisions, may not in fact reach the point of collective benefit.

But apart from such cases, what we need now is to identify certain areas of activity and look very hard at the resources available within the boundaries of your own society, and then say, "What do we consume, why can't we produce it here? What resources do we have and how can we use them and press them to the uttermost? If we have a resource that requires processing, how far can we carry that processing before we let it out of our hands?" Never take 'no' on the question of technology. If people say it is impossible, our experience says it isn't impossible. It is only impossible as far as the chap who is speaking to you is concerned but it is also true that you can find very large numbers of people now who are prepared to turn their minds to this question to make relatively small scale and relatively efficient technologies work. Well, you have already had evidence of this, to have a man of the calibre of John Todd turning his mind to the question of small-scale, non-violent farming, this is a very good example. I think more and more people are beginning to think in the same way.

So, we are arguing now increasingly in the rich countries as well as the poor. We are really saying that the poor countries require this sort of technology - small, simple, capital-saving and in this way, non-violent. The rich countries also need a new technology partly because people are tired of the large-scale technologies where

Mr. McRobie (continued):

the people are of no account, where, as somebody said, raw materials and inanimate objects leave the factory improved, men leave the factory diminished. That is the sort of production system that we have developed increasingly and we are reaping the results of it, perhaps in many aspects of violence in our society. So there are human reasons for changing our technology. There is also a profound environmental reason for changing our technology. Until within the last 15 years the scientists and technologists who were previously saying "Let it rip, the sky is the limit" are now turning around and saying "Sorry, you cannot go further along this road; this way means death." Atomic energy would be a very good example. But there are many less obvious ways of slaughtering future generations. You could only justify atomic energy programs by taking the somewhat robust view attributed to some American philosopher (would that be the word?) who said, "Why should I worry about the next generation, what has it ever done for me?" On that ground you could go ahead with the atomic energy program. But there are many other aspects of the environmental damage that is being done by large scale technology. Maybe these two could have been contained but the energy crisis in 1973 changed all of that and we now need, for three reasons, a new technology: the human reason, the environmental reason, the resource reason. If we take these three together it is pretty decisive that we have to start looking at a form of technology which will not be the same as the one we have had up to now.

So, I would end by saying in our experience it is perfectly true, I think, that the title of Schumacher's book, Small is Beautiful, in our experience over the past ten years, that small is also possible.

Thank you very much.

PREMIER CAMPBELL: Mr. McRobie, I am sure most of us here and many Island viewers of this program have found it possible to fit Prince Edward Island right into the kind of world you were describing and much of what you have said, I am sure, hits home in a lot of places here in Prince Edward Island. I might make one observation. As you have suggested, manufacturing and corporate entities tend to grow larger and larger seeking the so-called greater efficiencies, leaving us in the more remote areas of the continent to pick up the remnants of a very centralized, industrialized society. One of the dilemmas we have is that whatever development on whatever scale of size we hope to achieve, the centralist large corporation does not tend to want to centralize its capital investment in smaller units in the Atlantic provinces. In fact, they want to buy up the smaller ones and close them down. Now where you have been associated with the establishment of enterprises on a smaller scale, what have been your sources or what have been the sources of capitalization?

MR. MCROBIE: Local governments almost exclusively. This is really one of the reasons why we have tended to concentrate on low capital cost, so that it does not require the resources of a large corporation to put up the money for it. And the sort of technologies we are thinking of would be in the range of a few thousand pounds.

Now if you translate these into the quite obviously higher sophisticated levels of Western economies, you are still talking in terms of tens of thousands of pounds and not in hundreds of thousands of pounds. You are talking relatively small workshop-type industries and that might be one of the ways of overcoming this problem. I quite agree with you, and this is a point I should have made but didn't, that the capital supply is in the hands of people who are only interested in very large agglomerations of capital. But if one can think in terms of much smaller scale units of production, you then escape, or rather bypass, the large scale unit. And this is one of the things I think can be done on quite a large scale. You may not be able to attack the large corporation point blank, but you can bypass it, and bypassing it would simply mean producing a slightly different product, different from the one the corporation produces which isn't difficult, which you can generally improve on the product in terms of quality at least, and then find local capital to put up money to do the process locally. It does require the assistance of people in engineering and science to help you to design that sort of equipment.

Now, to take an example, I believe it is true that a lot of the solar energy equipment is now being made by relatively small firms. I think John Todd mentioned that to me the other day. Solar energy, wind power and probably small-scale water generation with small-scale turbines, lend themselves to small-scale local operation and you would not require vast capital outlays for them. I suppose there are cases where you do, but I think the first move would be to say, "Right, how can we make this small, how can we make it capital cheap and how can we bypass the need to go to the big capital market for this money?"

I may add to this, in the case of the egg tray machine, we did not even need to go to any manufacturer. The banks put up the money locally; 9,000 pounds, not a lot of money.

PREMIER CAMPBELL: Well, that has generally been our realization and I think the governments in the Atlantic Provinces have been putting up more than the usual amount of capital investment in business enterprises. We are caught on another side of the equation as well. The larger corporations tend to have the marketing expertise and indeed the big clout in the markets, we have found some examples in Denmark that would have useful application for Prince Edward Island in the North American context in terms of the concentration, quality and development of a good deal of technology. Do you have some comment about the small technology and enterprise on a small-scale competing in a very sophisticated market system?

MR. MCROBIE: I think this is always possible because you have got certainly an advantage of a local market and I am not always thinking in terms of export but one can do a great deal locally to get people interested in a local product, provided of course it is of high quality. A certain amount of assistance on the management side and the marketing side would be needed because, although there are many people with technical ingenuity, they may need assistance on these fronts. I think this is perfectly possible and a lot of the small-scale industries both in Denmark and the United Kingdom still operate by being able to provide a high quality on a relatively limited production run. I think this is still very possible. I would say the same would apply to, maybe, quite a lot of agricultural equipment once one got around to looking at different designs from the ones provided by the huge manufacturers.

DR. MALONEY: Do you think one is likely to get more entrepreneurialism in a society in which you have small manufacturing, because this is probably the greatest obstruction to development, certainly in the under-developed areas in Canada? It is not really that there is no money. While there is not a whole lot of it, there is a certain amount that is available. And it is not labour, but it seems to be a lack of creativity, of innovation or risk taking, of just general enthusiasm that a job can be done.

MR. MCROBIE: What you say is very interesting because our experience on the whole has been that the number of entrepreneurs coming forward is not independent of the level of technology you provide. If you provide only a highly sophisticated, complex, expensive technology, the number of people capable of running that in any community is relatively small. If you try to make it simple and small within people's reach and comprehension, the number of people running it is very large. I would put a great deal of emphasis on this. This level of technology is really very important in terms of the number of people that you will get round about to be involved in it, to take it up. So I think that is a very important point indeed. You can't think of the technology simply as being a fixed thing, we have generally tried to provide a range. The important thing here is, people don't know about the range of technologies in existence. Even now, with all the interest there has been in wind power, it is extremely difficult to find a catalogue of wind power machines suitable for different purposes to meet different needs. Where is it? Maybe people are compiling them all over the place but could you lay your hands on one tomorrow? The answer is no. And we have been doing this for a long time. We now have a host of about 60 publications that we have produced on simple technology and each time we have had an argument with the Ministry of Overseas Development in the United Kingdom (with whom we have a very curious relationship which I can only describe as a sort of a love/hate relationship in which the element of love is sadly deficient). They say, "Show us the demand for these technologies and we shall respond." Now you don't need to believe the latter part of the statement necessarily to know that the first part is nonsense. How can people ask for something when they don't know it exists? Now this is one of the great deficiencies in our modern society, the lack of knowledge of any alternatives to the high technology. It just isn't there. And so one of the primary tasks would be to make known the range of technologies that exists and make it known freely, to publish little guides, showing different technologies for woodworking, metal working for all sorts of activities people might want to undertake. Without these, people simply do not know and when they don't know, they think it is beyond their reach. A very important point.

MR. MCINTYRE: I wonder Mr. McRobie, you mentioned four essentials there - land, labour, capital and knowledge. We appear to have a reasonable amount of land, fair amount of labour; the capital and the knowledge is perhaps a bit questionable. How can we obtain this technology within our own society?

MR. MCROBIE: Judged upon our experience, this is really not difficult, once you can begin to identify certain areas of work. Obviously agriculture would be one area that you would be interested in; another would be everything connected with the sea; others would be manufacturing supporting both these activities, perhaps processing the inputs to these and the outputs of these. Now that would give you a range, probably of 20 or 30 quite clearly identifiable technologies and then it is a matter of going out to discover who knows what about each one. We have operated through a system of voluntary panels where we have brought together people from government, industry and the universities to advise us on the best technologies that exist in these fields. This is always a very productive combination because normally people from universities, business and governments don't meet unless it is to argue about something. To bring them together and say, "Now, let's concentrate our minds about the questions of agricultural technology. What alternatives are there in the field of agricultural technology of the kind of agriculture we are interested in?" Through this we can identify (a) what exists, and (b) where are the gaps. Where is new work needed to be done? Are there big gaps in the technology? Who can we persuade to start working on this? Very often you can find that there is an agricultural university somewhere desperate to do some work on it.

So you first of all identify the range of technologies that exist and out of that you can usually find what are the gaps in that technology. How can you then get them filled? And it is astonishing how you can begin to persuade universities and government research establishments to work on what are quite obvious needs. You haven't just plucked them out of the air. You have looked at them carefully and you have said there is a need here for a new improvement in technology. Well, will you welcome it and if not, why not?

MR. MCINTYRE: I think you did mention machinery somewhere along the line, were you thinking of suggesting a pooling of machinery within our agricultural communities?

MR. MCROBIE: No, I didn't have that in mind. I was thinking really of looking at machinery which was less capital intensive than equipment that now exists. This is on the reasonably founded belief that a great deal of farming equipment is now getting more and more expensive; that people are in a sense being sold only what it suits the manufacturer to sell them, and this probably applies even more to processing equipment as to production equipment. I also had in mind enlarging the range of activity that is open to a rural community by saying, "To what extent can we process your own outputs as near to the point of production as possible?" I am thinking in two senses: (1) can we find simpler and cheaper equipment for existing use? (2) can we introduce simple, cheap equipment for processing locally to increase the farmer's income at the point of production? These are two thoughts; I didn't spell them out sufficiently.

MR. MCINTYRE: Are we talking about necessarily smaller units of operation for doing the same type of work?
MR. MCROBIE: Well, on the whole, our experience has been that the nearer you get to sort of horticultural type of farming, the more efficient the farming becomes in terms of output per acre. But your conditions I would not like to talk about because I don't know them. The universal experience elsewhere in the world has been the more people you have working per unit of land, the higher the productivity per acre which as you know is the only important thing when one is discussing food production. But I would hestiate to talk about agricultural scenes that I know nothing about.
MR. WELLS: I think it is about time to ask our technologist to invent an appropriate microphone that could be slipped from man to man.

Our next and last speaker today, prior to the panel arrangement I talked about earlier, is Mr. Amory Lovins, who is a consultant physicist concentrating on energy and resource strategy. Mr. Lovins, after two years each at Harvard College and at Magdalen College, Oxford, was elected a junior research fellow of Merton College, Oxford in 1969. He resigned his fellowship in 1971 to become a full-time British representative of Friends of the Earth Incorporated, a United States non-profit conservation lobbyist group. His activities on the international energy grapevine have included work on energy policy in about 15 countries in the last year. His current or recent clients none of whom, he's quick to point out, are responsible for his views, include several UN agencies, the Organization for Economic Cooperation and Development (OECD), the International Federation of Institutes for Advanced Study, the M.I.T. Workshop on Alternative Energy Strategies and Science Council of Canada.

Mr. Lovins has testified before parliamentary and congressional committees, has lectured and broadcast extensively, and has published five books, several monographs and many technical papers, articles and reviews.

I would now like to call upon Mr. Lovins.

Soft Energy Paths

MR. LOVINS: Thank you. Mr. Premier, Honourable Members, I am delighted and honoured to have this opportunity to explore with you some ideas on which many energy strategists in many countries are now starting to converge, ideas central to the experiments that place this Island in the forefront of world efforts today to find sustainable energy futures that we can live with.

My talk will be in two parts. First I would like to use an example from the United States to illustrate some simple, fundamental concepts that are relevant to other countries and then I would like to apply some of these ideas to Canada.

So first let me describe two possible kinds of energy futures for the United States, not as precise recommendations but rather as a vehicle of ideas that may suggest useful questions to ask here in Canada where the general structure of the energy system is quite similar to that of the United States but the local conditions, of course, are diverse.

TWO ILLUSTRATIVE, SCHEMATIC FUTURES FOR THE U.S.

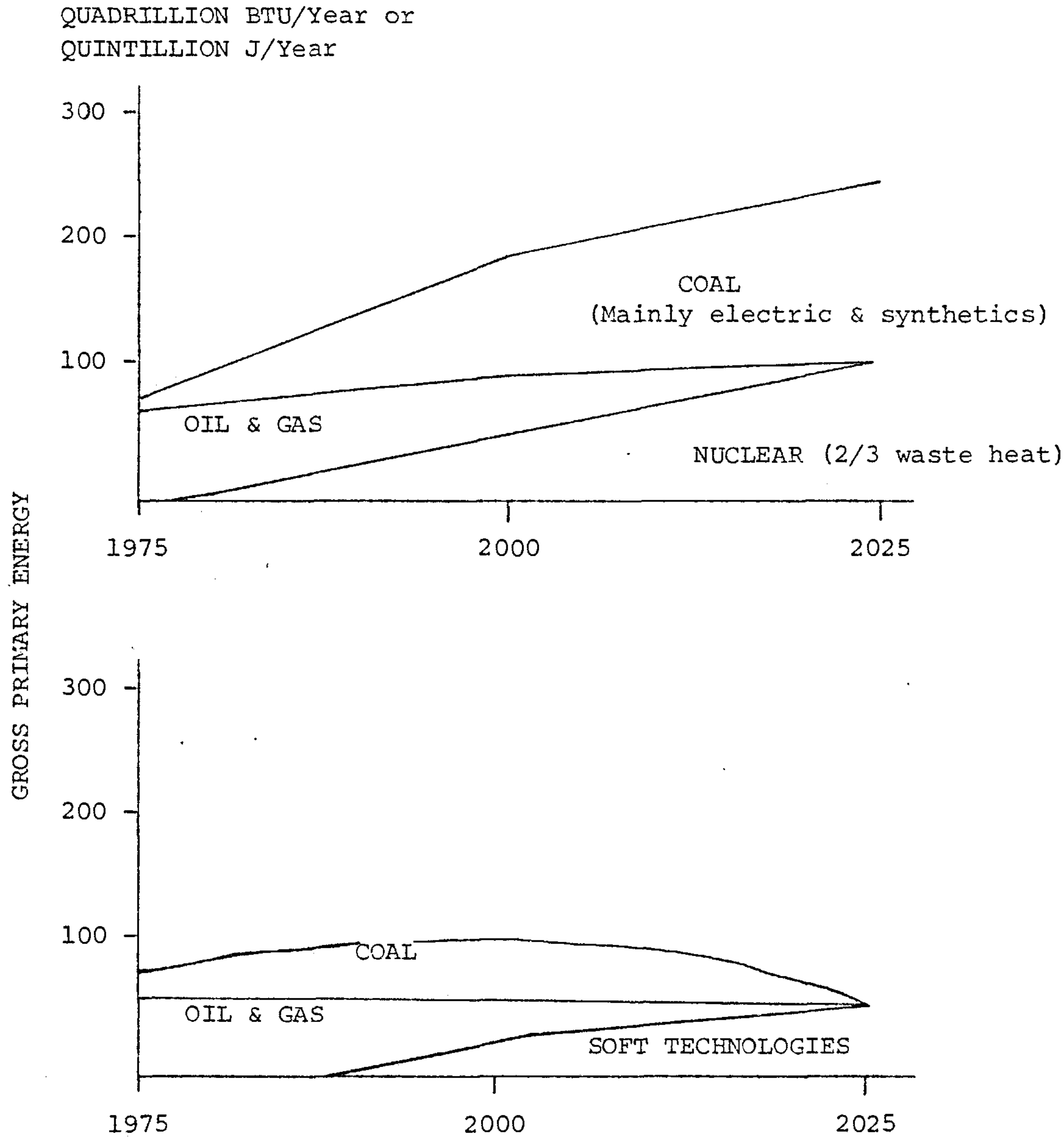


FIGURE 47

Mr. Lovins (continued):

What we have on this chart is a sketch of two possible long term energy futures for the United States. (See Figure 47). I am only showing main terms. These are schematic, they are not intended to be precise. At the top, I have a graph showing something like the federal energy policy in which we push very hard on all our domestic resources in order to reduce short term imports and dependence. We have a massive coal-stripping program. The coal goes mainly to electricity and synthetics. We have a lot of Arctic and offshore oil and gas, a lot of imports; we have a huge new nuclear program; we have, in short, a program which has been called 'strength through exhaustion'. And it has a number of serious problems. For example, it gives you more electricity supply options than you actually need but you find, especially from the 1980's onward, that you are still short of oil and gas. Even worse than that, at least half of the huge energy growth shown there never gets to the consumer at all. It goes to fuel the fuel industries. We found in Britain, for example, that half of our energy growth since 1900 has been swallowed up in conversion losses in an increasingly inefficient chain of conversions from one fuel to another.

Now, there are some important reasons why you can't do what the upper graph suggests. And my second slide (See Table 34) gives one of the reasons. What I have shown here is the approximate amount of money that you need to invest initially in order to buy a complete energy system to deliver a barrel per day of new energy to consumers. Now this isn't the kind of bookkeeping most people do. Some of the numbers we heard yesterday referred only to the cost of a part of an energy system, like a power station, and they referred only to installed kilowatt, not a delivered kilowatt. It is a big difference.

When you start looking at the whole system a very important fact emerges. As you go from traditional direct fuel technologies on which we built our economy, through frontier oil and gas, to synthetics from coal, the capital intensity goes up by about a factor of 10. And as you go from there to electrical technologies, especially nuclear ones, the capital intensity goes up about a further factor of 10. It is that kind of capital intensity that led, for example, the strategic planners in the Shell Group in London to conclude some years ago that no major industrial country can afford to electrify most of its economy, and they are starting to think the same now about synthetics, that these are such big, expensive technologies that nobody can really afford to do them on a big scale. They are starting to look like future technologies whose time has passed.

Now, if we go back to the first slide and apply these numbers, or indeed if we apply a very detailed analysis that the Bechtel Corporation did last year, we find that just the first ten years of President Ford's energy program in that upper graph will cost about a trillion of today's dollars. And when you work it out you find that that means the energy sector would be requiring not a quarter, as now, but closer to three quarters of all net private domestic investment over that ten years so that the energy sector would be consuming its usual share of your discretionary investment plus two thirds of all the rest.

APPROXIMATE CAPITAL INVESTMENT (1976 $) NEEDED FOR AN ENTIRE ENERGY SYSTEM TO DELIVER EXTRA ENERGY TO A CONSUMER AT THE RATE OF 1 BARREL PER DAY (EQUIVALENT TO ABOUT 67 KILOWATTS)

Traditional Fossil Fuels, 1950s-60s	$2-3,000
North Sea Oil, Late 1970s	$10,000
Frontier Oil and Gas, 1980s	$10-25,000
And, in a different league:	
Synthetic Fuels from Coal, 1980s	$20-40-70,000
Conventional Coal-Electric, Mid-1980s	$150,000
Nuclear Electric, Mid-1980s	$200-300,000

Note: These are U.S. data, but the Canadian data would be similar

TABLE 34

Mr. Lovins (continued):

And it is not hard to see some deserved political obstacles in the way of that kind of diversion of resources. It isn't just a problem for the first ten years either because the further up that steep curve you go, the more you find that what you thought was your added wealth from extra production has to be ploughed back into the care and feeding of this very capital-intensive energy system. So you are running harder and harder in order to stay in the same place.

If you do a similar calculation for Canada, by the way, it tells the same story. And you can get numbers quite similar to this for Canada by just dividing by nine or ten. The problem is basically the same.

At this point, I think it makes sense to ask what we could do instead that might be a bit more attainable, and I have sketched at the bottom an example of a softer energy path. You will notice that I am defining these paths not by the amount of energy that is used but by the technical and political structure of the energy system. That way I can emphasize the social implications of that structure which I think are very important in the long run. I'll get to that presently.

Whether a path is hard or soft is really what is the primary interest; whether it is high or low is derivative and not nearly so interesting.

Now a soft path has three main elements which I would like to treat one at a time. The first one could be called conservation but I don't mean by that curtailment. I mean wringing more social benefit from each unit of energy. Initially, for the first few decades, this means what is called technical fixes. These are just measures to increase the efficiency use, using today's technologies which are now economic. In fact many of them have been economic for a long time and we have just not bothered. In the process of trying these technical fixes, we save money. Sometimes the first cost of the conservation measure is negative because if you build a really energy-efficient building, you save so much on the heating plant that it more than pays for the insulation. You also save a lot of jobs for reasons that earlier speakers have described. The last I heard was that if you wanted to build a power station you would have to put in about a quarter of a million dollars to make one job. It is about the most capital-intensive major investment in the whole economy. Any other way you spent the money, you would make more and more lasting jobs.

I mentioned initially you work by technical fixes. You just get more rich meaty goodness out of your energy but later on there is a wide range of paths that you can follow if you are willing to consider structural or value changes. For example, we are finding in many of our cities that what we had thought was going to be voluntary mobility has turned out to be involuntary traffic where you work to buy a car without which you can't get to work and the net benefit of that may not be very substantial.

If you double your efficiency, and we have ample evidence in the States that we could do that by about the turn of the century, then you could be as affluent as now with half as much energy or twice as affluent with the same amount or any other combination you like, and it will take

Mr. Lovins (continued):

us a long time to make that kind of decision. So I have just arbitrarily drawn one of many possible paths that we could follow, and we don't need to be very specific about it yet. You could just look at the first half of the graph up to the year 2000 if you like and ask yourself whether that makes more sense than the other graph.

Now the second element of the soft path is the use of diverse soft technologies which operate not on depletable fuels but on energy income. You can show that in the United States or for that matter, in Japan, or Denmark, you can construct a perfectly sensible energy economy 50 years from now using soft technologies which are now available, without using anything exotic, without using cheap photovoltaics or sea thermal, or anything like that, but only quite straightforward technologies. But soft technologies are not defined only by their reliance on energy income, they have two other very important properties. First they are matched in scale to end use needs for the reasons George McRobie has so well described. This means that you get your economies of scale not through large single units, but in two other ways: first, by mass production, if you want; that is, you can make soft technologies in small local shops using local skills and materials, adapting to local needs, but you can also recycle the car industry to make heat pumps or wind machines if you like, and you can do some quite impressive things this way. We have in the United States about 40 times as much prime mover capacity installed in our cars as we do in our power stations at less than a tenth of the unit cost because we mass produce cars.

And the second way you get economies of scale in small, soft energy systems is that you virtually eliminate overheads. Roughly half of a typical electricity bill doesn't go to buy electricity. It goes to pay transmission and distribution equipment, meters, people to read the meters, billing computers, ad agencies, inter-office memos, planning engineers - all the overheads of this octopus. And in an energy system based on local-scale the overhead tends to go away. So when you compare the right hand ends of the two graphs, the difference isn't nearly as big as you would think. There are two things happening at once. On the one hand you are getting a lot more social function out of each unit of energy; on the other hand you are eliminating the system overheads, distribution losses, the conversion losses which make up more than half of the growth in the upper graph; that is, all of the energy you are left with in the lower graph at the lower right hand end, is useful energy being used efficiently.

The final characteristic of the soft technologies is that they are matched in energy quality to end use needs. You supply energy only in the quality needed for the task at hand.

If you look at end use in the United States, for example, you find it is something like 58% heat; 38% work, making things move, of that 31% is in vehicles and 3% in pipelines, 4% runs motors in industries. There is another 4% which consists of all lighting, electronics, telecommunications, electric metallurgy, electric chemistry, welding, electric railways, electric motors and home appliances (all for which things

Mr. Lovins (continued):

are appropriate) that is only 4% of end use energy. And you can do an interesting thought experiment. If you take the 4% of end use that runs industrial electric motors, you can cover all that with co-generation making electricity in industry as a by-product of processed steam. If you take the other 4% of end use that runs all the other useful electrical things that we rely on, if you use that efficiently, you cut that in half. It goes down to 2% and you can cover it with today's installed hydro. That is, if you really wanted to you could run the United States right now with no central power stations. That we are not doing so is really a measure of how far out of step we are with supplying energy only in the quantity that we need. I haven't found an industrial country yet in which extra electricity, more than we have now, can really be used to advantage, justifying its extreme capital intensity which I had on an earlier slide. And even at the consumer's end, electricity is very expensive stuff and you are probably paying $80 or $90 a barrel for your electricity right now which makes arguments about $8 or $10 for a barrel of oil seem pretty trivial.

We have had very rapid progress lately in the soft technologies, some of which has already been outlined. We can now build a completely solar-heated house in Denmark with a heating system which will cost less than half as much as doing the same thing electrically. We have flat plate collectors which on a cloudy day in the winter in Denmark will give us a working temperature of many hundreds of degrees Celsius just by high selectivity.

The wind machines that were described yesterday are in the right ballpark to compete with nuclear power. If you want to make electricity with the wind then you can do even better with the wind compressing air to run industrial machines or pumping heat. We have in hand enough conversion technologies to change organic wastes now available in the United States into methanol and other fuel alcohols to run an efficient transport sector. And you can work out that the scale of the conversion industry needed to make that much fuel alcohol would be about seven times the size of a microbiological industry making beer and wine that we have right now. Now this doesn't sound too unreasonable because such a conversion industry would eliminate half of your refinery capacity. And that is a very big industry.

I haven't even mentioned that many of the soft technologies work nicest in hybrid combinations. Sun and wind for example are often complementary. You get the most wind in most places in the winter when you need the heat and you can use wind heat pumps or solar heating to drive biological conversion schemes. These systems fit very well with institutions we now have as well. We have heating oil dealers in New England getting excited about becoming the suppliers of solar heating equipment because then they will keep dealing with the same customers they have always had and it is just the next logical business to go into. We have auto makers going into the windmill business. We have over 150 solar vendors in the United States, most of whom are small

Mr. Lovins (continued):

and indigenous. We have fluorescent light manufacturers going into the tubular solar collector business and there are many ways in which soft technologies can use our technical resouces.

Now the third element of this lower graph (See Figure 47) is the use of fossil fuels to buy the time you need to deploy the soft technologies because that takes about 40 or 50 years. It takes you that long to do anything else either. But you can use the fossil fuels briefly and sparingly to build a bridge to a soft energy economy provided that you use the fossil fuel at the right scale so it is adaptable, so that you can plug into the soft technologies as they come along. Let me give a simple example. Suppose you want to heat people's houses as oil and gas run out. One way you could do it is to spend a billion dollars on a huge synthetic gas plant and feed coal into it. On the other hand, you could built eight small gas turbines run by coal-fired fluidized beds and using district heating and heat pumps and the cost of that whole system, which is now commercially available, will be no more than half the cost of the synthetic gas plant. It will use only two-fifths as much coal. Beyond that, if you build the district heating system on the right scale with neighbourhood tanks that aren't too big, in the long run you can heat those with neighbourhood solar systems or local wind collectors or waste heat from a local factory or whatever becomes available. You have the flexibility. In fact, I think solar retrofit on a neighbourhood scale is not nearly as hard as some speakers may have suggested yesterday because if you have a neighbourhood hot water tank on to which you can piggyback your solar system later, then you can marry buildings which can take more than their share of collector capacity with other buildings that can't take any collectors, because there will always be some of those.

By the intelligent use of coal conversion on a fairly small scale, for example through flash processes or super-critical gas extraction, we can also cream off oil and gas, premium fuels from the coal, to meet our transitional needs and the effect then is that we are squeezing the oil and gas wedge from both sides. So that in the medium term, around and beyond the year 2000, that oil and gas wedge is much more slender than it is in the upper graph. That means that we are doing without most of the very difficult frontier extraction and long term imports and we have not used a big coal expansion.

Now you can compare these two paths in many ways, and that is where I think the interesting policy points emerge. You can compare the two paths and rates, for example, and you find that the soft path is quicker because the systems you are using are smaller, much simpler. They don't require elaborate central management, they don't have big overheads, and they have short lead times. We have a school in Boston that ordered a solar heating retrofit in March and it had the system on line in May. You can't do that with high technologies.

Now, I don't want to leave you with the impression that soft technologies are free. They are relatively capital intensive although they are less capital intensive than the big high technologies which

Mr. Lovins (continued):

you would otherwise have to use if you didn't use the soft technologies. And I think there are innovative methods we can use to put at the disposal of ordinary householders by providing access to capital which heretofore has only been enjoyed by utilities and by big corporations. For example, suppose I want to put a solar collector on my roof. One way to do that would be to have the utility finance it, acting as a bank essentially, and I could pay back the utility through my electricity bill, just by paying the bill at the old rate as if I were still using the same amount of electricity. Now the advantage to me is that without having this huge capital burden I have managed to minimize my life cycle cost; I am making the best use of society's resources. But there are also three advantages to the utility. It is having to spend less than half as much money as it otherwise would if I didn't use the solar system because then it would have to build a power station which is much more expensive. The utility is turning over its money two or three times as fast because the payback time is much faster on a solar system than on a power station. And the utility is avoiding social obsolescence. I think these are substantial incentives.

We can compare these two paths in risks. Clearly the environmental risks are much higher with a hard than a soft path, and particularly there is a risk that our coal burning will run into climatic problems earlier next century. In the lower graph we have hedged our bets.

The upper graph relies on a few very difficult high technologies which may or may not work - breeder reactors, big coal/gas plants and so on. The soft path relies on a lot of very diverse soft technologies so that you are spreading your risk of technical failure and, anyway, you know that most of these work. The soft path is much better for equity within and between countries for reducing political tensions. It really helps the poor countries because the technologies that are oriented toward real human needs rather than abstract economic services are just as much needed in poor as in rich countries and are much more transferable than big high technologies.

Now social change is substantial in both of these futures as it is in any 50 year energy future you can imagine. But I think there is a lot of evidence now to suggest that the social changes you need to make a hard path work are a lot less pleasant, less plausible than the social changes that could make a soft path work. Because the upper graph there means that you have strong central control, making decisions by elitest technocracy, in order to allocate the resources you need to build these very expensive big systems. Political and economic power are greatly concentrated and there is encouragement to monopolies. Energy users are becoming politically isolated from the people who supply and regulate the energy and our lives come to depend on an inherently vulnerable centralized supply system depending on a remote, bureaucratized, technical elite to run it, depending also on strict social controls to keep a rifleman or a few strikers from turning us off.

Mr. Lovins (continued):

I think the upper graph is inequitable because it lets you allocate costs and benefits to different people. People in the cities export the social costs of their energy systems to a politically weaker minority in the countryside. And more broadly, central authority is pitted against local autonomy in a kind of centrifugal politics that becomes very divisive. I think these are high political costs which you don't incur in a properly conceived soft path because its structure is completely different. It doesn't depend on very difficult big projects under central management; it depends instead on a marriage of individual consumer choices based on local conditions and resources. And everyone gets the costs and benefits of the energy system he chooses, not somebody else's. Instead of having everyone's lifestyles moulded the same way by the imperatives of the big energy system, we have diverse technologies that offer something for everybody, no matter where he or she lives. Matching that way is social pluralism.

Now the conventional view I think of the upper graph is that it involves mainly technical problems whereas a soft path involves mostly social problems. Our track record is better with the technical than social problems, so some people think we ought to prefer to incur the technical problems. I think though, that both these paths involve difficult social problems. You can't get away from that any more. So that the most important and difficult and neglected energy questions now are not mainly technical or economic, but rather social and ethical.

And perhaps the most important feature of these paths is that they are exclusive. If you don't get serious about end use efficiency very quickly then the wasteful use of energy runs on so far that there is no way to catch up. If you delay the soft technologies, if you imagine that wedge pushed off to the right, then there is no longer a credible fossil fuel wedge to bridge it. If you don't put the transitional fossil fuels in place at the right time, then what they give you will no longer mesh with your transitional needs as the oil and gas run down.

Now, I think nuclear power is not only unnecessary but a positive encumbrance because the heavy demands that such a big high technology will place on our resources, our money and skill, our time and political will will keep us from doing the three tasks of a soft path at a sufficient priority to make them work together properly. In fact there is a more serious trap that we can fall into with the upper path and it is one that so far you have avoided in this Island; it is a capital trap. So far our major transitions in energy supply have been smooth because we have paid for them with cheap fossil fuels. Now, the capital intensity of our new energy has just gone up by a factor of ten or 100, and it is going to stay there. Energy will be expensive no matter what we do. So we aren't going to have all this cheap political capital sloshing around and wherever we make a transition to, using our last cheap fossil fuels to get there, we are going to be stuck there for a long time. So that if both these paths cost the same, which I think

Mr. Lovins (continued):

they don't, and if there were no other reason to choose one over the other, I think we would still be wise to use our cheap fossil fuels sparingly to finance a transition that is nearly as possible straight to our ultimate energy income sources because we won't have another chance to get there.

Now, can some of these ideas be applied to Canada and to this Island? I would like to share with you the results of some calculations I did last month in the Ministry of Energy, Mines and Resources in Ottawa under the auspices of the Science Council of Canada. And perhaps I should start with how Canada used energy three years ago in 1973.

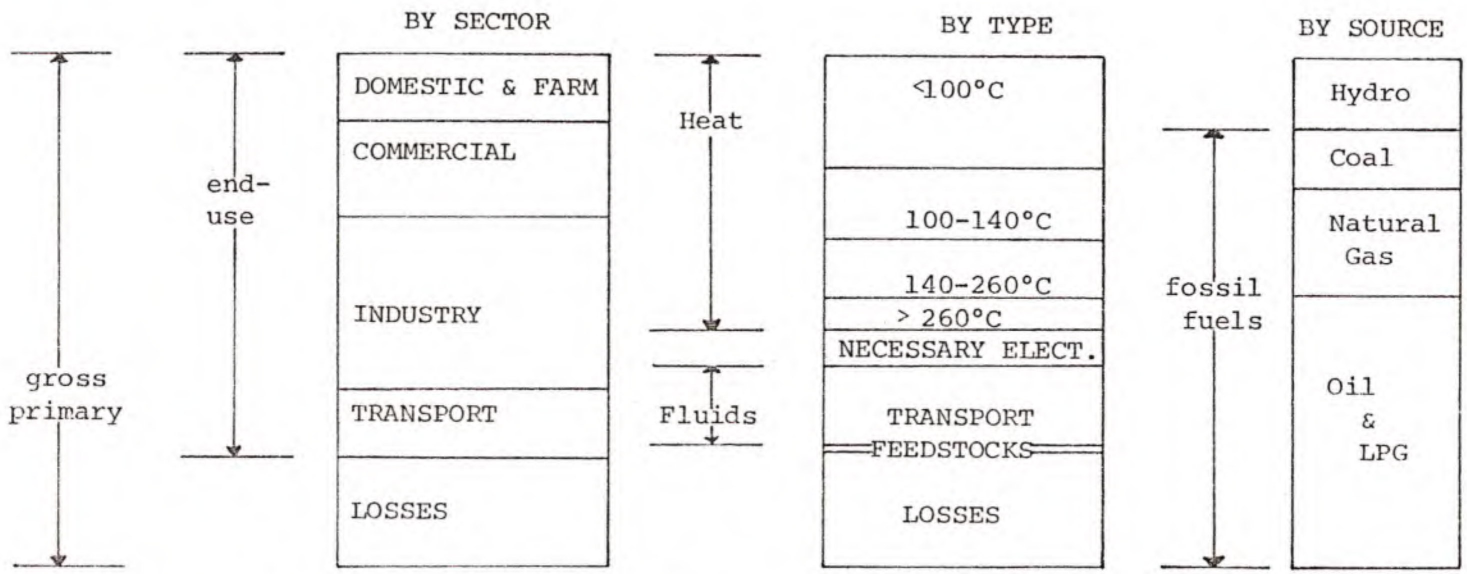
At the left and at the right I have given the sort of classification that you have seen many times, although perhaps the distinction between primary energy and end use on the left is not always made as clear as it should be - about a quarter of our energy is lost before it ever gets to the consumer (Figure 48). And you see on the right of course we are overwhelmingly dependent on depletable fuels. But, in the middle I have given a kind of classification that I don't think anybody had done before and it is quite an important one. You see, out of our end-use energy, a large fraction is delivered as heat. A very small amount is required as electricity. There is a tiny bit for feed stocks, like coking coal and petrochemicals, and the rest is fluids for running our vehicles. Now the next graph looks harder at this heat distribution. This is some work by Puttanunta at White Shell. And following standard projections, it appears from 1958 to the turn of the century the distribution of heat amongst the various categories, the various temperatures, is practically constant and the amount that we need at high temperatures is very small. Most of our heat is low temperature for heating buildings. (Figure 49).

Now, if we just go back a minute to the previous graph, I would like to point out one other feature; that is, if you take the hydro on the right and match it with two sections of the middle bar - that is necessary electrical and high temperature heat, over 260°C - they are about the same. That is, you already have enough hydro capacity in Canada on an aggregated national basis to meet all your electrical needs where electricity is appropriate. That doesn't mean space heating and all high temperature heat needs in the whole economy. That suggests to me that one would have to look very hard to decide whether it is worth building any more power stations. It doesn't look like you need more electricity with its great expense; you may need other kinds of energy, but they are cheaper.

Now the kind of exercise that I was doing for the Science Council involved looking ahead about 50 years because that is long enough to make a major change in an energy economy. And I want to start at the other end. I want to start with where we could get to in 50 years and then work backwards because that way we can discover the existence of very different paths which would be invisible to anyone who only works forward in time. What I tried to do was to take Canada 50 years from now with maybe 40 million people and to estimate how much energy

CANADIAN ENERGY USE IN 1973

(22 million people)



TOTAL = 6.6 quadrillion BTU or
6.9 quintillion J

(Wood and Nuclear
<1% each)

FIGURE 48

TEMPERATURE DISTRIBUTION OF HEAT ENERGY CONSUMPTION

IN CANADA

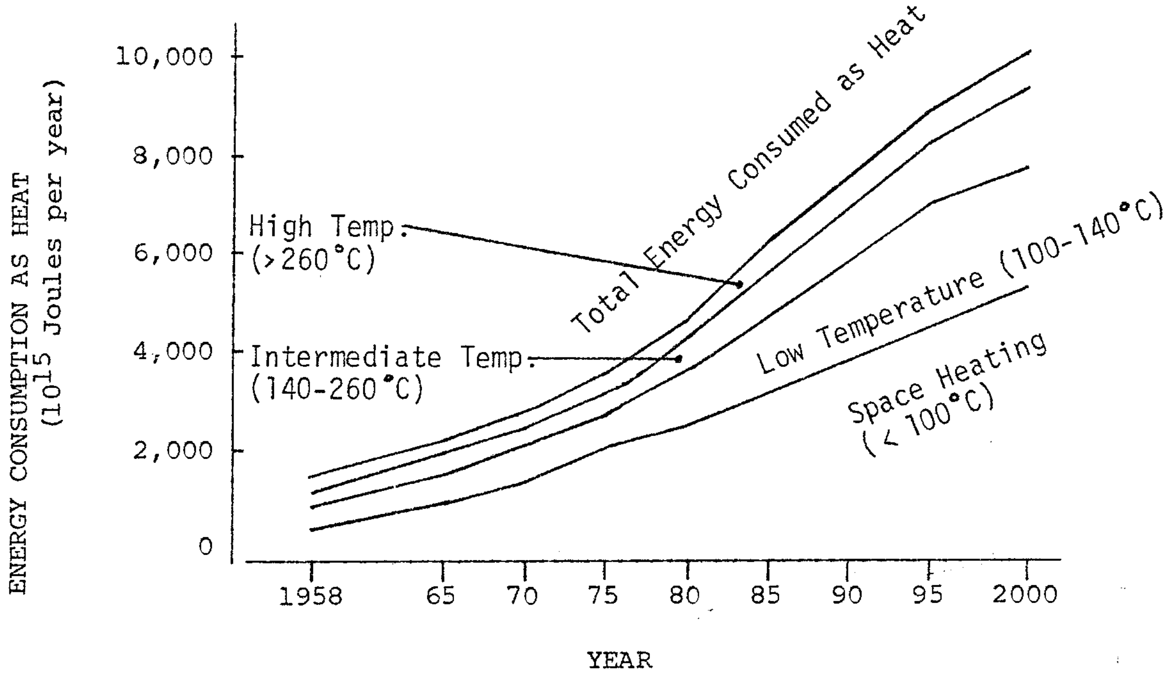
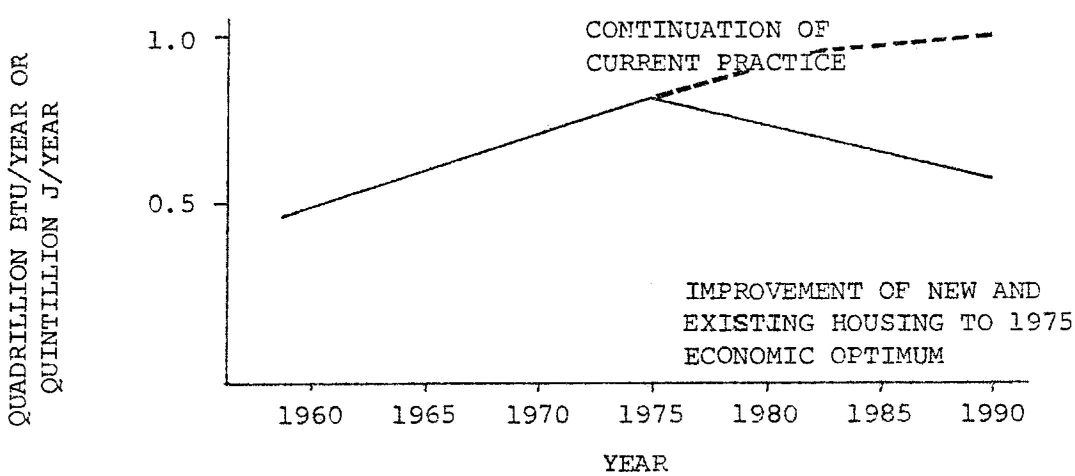


FIGURE 49

CANADIAN RESIDENTIAL HEATING ENERGY

(70% of Total Residential Energy)



Source: EMR (1976)

FIGURE 50

Mr. Lovins (continued):

Canada might need just by estimating main terms in the spirit of experimental physics, which is my old discipline. I wasn't trying to be terribly precise, as an economist might, but I think the results are still very useful.

I generated two sets of numbers, the first of which might be called the super technical fix. I started with some of the assumptions shown in the next three graphs.

David Brooke's group, the Office of Energy Conservation, has worked out a series of technical fixes for energy in Canada over the next 15 years. They believe for example that by improving new and existing housing to a level which is economically worthwhile right now at Canadian prices and doing their sums conservatively, they can make the energy use for heating houses actually go down over the next 15 years even though the number of houses goes up. (Figure 50).

The next graph shows a similar effect in the commercial sector. (Figure 51). These are all calculations by the Office of Energy Conservation. And the next graph shows what the Office believes could be done in the transport sector. (Figure 52). The top-most line shows what would happen with business as usual, that was the kind of projection we were all working on until recently, and there is a large gap which is saved by energy conservation. There are two lines which are rather similar; one of them shows what happens if you use improved car technology but you don't change in any way the growth patterns for traffic, car traffic. Then there is a line slightly below that which shows what happens with quite modest shifts toward car pooling and public transport. But it is a small effect. It doesn't mean we shouldn't do it because the effect becomes very large further off to the right; it just takes a long time.

Now the question I asked when I worked for the Science Council is what happens if we look beyond these 15 years - look instead at 50 years and allow these technical fixes to run to completion. The result is shown in the next graph. (Figure 53). You can do these calculations with completely transparent assumptions. They are very easy to explain and understand. With 40 million people you could be using less energy in Canada than you use today and I have stated the main assumptions there. In the domestic sector you would just use the improvement in building efficiency that the Office of Energy Conservation think are conservative; in the commercial sector, I am supposing that 50 years is long enough to make all buildings have the average efficiency of the Ontario Hydro Building in Toronto.

In the industrial sector you can assume normal sorts of growth projections with high energy efficiency or slow growth without much energy efficiency or any other kind of combination you like. In the transport sector, I assume to be very much like the Ministry's projections for 1990 with a very modest further improvement in car and plane efficiency, which you can account for very easily just on technical grounds. You would end up with cars maybe as efficient as a modern Mercedes, which isn't very small and tiny.

Now I generated also another set of numbers. You see this set amounts to a per capita energy shrinkage, primary energy, by about a factor of two from today's level with steadily increasing affluence

CANADIAN COMMERCIAL-SECTOR ENERGY

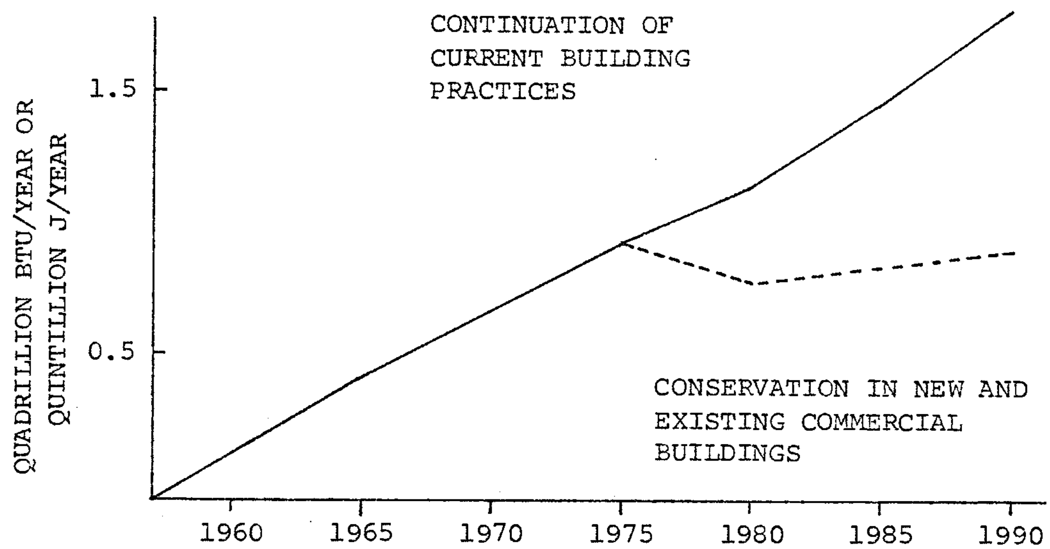
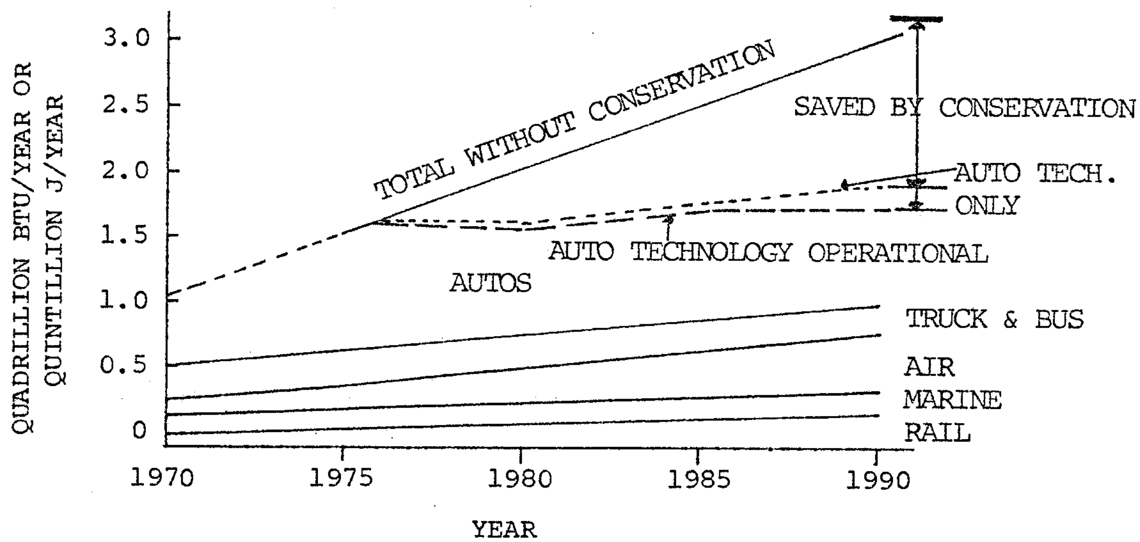


FIGURE 51

CANADIAN TRANSPORT ENERGY



Source: EMR (1976)

FIGURE 52

CANADIAN ENERGY USE IN 2025

(say 40 million people)

"Super Technical Fix"

	MAIN ASSUMPTION
DOMESTIC & FARM	Normal growth; improve energy efficiency 25% on olf, 75% on new buildings
COMMERCIAL	1970 per-capita floorspace, efficiency as Ontario Hydro Building
INDUSTRIAL	Normal growth with high energy efficiency
TRANSPORT	As EMR 1990 per capita with modestly improved car & plane efficiency

TOTAL END USE: 5.9 quadrillion BTU or 6.2 quintillion J

FIGURE 53

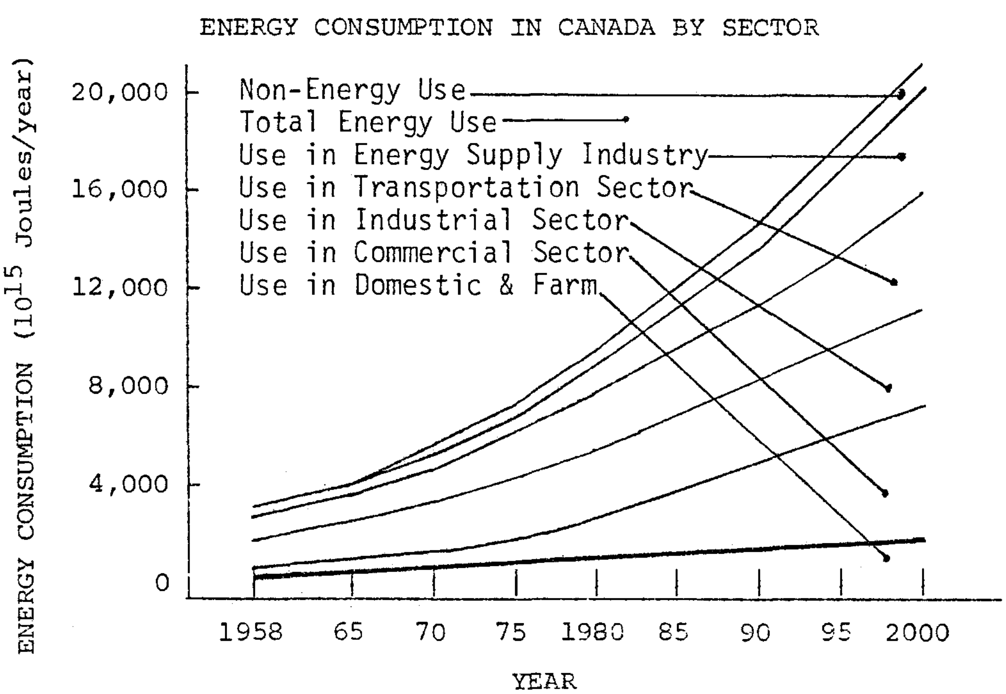


FIGURE 54

CANADIAN ENERGY USE IN 2025

(say 40 million people)

"Conserver Society"

	MAIN ASSUMPTION
DOMESTIC & FARM	Same as "Super Technical Fix"
COMMERCIAL	1960 per capita floorspace, efficiency as Ontario Hydro Building
INDUSTRIAL	1960 per capita production with 1975 technologies at best energy efficiency obtainable in 1975
TRANSPORT	1960 per capita traffic levels at energy efficiency of good 1975 European systems

TOTAL END USE: 3.2 quadrillion BTU or 3.4 quintillion J

FIGURE 55

CANADIAN ENERGY USE

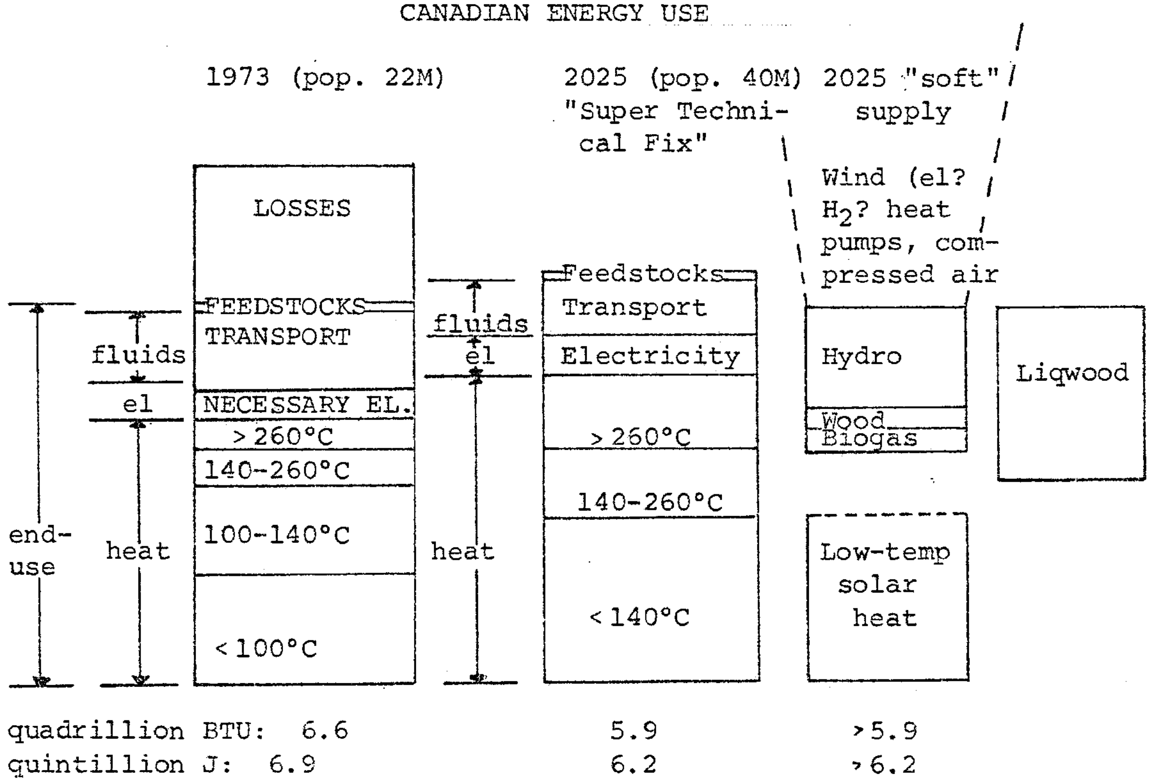


FIGURE 56

Mr. Lovins (continued):

in a normal economic sense. But, I also did another thing which arose from the next graph. (Figure 54). This shows the history of energy growth in Canada and some standard projections of the future. And you notice that if you run back from 1975 to 1960, the domestic and farm sector hasn't grown all that much; industrial and transportation, a little more; and the really big growth sectors are the energy supply industry itself and the commercial sector. Especially commercial, that has been the real growth area.

Well, in the spirit of the Science Council's work on conserver societies, I wanted to ask how much energy you might need 50 years from now if you had a conserver society. And I really didn't have the information to build those numbers from the bottom up as I would have liked to do. So, what I had to do instead was to say, suppose we took the per capita activity levels of 1960, the industrial production per capita because we might have a lot of recycling; we might design things to last a long time; we might have less throw-away packaging and so on; we wouldhalve the number of vehicle miles that people drove in 1960; we would halve the amount of commercial floor space that each person had to his name in 1960, and so on. And I think it is reasonable to get a rough estimate of what a conserver society might look like because we have all been there before, we know what it looks like.

The result is shown in the next graph (Figure 55) and it is a further per capita factor of two shrinkage in primary energy beyond what the super technical fix showed. Just to summarize the numbers for you: in 1973, we used 6.6 quadrillion BTU. A super technical fix 50 years on would be 5.9, and a conserver society 3.2, despite the increase in population to 40 million people. Now you could say, where I live in Britain, we have the second factor of two shrinkage without the first, that is we have personal activity levels somewhat like those of North America 15 years ago but we don't have the technical fixes.

Now the last part of this exercise which I did before my time in Ottawa ran out, was to look at how energy might be supplied 50 years from now. That is shown in the next graph. (Figure 56). For comparison, I have shown at the left-hand side a repeat of the thermodynamic breakdown, of how we used energy three years ago. Again it is mostly heat, a little is required as electricity, the rest is fluids or is lost. In the middle I have shown a similar classification for the higher of my two sets of numbers - the super technical fix, in which we again have perfectly standard sorts of economic growth but we just use energy at a level which would be economically proper in efficiency today.

On the right I have sketched some soft supply options for 50 years from now. The hydro-electricity I have shown is that level to which Canada is already committed, that is the lowest Ministry projection for 1985, not including James Bay. It is ample to cover all electrical and high temperature heat needs in the economy. So again it is not clear to me why you would want to build any power stations.

Mr. Lovins (continued):

I have assumed that 50 years is long enough for you to be able to meet low temperature heat needs with the sun. You can do that with today's technologies. And there is a block at the right called liquid. This is a result of a Canadian Forestry Service report on how much net fuel alcohol they could get from round wood and forestry residues in a conservative, sustainable cut above the present level. So that you would freeze pulp and paper production at the present level but increase the cut to a sustainable level and use the difference and the residues from the whole operation to make alcohol.

I think they have done the calculations well. What I am not sure about is the initial numbers because they have not yet done long term ecological studies on the consequence of that type of forestry operation. But I think it is clear that even if the liquid term is too big it is still a lot more than you need to run the transport sector. So there is a good deal of play there.

Now one conclusion emerges very clearly from this; that add to the hydro to which Canada is already committed, any two out of three main soft supply sectors - that is solar space heating, conversion of forestry products, and wind - any two of those will give you an energy surplus. I haven't shown wind because I don't really know how big it could be. There is a number from the National Research Council that if you were to put standard wind machines into the Le Grand complex water shed, the area to be flooded by Phase I of James Bay, you would get out 13-odd Gigawatts of power on average instead of 8.3. It is a very impressive number and you can use wind not only to make electricity or hydrogen but to run heat pumps or to compress air for industrial work. It is a very flexible sector which can fit in anywhere you need it in any of these categories.

So I would think these results suggest that on an aggregated national basis you have ample soft technologies to run an efficient energy economy 50 years from now which is about how long it would take to get all these technologies in place and it would take that long to do anything else.

Now there are several parts of this exercise that I didn't get time to do and the Ministry staff are working on them. The next step is going to be to work backwards from 2025 toward the present to see what you would have to do in order to get there; and then if you found it looked a bit fast, you didn't think you could do it that fast, that's OK, you just change the date at the end. You would stretch out the process because there is nothing sacred about 50 years, that was only an initial guess. And of course you would have to do this by regions because your hydro electricity and wind and wood are not evenly distributed through Canada. So that is the next step and then you would look at the total cost of this path compared with the total cost of not doing it, of the present policy. And then you compare risks and social changes and so on. Now, these have not yet been done but I can say two things that I think would bear on the Canadian calculation.

Mr. Lovins (continued):

First, that if you look at each of these soft technologies and pair it off with the high technology which you would otherwise have to use instead, you find the soft ones cheaper. It is cheaper to make fuel for your transport sector from wood than to make it from tar sands or coal. It is cheaper to heat a house with the sun than with nuclear electricity and probably cheaper than synthetic fuels. You can pair off the technologies this way and I think there is a good deal of evidence to suggest that the soft ones would be cheaper for the reasons I mentioned earlier.

And second, this entire working backwards exercise with the cost comparison has already been done for some other countries including Japan, Denmark, the United States and the Scandinavian region. It is underway in several others and in all those in which it is completed the soft path turns out to be faster and cheaper than present policy. I think that is especially important when you look at Denmark because Denmark is a bit like Prince Edward Island in many ways. It has a good agricultural base, somewhat similar climate, it is at higher latitude, gets less sun, it is over 90% dependent on imported oil, it is the western version of Japan. The attractiveness of the soft path in Denmark, I think, is a good omen for its attractiveness here. I am quite confident from the work done so far that when we finish the Canadian exercise, it will show that going to soft technologies is at least as quick and as cheap as doing anything else.

Now, you on this Island are among the world leaders in efforts to explore soft paths as a practical reality that fits the pattern of social development your people want.

I sense that the traditional values that most countries have stuffed away in the attic, values like thrift, neighbourliness, simplicity, diversity, craftsmanship are alive and well here and being recycled. The way your Island society evolves is important to other provinces and other nations, and I know they are starting to watch you carefully as this building, which I am told gave federalism to Canada, becomes the focus of a second and more significant effort to create a different kind of energy future, one that we can look forward to and have good dreams about.

Thank you very much.

DR. MALONEY: I would like to ask you a question. Do you see any particular institution being responsible for or providing the sort of evangelical thrust that you need to change over from one to the other? It is a cultural change, really isn't it, and you need something to spearhead that don't you? It is not going to come from the schools unless you put it in the schools. There is not much that comes from the schools ordinarily that is original. You have to put it there.

MR. LOVINS: The fact that we are here today, saying the things we are, I think is a good sign that the cultural change is already occurring in this Island. You really are in the lead within Canada and I think compared with nearly all countries. And I don't know why it happened to be here, perhaps it is because your traditional values are stronger here. Perhaps the kind of energy future that I have been talking about meshes so well with your agricultural and social development. But I don't really see these changes coming about from someone coming in on a white horse, proclaiming to the people. I think it is a grassroots phenomenon and it happens through the political process.

DR. MALONEY: Do you see the government as the institution that should be the instigator? I suppose you would say that anyone should in default of others, but does it seem to fall upon any one institution in our society? I agree with you, I don't see anyone else coming in because no one ever helps you, you always help yourself. But, within your society do you see any one particular group?

MR. LOVINS: I don't think so. I think these ideas are widely distributed among a very wide range of people. There are centres in which the ideas and hardware get more fully developed, New Alchemy is one of those. And government has an important role to play but these are not changes that can be brought about merely by passing laws. The important changes happen in the heads of the people in this Province. I think they are starting to happen and I am very encouraged by what I sense to be a reservoir of interest and enthusiasm in projects which people can see are directly relevant to their own lives and are technically understandable; that is, you are starting to re-integrate technology into society instead of leaving it as something arcane and removed.

PREMIER CAMPBELL: I think the question is still valid however, because certainly Prince Edward Island is not going to change the world or cause the governing authorities of the United States to change their ways.

MR. LOVINS: Why not?

PREMIER CAMPBELL: Well, I am an optimist but there is a little bit of realism thrown in there as well. I think there is an example to be served but we are talking about a very major cultural shock in challenging a lifestyle. At the moment the whole energy future seems to be a matter of great interest among a very small elite group, perhaps those who have enjoyed the good life and see a way of preserving it on through the future, while those who are essentially responsible for industry decisions and public decisions are trying to keep the system going somehow by either declaring new ways or thinking up new major, massive projects to keep the economy rolling along. It seems to me that somewhere was born environmental concern that grows within, let's say, a 15 year period to the national and international policy level, but you are advocating a change of lifestyle in the sense that the Prime Minister of Canada has. He hasn't been too successful with his notion of the new society as yet, but nevertheless I believe this is the very essence of what you are saying. Perhaps a questioning, a challenging of many things that we have all come to take for granted.

MR. LOVINS: I think the kinds of energy changes I have been talking about run in very much the same direction as strands of existing social change and I don't just mean dissatisfaction with big, remote bureaucracies - I mean more fundamental things than that. We have in our industrial societies assumed that people strive to escape from repugnant work into blissful leisure, so we mechanize and fragment work and deprive people of meaningful social roles. We have alienation, instead of fulfillment. I think a lot of people caught up in that process are starting to ask whether they should try to enjoy life as it is lived, instead of trying to turn it into a means of accomplishing something else.

DR. MALONEY: I think a possible source of funds on a national level is unemployment insurance because first, it is a large reservoir of funds; and secondly, I am quite sure that is our basic unemployment problem in Canada and the United States, which we never really solve because we never really get down to below 7 or 8%. I think it is due to the fact that we have not enough small technology which can employ people. We take the higher (we have graded all our jobs upwards all the time) so that those people who either are lower on the intelligence scale or just don't care that much about it, are finding themselves unemployable.

MR. LOVINS: Indeed. I have noticed a very interesting effect in England lately which was exemplified by a lady who was interviewed on the BBC lately. She was asked why she had gone out to work to earn more and raise her standard of living. They asked what she had bought. Well, first she had bought a car without which she couldn't get to work. Then she bought a refrigerator and a freezer because if she was working she couldn't go to the market every day, only once a week. She bought nursery school for the kids and so it went. It was a list of remedial costs which she had been told were the benefits of affluence. Now there were real benefits of going out to work, intangible ones; it was a change of scene, responsibility, new friends, getting out of the house - many things which she had not articulated, and therefore she didn't ask herself whether she could get those or similar benefits in another way without the remedial costs. But once you have this kind of realization that you are just running in a circle, it is irreversible. It is like seeing big cars as silly, they will never look nice again. And I think this kind of subversive idea about what is a cost and what is a benefit is spreading rather rapidly. We are seeing also that our transaction costs are so high that they are exceeding our productivity; that is, our society is working so hard to manage its growth, sort out its conflicts and inequities, that it isn't having enough output left to get anything done with. So that is another drive toward simplicity and doing things for oneself. In the societies like England and Italy, where this process has gone furthest, people are indeed starting to do things for themselves again instead of making it part of this increasingly complex and unrewarding economic process.

I think the social changes we are talking about run very deep and we are really not going to stop them. It is a question as to whether we swim against the current and get exhausted, or try to turn around the other way. Elwin Reese says when you come to the edge of an abyss, the only progressive move you can make is to step backwards. I think it could be said that you can turn around and step forwards, and it is the turning around part that interests me, because I see it happening right here.

MR. WELLS: If Members of the Legislature would like to throw questions at our panel, we will let the panel argue or contradict one another or agree with one another, and perhaps we could have some exchange of opinion and view.

PREMIER CAMPBELL: Well, let me toss out a preliminary question to these four learned gentlemen. Ron, this morning, I thought perhaps your comment - oil for 30 years - might have been challenged, no one really directly challenged you on that point but we have through the day, however, begun to receive insights into what I should conservatively call a dramatic change in the nature of society, perhaps more so than the kinds of changes which you anticipated during the course of your remarks, and I am not sure whether you disagree or agree with those on your left and right but that might be a good way to start the conversation now.

MR. RITCHIE: Well, Mr. Premier, I certainly don't disagree that those are very reasonable and perhaps attractive possibilities. When Amory was talking about his 50 year potential scene and with some of the things he had to say about it, I was very much attracted because one of the things that does worry me about our current society is too-big units, too-centralized decision-making. I don't think that is all as bad as it is sometimes painted, but I think it can be a danger to real democracy, and therefore some of the small scale things that were sketched as possibilities this afternoon are very attractive. My qualification, and it isn't necessarily a qualification, is that I am not sure how big a price in real economic income, people would be prepared to pay for that if there is such a price. Some of the arguments this afternoon are that there is not such a price and I would hope that the decision is made, by and large, a little bit more by the market place, than by a political decision. That is one reason I was glad to hear Amory say that he wasn't for a man on a white horse.

PREMIER CAMPBELL: I would argue however, that the market place is almost the instrument of the industrial complex, inasmuch as people's appetites are pretty well generated by advertising, and by the production of goods. Am I away off-base here?

MR. RITCHIE: I think we go through a stage on that. I think that when people first get more wealth, they tend to concentrate on material things but I think that is an evolution and if you look at what is really going on in Canada, as well as in some other societies, we are spending more, for instance, on education today as a percentage of our income than we did. We are spending more for various forms of cultural activity than we did. We are spending more for travel which may be good or bad, I am not sure. But in any event I think this materialism that a lot of people decry is perhaps a necessary phase in an evolution of taste.

DR. MALONEY: It is just another way of saying that sometimes there is no one more materialistic than the poor; there is nobody more interested in material, than those with an empty stomach.

MR. LOVINS: Indeed the people hardest hit by badly insulated houses are the poor. They should be the first to get their houses insulated. You know in England, we have a marvellous system where one Ministry builds cheap, council houses (public houses) with resistance space heating and bad insulation. Another Ministry builds power stations to supply the electricity to heat the house. A third Ministry subsidizes the council tenants to pay their electric bills. The fourth Ministry cares for hypothermic pensioners who can't pay their electric bills. If you were to set about devising a really nifty way of wasting money, you could hardly do better. I think that fragmentation of responsibility and giving people bad signals in the market is a lot of our problem. I am not really much of a believer in the price mechanism as a solution to all ills; it puts a very high premium on live dodos, and that doesn't help you much. But you could argue, maybe I would, that the biggest single step we could take towards a sensible energy policy would be just to apply sound economic principles. We should price our energy by how much it will cost to produce the next unit, not how much it cost to produce a unit 30 years ago. We shouldn't give big users a discount. We should value assets by how much it costs to replace them, not how much it cost in the first place. There is a whole list of sensible economic things we could do to help people get better signals in the market; to help them make better use of the resources we have got. I mentioned earlier that the household cannot float low interest bonds and amortize over 30 years as a utility can. So it hardly makes sense to ask him to compete with the utility.

MR. MCROBIE: Could I make a point here? I think there is a limit to the extent to which you can really ask the marketplace to look after energy policy, because the market is essentially a bargain-hunting instrument and a temporary, very short-term bargain-hunting instrument. To ask it to take long-term decisions, such as what price do we put on a non-renewable resource which will last for 25 years; what price should we be charging for it now? It is a very difficult question and can only be a political question.

The new economic argument to this - we've always confused, I mean we have built our economy so far on the biggest mistake that any businessman could make - a confusion between capital and income. No businessman would last for a month if he made that mistake and yet nationally we have committed ourselves to it and we have allowed large, multi-national companies to make that mistake. We have said to them, use our capital, which is oil and coal, as if it were income. Astonishing theory of business thought! Now, the fact is that there is no business rule or economic rule that will enable us to say oil will only last for 25, or 35 years, therefore we must price it so much. The market cannot tell us this. The market is absolutely powerless to do this. The market will tell for this year and next year but it will not tell us what price to put on it for a long period of time. There has got to be a certain amount of looking beyond the marketplace and that can only be done by government.

MR. RITCHIE: Can I ask a question there because I would be inclined to challenge the point of view suggested?

If, in fact, let's make the assumption that oil unregulated would last only 30 years, and if by regulating it you could make it last 100 years, so what? In other words in what sense that matters is that capital, because we might extend it for two or three or four generations, but in the world's history that is immaterial, and the real question is, what are we going to replace it by? And, perhaps if you value it higher we would replace it earlier, I am not sure.

MR. MCROBIE: Well, I think the obvious answer to that is, that if in fact you spun it out a bit longer you would be putting a premium on other forms of energy; let's say you did it by saying you will put the price of oil up really high to make sure it will spin out for another 100 years. Then other forms of energy would become more attractive. So you would in fact be helping to bridge the gap. What I spent ten years in the coal industry in the United Kingdom stomping around with Schumacher, saying to government, to the public at large, but especially to government, was, "Don't close down the coal industry because we know while oil is cheap, there is a temporary surplus of fuel oil floating around Europe." You make decisions in the coal industry 100 years ahead; if you sink a new coal mine that coal mine is there for 100 years. It is not like putting up an ice-cream factory to be closed down next week. And, I know this takes into deep waters the whole of economics, which makes no distinction between renewable and non-renewable products. And that is one of the great failures and can only be done by some widely discussed view. I think this is a difference: you are saying government must take a sharp administrative decision but at least the discussion should be open and exposed and made quite explicit.

MR. LOVINS: Indeed, 50 years which is the period I was talking about, is only the end of the lifetime of a power station you ordered today. It is not all that far ahead and the question, I think, is not so much, "What do you do after oil?", as "How do you use the oil?" Do you use it to keep fuelling business as usual right off the edge of a cliff or do you use it to build a bridge to a particular place that you want to get to?

MR. RITCHIE: Well, I think we shouldn't lose sight of the fact, as one often does in these discussions, that we are really talking about people's incomes, their real incomes now. And you are talking here about an arbitrary decision that would prolong a particular resource availability maybe for longer than we need it because we are going to have to develop alternatives and the only way I can see, energy being what it is, that you could deal with this, would be on a world basis. There is no good in the Government of the United Kingdom charging its consumers a particularly high price because it makes a national decision. We are dealing with a world subject here. And, maybe it is fortunate in the light of what you are suggesting that the OPEC people seem to have done it for us on a world scale.

DR. INGS: I would like to ask a question. What do you see Prince Edward Island being like by the year 2000 as present trends continue?

MR. RITCHIE: I am not competent to answer that question, although by the year 2000 I would suspect that it and the rest of Canada are not going to be that much different from what they are now, certainly no more different than they have been in the last 25 years.

MR. WELLS: Which in terms of energy consumption is quite different.

MR. RITCHIE: Yes, but in terms of appeal, it is not all that different.

DR. MALONEY: Do you see any change in the makeup of our industrial world at that time? Do you see any break-up into much more farming out of sub-assembly plants, and that type of thing, into smaller areas with fewer people? You see, in other words, at the turn of the century, 25 years from now, you could if you look at soft technology being a reversal and going back to the energy levels of 1925 or something, that is one thing; but we really never go back, history never really repeats itself in the same way because you have added something to it. So the shape of the future is not going to be what it was in the past even though you enjoy or use or manipulate some of the modalities that we did in the past. We are going to do it in a different way, that is the question, isn't it? How are we going to do that in a different way? I think we are going to look back and see much of the social unrest that we have in our society as being indirectly a result of the type of industrial set up we have, the way we produce.

MR. RITCHIE: I am certain you are right and much of what we have observed in the last few years, some of the conflict we have had in the industrialized countries in the last few years is that, plus inflation. Inflation has been a real source of lack of social cohesion, or divisiveness in our society, not just Canada but in other places as well. But there is also, that fundamental thing, and there are several approaches that one can make to this, one would be to break down into smaller units. I suspect that we would pay a significant economic price for that, but perhaps not, because the facts are changing. This isn't in any way to quarrel with what Dr. McRobie said about developing countries because I think I would agree with him almost 100% on that but, in a developed country such as ours, I am not at all sure that we are going to break down into smaller units. I think it is possible, for the reasons that Amory suggested. But if we don't break down, there are ways to humanize industry, ways to humanize big organizations and they are happening to some degree. There are changes taking place and I think we should, just in case we aren't going to break down into small institutions, we should be working awfully hard on the other front as well.

MR. LOVINS: I think one has to look very hard at the overheads in a society. The Friends of the Earth office in London runs about 18 people full-time on a total budget of $80,000 a year. Now that is something like three or four or five times the productivity that you would expect in a normal government or industry office, because we don't have all the overheads. There is no red tape. It is a small outfit; people all know each other. I think when you go to smaller units carefully thought out, you can save so much on the overheads that you come out ahead even if you have dis-economies of scale and smaller production, and George suggested that you probably don't even have that. But I think your question is a very interesting one, because I have heard this question of level of energy use so often. I have been told in Denmark by many economists that you just can't conceive of a civilization in Denmark using half as much electricity as now. Well, they had one in 1965, when they were at least half as civilized as now. You mentioned 1925, the per capita level of energy use in the States in 1910 is about the present British level. I have lived in England for nine years. There are problems there but we certainly don't live in caves. And what the level of energy use leaves out is what you are doing with the energy. How much of it is going to poach fish in a river somewhere; how much of it is going to toast the feet of sparrows sitting on your roof because your house isn't properly insulated. I can go a lot further with one unit of efficiently-used energy than somebody else with four or five units of inefficiently-used energy. This is why I tried in my talk to concentrate not on the amount of energy used but on what you do with it and how; what is the structure of the energy system and how does that determine the structure of the society.

MR. MCROBIE: I think on the front of inflation, it is easily arguable that inflation is not something that causes social divisiveness, the other way round. You could say that a good deal of inflation is now the result of people and groups in society fighting to change their positions. As the Chinese say, there is the year of the mouse and the year of the dog; this might be the year of the underdog because a lot of people who were formerly quiescent and accepting their position downstairs at the bottom of the ladder so to speak, have suddenly said 'no'. Now this is only possible in a highly-geared society with huge agglomerations of capital where any one of them is violently at risk in the light of activities of others.

Now, what is now happening is that people certainly in the United Kingdom, coalminers and nurses and others who are pretty low down on the list, suddenly said, "No, we are going to earn as much as clerks in the stock exchange!" And clerks in the stock exchange are equally determined that historically and owing to our curious social class system, they will earn as much as the middle class. And so there is a battle going on between working class and middle class. Now that is a cause of inflation itself. This in fact arises partly from people being sick of the jobs they are doing; then money is the only compensation. If you work on an assembly line in a modern factory you are aching for the time you can get away. Money becomes the only thing that compensates you for the sheer dull stupidity of the work. Someone said we are suffering because we are spending more money on education, we are suffering from a moron shortage. We are short of morons prepared to do the kind of moronic work that industry offers them. So out of that you can get a continuous inflationary situation.

MR. RITCHIE: Every society is a bit different. In our society, increasingly the groups that are demanding more are well-off already. It's not a question of the deadliness of the job.

MR. WELLS: It's all relative surely. When a teacher here compares his salary to that of a doctor, it's not all that different from what George is describing.

MR. LOVINS: It is clear that the kind of energy system we develop determines our vulnerability. The more we get into centralized technologies, the easier it is for small, organized groups of people to turn us off.

MR. MCROBIE: There was another point raised about the costs of small scale. But the cost of high energy is so enormous. The cost in time and energy in simply preventing strikes is never counted. The diseconomies of large scale are huge. I've never gone into a factory where the manager says, "Look how efficient we are. I have maximized the movement of goods and services inside the factory." Well, if he does, he is out of his mind. But for a society as a whole, this is what we say, we say the more we move things up and down the country, the higher our national income. We call transport a net increase in the national income. If in fact we were all now given a million dollars each and told to travel furiously, at the end of the year the national income would be appreciably higher. In terms of large scale, what is happening is that you have got very large production units, you've got raw materials flowing into these, and then having to be distributed out from them. The chances are it would be very much more economic to have a number of small units which serve the local markets. And this is why I take the example of bricks, because in the United Kingdom it is no longer economic to export bricks from a little area in Bedfordshire where they are made, up to say Aberdeen (I just chose Aberdeen at random, of course, but let's say a little north of Newcastle) because it now pays to make the bricks at Newcastle instead of carrying them all the way up. I think the forces are against the form of economies of large scale and in favour of the small scale, more decentralized unit.

MR. WELLS: You are no longer bringing bricks to Newcastle?

MR. LOVINS: This is obvious with power stations. As we build these huge units, not only are they less reliable but when one stops working it is much more disruptive to the grid, so we are just having to spend in Britain over 100 million pounds building a pump storage scheme to stand in for a big power station that fails. It is like having a whole bunch of white elephants any of which might die in the drawing room, and that is very embarrassing, so you need to have another elephant to haul the carcass away. You just find your herd of elephants expanding steadily!

You touched on another interesting point earlier, sir, in asking how the Island might change. I think one of the things I would expect to change is our notion of employment. I think the whole concept will change. People will, I think, go more to a personal mixed economy rather than the crofter-like economy which still exists here, where one farms in the summer and fishes a bit in the winter, and if you don't like farming and fishing on a particular day, you dip candles or make fences or something else. I think people will do much more work in their homes instead of travelling to work. Work will be diverse and will be something you do wherever you happen to be. I hope we will have much better communications to help us with that.

DR. MALONEY: Dr. Todd, have you considered the making of protein than passing it through the fish, straight from the algae? Sort of an artificial meat?

DR. TODD: There was quite a flush of interest in the 1960's in the idea of algae as food for human beings and it turned out that you can product unbelievable amounts of algae; that problem was solved rather nicely. Then Arthur D. Little and Matel and some of the big research organizations got involved and there was quite a bit of money involved and they were going to solve how to get this into an edible form. And in those days there was no real thinking in what we call net energetics.

In other words, the concepts of energy were ignored, but economic concerns were a factor and by the time they had invented a centrifuge and the engines to drive the centrifuges which changed the pH in the water so that the algae dropped to the bottom and concentrated, they had themselves a real interest and a real industry and probably almost as costly as lamb or cattle, and not complete protein. In other words, they had to create a technology to produce something that was edible which the fish does simply by the act of swimming. In other words, a natural system is able to do it and we get an energy subsidy from that animal that we don't get if we do it physically. And consequently, all those schemes died on the vine. We were going to save the world with that before the green revolution came along (that was the big one just before) and we have gone back to thinking that the fish may have the answer. I think, though, that in the qeustion of food production we are on the verge of some ideas which might lend themselves very well to the Island.

There is a discipline in biology called ecology and it is basically the study of how different organisms are linked to each other in nature. Over the past 20 or 30 years the ecologists have begun to learn a little bit about how the world works. In the last few years there has been a shift; I think we may be on the verge of a major biological revolution. We are beginning to think that not only do we know how the world works, perhaps for the first time, but we can also simulate the processes in agriculture that have as their end points, foods. Farmers have been doing this for thousands of years, but this is in an even more complex way where the various links act to create controls and checks and balances which are now done with chemicals, or pesticides, or what-have-you. And, I can foresee the period when we will have farms which use trees much more than they do presently and in which the trees provide a lot of the crops for the feed stocks, for the animals that live underneath. Fencing will still be very critical, incidentally, in the management of these agricultural eco-systems. I think they will be much more productive than the ones we see today.

There is another very interesting resource on this Island which was not neglected by our parents and our grandparents and that is seaweed. Seaweed in agriculture is, I think, a very big, booming business. First developed as a global industry by an Englishman named Stephenson, who formed a corporation called Maxicrop about 1960. Basically he bought seaweed from Norway, Iceland, Greenland and wherever he could get it and developed a dehydration process where this was made into either a meal or very fine powder. A whole variety of interesting things that could be done with this powder and meal were discovered, which I think our grandparents knew in some ways. One, they contain concentrate trace elements, so that you are actually getting minerals and elements from the sea that go back on the land to create healthy crops. They also have, and this is a real hooker, growth hormones which actually stimulate the plant growth production. But they have another one which has transformed and extended the citrus industry and a number of industries in agriculture and that is that they provide crops with frost protection. So that every year the world market is fought over by Florida citrus people, people in California, and what-have-you so that if there is a frost, you simply spray a fine mist and this provides the material that prevents the crop from being damaged. They also use it in the springtime on crops like our apples, so that when you have a very bad period it tends to increase the amount of fruiting.

There is another thing they have done in French wines. They are now using the fine powder that I talked about, and the same seaweed incidentally which we have here and that is used as a foliant spray about four or five times a year on that crop, to provide feeds directly to the leaves themselves. The price of seaweeds in these highly refined forms is going up. Even farmers in the midwest are buying it and there is a regular scramble for a rather fine resource, because people are really taking it seriously.

There are several universities in the States and one in Europe that now have departments that are exclusively studying seaweeds. This was what I meant this morning when I said the bio-regional approach. An analysis of what exists here would turn up the fact that Maxicrop and other international organizations are huge businesses and they are no bigger than the amount of seaweed they have.

I started looking at the process a couple of weeks ago so that I would know something to tell you and apparently it is like a pressure cooker type of thing that could be wood-powered, for dehydration, at a temperature that is just below the flash point of the seaweed or the burning point, and that in fact it would be possible right here to compete with the Scandinavians and Maxicrop International which is a British-based firm but it is now throughout the world, with one of the most precious commodities, and it is a very recent discovery.

So there are lots of interesting things beginning to happen in agriculture which are becoming a little better known recently. McGill University is toying with the idea of establishing a small research centre for biological agriculture just to look at these gold mines but because they come from nature we tend to denigrate them. We tend to say, "That is just something from nature, it is not something we manufacture". So we don't treat it with the same respect we should. There isn't much agricultural training on the Island but one could foresee the possibility of workshops and seminars in new areas in agriculture developing over the years. I think a lot is going to happen that would lead to the overall diversity and strength of the province over the next ten or 20 years.

MR. MCQUAID: Did you ever look into the advisability of an Irish moss processing and extraction plant here in the Province?

DR. TODD: No, I am sorry I haven't. I assumed that there are people already who know an awful lot about it. I once tried to find out the ownership basis of moss. At the time, I thought it was a British firm but I guess it is American. Is that correct? Well, everyone on the Island knows that it is very valuable stuff. Its role in the food industry is important and I think will increase.

MR. MCQUAID: From your investigation, you have satisfied yourself that an extraction and processing plant for our seaweeds would be feasible?
DR. TODD: Yes. I wouldn't even be surprised if the fastest way to go about it would be to ask the president of Maxicrop to act as your consultant to build it. In other words, the people who developed it. I have a feeling from the little I know about them that they would consider that, even though you would be a direct competitor. It's like goose down; there is not enough of it and there is no way there is going to be enough to satisfy the market in the next five years.
MR. MCQUAID: Irish moss?
DR. TODD: No, seaweeds in general. I am not sure. I think we might even carry out some experiments to see what kind of crops might be grown here that normally are just squeezed because of the season. I have my own private orchard that I maintain and I am using the seaweed sprays this year for the first time. They also have another material which is made from seaweed called Lactobase and it is used to protect the root systems of trees and plants being shipped, very expensive, $16 a pint!
MR. WELLS: That's four times whisky.
DR. TODD: I think that is why it has its name; it is a bacterial process that is used to complete the activity, I have a feeling if some of the pioneers in this area were invited, they would be delighted to assist you. The book on the subject has been printed in the States recently by a woman from the University of California, Berkeley, who has a small agricultural printing programme.
MR. MCINTYRE: I am wondering what sources of oil are available at an economic cost to this area other than the Middle East? It appears that Alberta has quite a bit of oil and there is a considerable amount of oil in the United States, but the thing is getting it here. What are your views on this?
MR. RITCHIE: In pure economic terms, oils from Venezuela or West Africa or North Africa or the Middle East should be competitive here depending a little bit on tanker rates at any given time, because when tankers get expensive, which they aren't now and don't seem likely to be for quite a while, the oil from further away tends to be priced out of the market; or alternatively, what happens is that Venezuela raises its price to pick up the benefit. In general those sources are likely to be competitive, even if we have a subsidy system domestically which we now have. They are likely to be more competitive than any supply from Canada, unless later down the road we make discoveries offshore here or even the eastern part of the Arctic. In that case, those oils would presumably be very competitive in the Canadian market.
MR. LOVINS: But they wouldn't be cheap.
MR. RITCHIE: They would presumably be, well, one couldn't tell unless there are policy questions. Otherwise they would sell at world market prices.
MR. MCQUAID: Isn't it strange that over the course of the four days that we did consider alternate sources of energy, nobody gave very much stress or laid very much stress on the possibility of water power. There is some suggestion that right here in our own province by damming up some of our streams we could generate a bit of electricity, enough

to supply some of our smaller communities. As a matter of fact we have had streams dammed up here and used to run factories of different kinds. Is there any possibility from that angle at all?

DR. TODD: I think there are several of us that would like to address this question. I think the reason why it hasn't been discussed is there hasn't been enough time. You may want to say something, George, about the technology involved that you were discussing at lunch. I think that one might even do all the Maritimes a great service by installing in the Hillsborough River under the old bridge a tiny tidal turbine system. It is close to the plant, and we could begin to get some idea of how these things work and concepts of scale which could then be extrapolated and people could have a little bit better feeling about the Fundy Tidal projects and things like that. I think there is a lot of scope here, not only to use the rivers through damming systems - perhaps maybe that isn't the solution - but through working with tidal turbine systems which simply invert as the tide changes.

MR. LOVINS: I think in that sort of a miniature tidal scheme, and perhaps in your rivers, although I don't know your geography at all, you might do well to look at low head axial turbines; they are not designed to take a high head of water from behind a dam, they are designed to take water running along a surface or running through the space between your old bridge piling there that John mentioned. I am told that the French know a great deal about this technology which they have been interested in because it fits with their old colonial enterprises in Africa and South East Asia. I have been told in France if they were to do the Rheims tidal scheme over again, they would have much better turbines to put in, which they could also use on a small scale.

MR. MCROBIE: Just to add a very quick word to that. Some time ago, we were looking at small scale turbines, and the last manufacturer of small scale water turbines in the United Kingdom, a firm called Gilbert Gilkes, north of England. They said that no new technology had gone into small scale turbines in their knowledge since 1905. Now this is a perfect case where one should take this whole case along to a number of technological universities and say, "Do us design studies of two or three ranges of size, of highly efficient, modern, small-scale water turbines". Because you are absolutely right, there is enormous future for these which has been totally untapped and it avoids problems such as distribution losses, the huge overhead systems and so on. There is one family of engineers in the United Kingdom we found that is making the small-scale water turbines using cut down ship propellers. Now this is a little industry that you could start here tomorrow because you probably know more about propellers than most other people. This is a very productive field and what the other lads have said is absolutely right. One of the things that really has to be done is that at the same time as your experiments are being carried out, a very detailed, exhaustive investigation by people really knowledgeable in hydraulics should be undertaken. What are your water flows at different times of the year, where are they located, near what industries and activities are they?

MR. MCQUAID: That would be a good initial project for our Institute of Man and Resources.
MR. MCROBIE: It would be a beauty.
MR. LOVINS: Perhaps, I should mention a couple of technologies that have certain similarity here in that they have been much neglected in recent decades and have much to offer us today. One is the use of compressed air. If you look it up in the Encyclopedia Britannica, it is billed as a cheap, simple, reliable and versatile way of moving energy around with over 200 major uses. I just looked in the Yellow Pages in Boston recently and found about three pages of compressed air technology, it is alive and well. Now it is a much cheaper way of moving industrial work around (driving machines) than electricity is and there are cities in Europe, I am told - Vienna and Paris - which used to have a standard compressed air grid as a utility and they ran all their engines on it all over town. They recovered the heat of compression and the cool of expansion. There was a whole journal of compressed air technology that ran for 40 years and is sitting down in the basement of the M.I.T. library. Now, this technology is much used in mining but so far as I know, nobody in the world is looking at it as a component of modern energy systems and I think we should be.
DR. TODD: In questions of compressed air technology one of the problems that we were confronted with working in a number of areas, is that we had a water source that was somewhat distant from our wind source and we wanted to pump water into irrigation schemes. And so we looked into the compressed air technology and this spring we are embarking on a project to use compressed air-driven submerged pumps to run our irrigation schemes, at some distance from the source of the wind and the source of the water. We may be given an economic boost in this research which involves an oceanographer who has been developing a submarine pump at Woods Hole and by the United States Department of Agriculture. Their rationale for considering giving us some help with this research project is that 20% of the energy in agriculture in the United States is in pumping water. They see great areas, in the South West particularly, that are going out of alfalfa production and other major fodder production because they simply can't afford to keep the diesel and the electricity generators running. It is a major crisis in American agriculture right now and it is played down but it is very actively being considered.
MR. LOVINS: You can make compressed air with a wind collector and then you can store it quite easily in a tank, unlike electricity.

The other technology that comes to mind in simple things that we should look at again is fluidized bed combustion. I have seen, in Professor Elliot's lab in England, beautiful little fluidized beds this big. They consist of a piece of porous fire brick with a bit of brick around it to make kind of a well, and sitting on this porous fire brick is a shallow layer of fine sand. Then coming up through the porous fire brick from below is a rush of air from a little pump and the air is at the right speed so that the sand is turned into a kind of fluid, it dances around. It is very low viscosity. If you were to put your hand intc it you couldn't feel any resistance and if you took the whole thing and shook it, it would slosh just like water and have waves splashing around. Now if you heat up the sand to 700-800°C, say with some bottle gas, it takes just a couple of minutes, you could then put in a pinch of anything like coal, or bark from trees or any other organic material, wet or dry, and it will burn very quietly and cleanly with extreme efficiency. Professor Elliot has, for example, a little grate that is this big that fits in an ordinary fireplace surround, and there is a little half inch pipe coming down the chimney which every now and then sprinkles in a pinch of coal. This thing sits there radiating something like six kilowatts. You can't stand in front of it, it is that hot. It has a radiative efficiency of about 50% compared to about 15% for an ordinary coal grate. If you stick a sheet metal reflector behind it the efficiency is about 85%. If you take a second fluidized bed with no fuel, just the fluidized sand, and stick it up in the flue, you can use it with a boiler tube in it to recover the heat of the escaping gas and then your system efficiency goes up into the 90% range. You can make this on an industrial scale. He has a little fuildized bed this big which runs off a thing the size of a lady's handbag. That turns out to be a ten kilowatt steam engine, and then they go on from there. You can buy commercial fluidized beds up to 200 megawatts thermal these days.

Now these are extraordinarily simple systems, especially the small ones. They are good for back-fitting boilers in existing buildings. They are commercially available. Very few people know about them. They are very clean. For the domestic ones, nitrogen oxide is about two or three parts per million, with an ordinary gas fire in your house, you get about 50 or 100. You can soak up all the sulphur in high sulphur coal by injecting a little limestone or dolomite. It is just a very elegant, efficient way to burn ccal and because the sand is always swirling around, it transfers its heat with extreme efficiency to whatever kind of a boiler tube you have in there. Now this is a very simple thing which anybody can understand. There is just nothing to it. And it would be ideal, I think, to start making right here using your existing technical resources.

PREMIER CAMPBELL: Is there a commercially developed operating generator based on this principle?

MR. LOVINS: There are many commercial fluidized beds. They have been in use for some years for burning rubbish. There are about 80 industrial beds in use mainly for heat treating furnaces. You see if you want to treat steel components for ballbearings you just immerse them in this red hot sand and they get very uniform heat; they heat very rapidly and you get a saving of several-fold in cost over conventional radiant furnaces. Now large fluidized bed sets for making electricity, where the fluidized bed runs a gas turbine, are commercially available but not yet commercially installed, partly because the British and American governments seem intent on re-inventing the wheel and building large instrumented test beds which are not commercial. I think they should be going commercial right now because there is a reputable vendor happy to supply such a set. It is designed for district heating as well. It is about 70 megawatts electric plus 120 thermal.

DR. TODD: By that you mean you could have a heating bed, say in Charlottetown, where each house would get its heat from the power plant. Is that correct?

MR. LOVINS: Yes. You would distribute hot water to every house in town. It is very interesting in Stockholm. There has been a very detailed study of what it would cost to put in a district heating grid to distribute hot water to every house. They would do this not by tearing up the streets, but by tunnelling underground, 30 or 40 yards down, and then they would tunnel up into your basement to make the connection. They figure that doing that would be a lot cheaper than strengthening the electric grid enough to heat the houses electrically. And of course the heat is essentially free because at the moment they are throwing it away.

PREMIER CAMPBELL: Of course it sounds like a very efficient way of burning wood for electrical generation.

MR. LOVINS: It would be, yes. You could burn essentially anything. It doesn't matter whether it is combustible or not in the usual sense; you could burn wet rubbish very efficiently.

DR. TODD: Who is the manufacturer of fluidized beds?

MR. LOVINS: There is a commercial outfit called Fluid Fire Development Limited in England which is more a development than a manufacturing outfit; that is, they would rather license somebody else to make the things but they have sold many industrial fluidized beds and have probably as much operating experience with them as the rest of the world put together.

PREMIER CAMPBELL: Where do you find most of the inventiveness around the world? You have mentioned England twice and not very often have you referred lovingly to the United States.

MR. LOVINS: Well, I think the best technical work on energy systems is going on in Scandinavia, Holland and the United States. I wouldn't really put Britain in that list although there are a few good people there. But, I think more importantly, the social innovations we need are likely to come not from the high technology countries but the small countries as they have always done - everything from Scandinavian social welfare to Dutch bicycle lanes. Likewise within a country, I think Prince Edward Island is in a much better position to come up with social innovations than the rest of Canada, than let's say Ontario would be.

MR. MCINTYRE: Are there any other areas throughout the world that find themselves in the same position as we are regarding energy, and if so, what avenues or alternatives are they considering at this time?

MR. LOVINS: I would say the classic case is Denmark, and in Science last July 25th, there is a nice article by Benot Sorensen, on how to construct a completely soft Danish energy economy.

MR. MCROBIE: I am going to Tasmania next month which has almost the same problem and probably Sri Lanka, although that has totally different climatic and vegetation structure. But Tasmania may be one of the nearest, Tasmania and Denmark, would be the two that would instantly spring to mind that would have very much the same sort of problem. The population is roughly in the same order of magnitude, we are not talking about 30 or 40 million people. Tasmania, I think, has 300,000.

MR. MCINTYRE: And what are they doing for alternate sources of energy?

MR. MCROBIE: This is one of the things I am going out to try and discover.

MR. LOVINS: Well, Denmark is one of the countries that is doing the looking-backwards exercise that I have described earlier, and they are among the leaders in some of the softer technologies, especially vertical axis wind machines. They have an operating zero-energy house. I have just spent a few days last week with a guy who has been living in it all winter and it bears out the notion that if you really insulate a house properly it needs essentially no heat besides what you get from the people and appliances. That is, the heat that house is getting from the sun is about a tenth of the total heat which a normal house would require in Denmark. You may be interested that the marginal cost of that solar system for that house is about $8,000; with modern tank technology which they didn't use, it would be about $6,000, and that at today's very high electric prices which will come way down.

MR. RITCHIE: In another sense, most of the world is in the same situation. If you define the situation as it really is, an area which depends on imported energy and which is facing the fact that that has become very expensive relatively in a short time, and the examples that have been cited are examples of areas where innovative approaches of a particular kind are being sought but the more common pattern, not necessarily the right one, is to try to develop major new sources of energy, such as nuclear energy, or major new sources such as North Sea oil, or to worry about coal gasification or liquification, or so on. What the ultimate answer or answers may be for the world as a whole is in the making. We don't know. But in a pretty basic sense, the Island is in the same position as large parts of Western Europe, Japan, many of the developing countries. For the time being at least there is no alternative but imported energy from some source at fairly high cost.

MR. LOVINS: And conservation.

MR. RITCHIE: And conservation, absolutely.

MR. MCINTYRE: I believe you were fairly specific this morning, sir, in your answer to the Premier on the question of how much oil we had. I think you mentioned something like an oil reserve for something like 30 years and I am wondering now if you might be able to tell us which is the right way to go from here.

MR. RITCHIE: Amory just said, 'slowly', and in some respects that is right and in others it isn't, because there are time pressures, but the fastest route that is sensible will also be slow because of long lead time, whether it is the new kind of smaller-based technology that we have been talking about this afternoon, or some of the bigger technologies, bigger sources of supply and what I would hope is that, to a fairly singificant extent, we avoid committing ourselves too far ahead to some particular route. In other words, we got where we are by a kind of evolution, a kind of set of among other things, economic pressures.

There are economic pressures at work very strenuously right now to provide answers and I would be afraid that if we get too fixed a set of answers in our mind and dictate our course in those directions largely by government edicts, that we would risk making some pretty major errors.

MR. WELLS: Wouldn't you agree though, Mr. Ritchie, that by and large if you don't make decisions to move in one direction or another that is conscious public decision, government decision, that in a sense we have already committed ourselves and that the Canadian society will go on the route that it is currently on which is quite different from the soft route that was described by Amory.

MR. RITCHIE: If the soft route is only viable by government edict, it is wrong, I think. That is an extreme statement.

MR. WELLS: But surely government edict, in an indirect sense, has had a significant influence in the direction we have already taken.

MR. RITCHIE: In some cases, and I would like to qualify that extreme answer because I too would give some weight to the social and political side of this. But I suspect that if, and I don't think there is any reason to assume that there is a high economic price to be paid for going this route at least in part, but if there were, I suspect the public should think very seriously about whether they really want it or not. My view would be to let these various alternatives compete, and we haven't really decided in my view.

MR. WELLS: Nor have we really allowed them to compete.

MR. LOVINS: No. We are subsidizing all the rest for a start.

MR. WELLS: Well, just the amount of research and development money which governments in this country and North America generally have applied to certain routes, to certain technologies, and compare it to the soft routes and it is overwhelmingly in favour - the research and development money - has overwhelmingly gone to that other route.

MR. RITCHIE: But now we are beginning to think about these new routes. I am not advocating we starve them for research and feed the others. I think we should feed both.

MR. WELLS: No, I was just a little concerned about your sort of standpat suggestion, the wait-and-see suggestion.

MR. RITCHIE: No, that is not standing-pat.

MR. LOVINS: The thing that you cannot do without government edict is the big high technologies and, I think we may be in a position where it is easier to see what we should not do than what we should do. These big technologies which are so demanding of our time, money, skill and political will are the most likely to foreclose other options. And then there are some things we know we can do, like increasing our efficiency of energy use, that are going to be a good idea no matter where we get the energy from. We really ought to get serious about that.

MR. RITCHIE: Well, I think to some extent we are and we would inevitably get serious about it without taking much direct action because there is a very powerful incentive now to get serious about it.

MR. LOVINS: But of course all the time that we wait, the oil and the gas that would provide our bridge to wherever we are going, are trickling away and in that sense we do have to choose one path or the other before they diverge much further.

MR. RITCHIE: I think we will choose. I am not sure what we should choose, nor would I have much confidence in someone else's decision on that. But, I think the beauty of it is that the systems that in effect win out, whether that winning out is partly social and partly economic or whatever the mix is, those systems will come in gradually. What we now have, to the extent that it is necessary, will phase out gradually and we could be putting far too much weight in the magic of 30 years or 50 years for oil and gas because in a sense that is a very arbitrary judgement. There are much larger reserves of fossil fuels of various kinds that can be turned into those attractive liquid forms if we decide.

MR. WELLS: Or if we have the capital.

MR. LOVINS: Conversion plans don't actually consume coal, they consume money.

MR. RITCHIE: That is all right because what you are really saying is that is part of the cost of energy and how much energy we choose to consume will depend on that cost including the capital cost over time.

DR. TODD: I think it also a fair bet before we get carried away with hundreds of years of coal reserves, that the coal is not resource-limited, it is climatically limited. And the current betting amongst my climatologist friends is that we will be getting trouble with coke combustion fairly early next century.

MR. RITCHIE: I wonder if you would explain that a bit more.

MR. LOVINS: That the carbon dioxide and other things that you release from burning any fossil fuel would press too hard on some climatic leverage points, like the Arctic Sea ice, and shift weather patterns or worse through at least the northern hemisphere. This is especially bad news for Canada because so much of your agriculture is climatically marginal. There are several major studies going on on this right now but the answers they are getting are really not very cheery, and I think a major element of our long-term policy then should be to hedge our bets in case it does turn out that we can't keep burning coal way into the next century either, direct or as converted fuels. Because if we found that out with more confidence, say in the year 2000, then it would be too late to do anything about it because it does take so many decades to shift our whole energy economy.

MR. RITCHIE: Well, here is a case where obviously market forces can't handle the subject at all. It has to be by some sort of public decision. In fact you are talking world scale. It couldn't be a Canadian decision or a United Kingdom decision, it would have to be more broadly based than that in order for it to be effective.

MR. LOVINS: This brings us back to the Premier's point earlier on. What use is it for this Island to have a sensible energy policy if other people don't? I think we tend to underestimate the political influence which a successful experiment has. Your experiment here is already attracting much interest in the rest of Canada and in the rest of the world. I have been in many countries recently where people have stood up and asked, "What is happening in Prince Edward Island, how is that going? We are very interested in it; we want to learn from it." I think your influence on this continent and others can be much greater than you realize.

MR. MCROBIE: I also think the self-sufficiency argument is very strong and becoming rapidly much stronger. We have now got this Committee of Seventy-seven in the under-developed countries who are intent on controlling much the same way other raw materials, as OPEC has done in oil. The idea that we can continue to get raw materials of all kinds - energy was the first one but there will be many others. Bauxite is rapidly coming to the fore; there is a Bauxite Producers Association which is more or less determining the price of bauxite. Very soon the same will happen with foodstuffs. So, the need to become self-sufficient as much as possible really becomes very important much more important than when we paid the piper and called the tune. We no longer do that, and the day when the rich West is dictating terms of trade and terms of payment and credit and all the other things to the international community, that day is rapidly disappearing, probably more rapidly than we imagine at the moment because we don't like to think about it. The boot is now pretty firmly on the other foot.

MR. LOVINS: As with Japan, Western Europe has very little fuel resource but a lot of energy resource. And in fact if you worked it out right now you would find much the major energy input to the Canadian economy is not oil but sunlight to grow your crops.

MR. RITCHIE: I would agree that a lot of people are intent on changing the world order in ways which some of the industrial countries might find less attractive. I wouldn't want to build that threat too high, nor would I want to completely agree that it is an argument for too much self-sufficiency, even if there is more success than I would anticipate in having tight cartels in some other products. There have been a lot of attempts at these before. The energy picture is almost unique, not just in history but even now, and temporary too. Because a decade or so from now, as we develop other sources, the hold of the present energy producers in terms of dictating price will no longer be what it is for the short term. But I think it is worth pondering that what they have done hasn't really been that bad, in other words there is a mutuality of interest even when a cartel, and a successful one, is at work. And so I would hate to see us divide the world up into a lot of self-sufficient entities on the grounds of too much security.

MR. MCROBIE: Fine. I am not suggesting that we are desperate to do so. I think this is one thing that is going to happen only because countries are saying now, for instance Ghana is not going to accept the situation where Ghana exports cocoa beans to the United Kingdom and to the United States and Canada, and then imports chocolate. A few years ago when I was there you could get some excellent chocolate, none of it made in Ghana, all of it made in Britain. This day is finished, gone forever.

MR. RITCHIE: I don't think it is. I don't think it is even in anybody's interest that it should be completely through.

MR. MCROBIE: It is not in our interest perhaps, but the developing countries have now understood that if you don't process your own raw materials you are on the prescription for poverty from now until kingdom come.

MR. RITCHIE: No, that is exactly what I would disagree with. That was the thing you said this afternoon that I would disagree although I agreed with most of what you said. This idea of processing things to the ultimate stage is not necessarily the best way to increase your income. The whole Canadian economy has been based on what you said impoverishes people, to a very large extent.

MR. MCROBIE: If the Canadian economy could further process its output, it would be even more rich. That is all you are saying?

MR. RITCHIE: No, I am not.

MR. MCROBIE: Well, let's disagree on that issue.

DR. TODD: There might be just one point that could be added. It would be really interesting to see how much Canadian ownership would exist in Canada had we not just shipped raw materials to the rest of the world.

PREMIER CAMPBELL: The international companies who deal with seaweeds have been telling our fishermen for a few years that there is an international surplus and they don't need it. But they will be prepared to pay us a ridiculously small price for it. We are going to follow up your suggestion and find about these alternative uses of seaweed which may be still one further benefit to be derived from these discussions. Thank you very much, gentlemen.

DR. MALONEY: Gentlemen, as Chairman of the Institute of Man and Resources, may I say how much we have learned and how much we appreciate your coming here, and on behalf of everybody I wish to thank you very, very much.

MR. MCQUAID: From our side of the House, I should also join with Dr. Maloney in expressing our thanks not only to you four people who spoke to us here this afternoon, but also the men who have spoken to us for the last three days. We have had a very interesting and instructive four days. I think too, that a great deal of thanks is due for this particular venture to Mr. Wells, who has spearheaded this whole enterprise, and of course, who will I hope, continue to spearhead it. It has been instructive; it has been interesting and I think we have gained a lot from it. Thank you very much, gentlemen.