Prospects for Sustainable Energy in Atlantic Canada *

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Abstract

The paper examines the sustainability of current and projected energy sources (notably imported oil and indigenous coal) and energy demands in four different sectors of Atlantic Canada's economy: residential, commercial, industrial, and transport. The paper proposes a strategy whereby a sustainable energy mix could be achieved: first, through conservation and more efficient use of energy (such as district heating and public transportation); second, by the use of renewable fuels (notably water, wind, and wood); and third, the adoption of hydrogen as the primary energy mover. The paper shows that the proposed approach would benefit Atlantic Canada's public health, its environment, and its economy.

1 Introduction

Our Common Future argues that in the industrialized world there are three key elements associated with sustainable energy that must be reconciled [1]:

- energy efficiency and conservation (attempting to minimize the waste of primary resources);
- public health (in terms of the risks inherent in various energy forms);
- environmental protection (both global and local from various forms of pollution, such as carbon dioxide and the risks from global warming).

At present, few, if any, regions of the world have implemented a sustainable energy policy that meets the above definition. Given the North American dependance upon fossil fuels, this paper considers the development of sustainable energy sources in Atlantic Canada. This is of particular interest since Atlantic Canada exhibits the following characteristics:

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- there is a growing reliance on coal for electrical production. As part of the federal government's plan to get 'off-oil', the fuel of choice is coal as shown by the projected growth in coal for electric generation in Atlantic Canada: from some 95 petajoules in 1984 to over 212 petajoules in 2005 [15].
- it has the highest regional industrial energy intensity (92 megajoules per dollar of industrial output) of any region in Canada [14].
- there is considerable potential for the development of alternate energy sources (notably renewables such as water, wind, and wood).
- projected population figures of negative or low growth do not match the expected increase in energy demand [18].

2 Current and Projected Energy Sources and Demands

2.1 Energy Sources

Primary energy demand in Atlantic Canada is satisfied through five major sources according to the National Energy Board (NEB) of Canada [15]:

- The fuel in greatest demand is **oil**, with the vast majority being imported from Venezuela and processed by several oil refineries located throughout the region. Oil is used primarily in three sectors: transportation (particularly the automobile and transport truck); home heating; and electrical generation.
- **Coal** is mined extensively in northern Nova Scotia and is used almost exclusively in electrical generation.
- Most available **hydro-electric** sites in New Brunswick and Nova Scotia have already been developed. However, considerable hydro-electric potential exists in Labrador.
- A single 630 MW Candu **nuclear** power station producing electricity primarily for export is located in southern New Brunswick near the Maine border.
- **Wood** and other **renewables** are found and used extensively throughout Atlantic Canada. Although these fuels are employed mainly for electricity and steam generation in paper mills, there is considerable demand for their utilization in home heating.

2.2 Energy Demands

National Energy Board data projecting future energy demands is based upon high and low price scenarios (high demand implies high oil prices and low demand assumes low oil prices, see tables 1 and 2). The low and high price scenarios show a 23 and 25 per cent increase respectively in oil demand between 1988 and 2005, while the demand for coal increases between 93 and 123 per cent for the same period.

2.3 Discussion

From the examination of energy demand in Atlantic Canada, it is apparent neither the projected energy demand nor the sources of energy are sustainable. First, energy efficiency is poor and there is little push for conservation. Second, the public health and environmental effects associated with this energy path are largely ignored.

For example, the reliance on coal shows a disturbing trend: the total carbon dioxide emissions *increase* between 1988 and the year 2005 anywhere from 40 per cent (low price case), to over 52 per cent (high price case) [9]. Not only does this exceed the overall Canadian average in carbon dioxide growth, it also makes a mockery of the Canadian government's call for a 20 per cent *decrease* in carbon dioxide emissions by the year 2005 [8].

If the goals associated with sustainable energy are to be met, both energy demand and the reliance on fossil fuels must be reduced.

3 Demand Reduction

Energy demand reduction cannot occur overnight; it takes a long term commitment. The following section considers a three part scenario originally outlined in [8].

In the short term (immediately), it is expected that individuals will begin following more energy efficient practices, such as:

- lowering the energy demand for space heating and cooling (i.e. air conditioning) in both the residential and commercial sectors.
- limiting the volume of motorized transportation (particularly the private automobile) by the application of a carbon dioxide tax on automobile petroleum products [2].

In the medium term (5 to 10 years), there is the expectation that both individuals and government agencies will take the following actions:

- decrease electrical demand through increased energy efficiency [6].
- develop efficient public and rapid transportation systems, thereby reducing the demand for private road transportation [3].

In the long term (15 years), it is assumed that a national energy policy will be adopted and will require that:

- residential and commercial heating and cooling systems (presently fuelled by natural gas and oil) be replaced by district heating and cooling systems [5].
- existing fossil fuel plants will either be closed or employ technological advances to capture the carbon dioxide [17].

4 Sources of Renewable Energy in Atlantic Canada

In order to achieve the proposed demand reduction and eventually to replace existing non-sustainable energy sources, sustainable energy alternatives must be found. This section examines some of Atlantic Canada's renewable energy sources.

4.1 Water

4.1.1 Hydro-electricity

As already mentioned, most hydro-electric sites in New Brunswick, Newfoundland, and Nova Scotia are already producing power (see table 2). However, Atlantic Canada's major source of hydro-electric power is found in Labrador at Churchill Falls (some 6,000 MW); the estimated potential of other sites exceeds 5,500 MW [9].

The major problem at present is *how* to get the power from Labrador to the southern parts of Atlantic Canada. Newfoundland and Labrador Hydro have proposed high-voltage transmission lines via under-sea cables. To date, this proposal has fallen on deaf ears, in part because of Nova Scotia's commitment to heavily-subsidized coal-fired electrical generation [7, 20].

4.1.2 Wave and Tidal Power

The proximity of Atlantic Canada to the Atlantic Ocean makes wave and tidal power potentially attractive options. For example, some of the world's highest tides occur in the Bay of Fundy, with the estimated output from a series of power stations (4,000 MW) being some 50 petajoules (PJ) [4]. Two issues of concern regarding the implementation of any tidal power scheme are the impact upon fish and shellfish stocks [4] as well as upon the tides themselves [11].

4.2 Wind

Atlantic Canada has some of the highest annual wind densities in Canada: from 250 Watts per metre^2 in Nova Scotia to almost 500 Watts per metre^2 on the Labrador coastline [16]. The application of wind farms in these areas could produce several hundred petajoules annually. For example, a series of one hundred wind farms on the Labrador coastline, each consisting of 200 one-megawatt wind turbines, could produce over 300 PJ annually.

4.3 Wood

There is considerable scope in the use of renewable fuels for electrical generation in the Atlantic region. For example, the Small Power Producers Association of Nova Scotia is currently negotiating the sale of some 60 megawatts of electricity from the combustion of wood-waste in wood-fired power stations to the Nova Scotia Power Corporation [13].

A conservative calculation based upon the volume of wood cut in the Atlantic region serves to demonstrate that 240 megawatts of electricity could potentially be produced. The use of tree plantations could boost this annual output substantially.

5 The Application of Hydrogen

Other than tidal power, the two main sources of renewable energy that Atlantic Canada can rely upon are hydro-electric and wind, primarily from Labrador. Labrador's geographic distance from the main centres of demand *and* the intermittent nature of wind-generated electricity suggest that converting the electricity into hydrogen and transporting it by pipeline for later use is a strategy that might usefully be examined [10, 19].

In an earlier paper, the authors proposed a scheme whereby hydrogen could be shipped, via pipeline, from the hydro-electric sites in Labrador to the southernmost provinces [9]. The scheme had hydrogen being produced in electrolysers at Churchill Falls, then being piped across Labrador to the Strait of Belle Isle. The pipeline would pass under the Strait in a tunnel (to avoid iceberg scouring) and down the western shore of Newfoundland. The pipeline would continue to the southernmost provinces through an undersea pipe joining Newfoundland and Nova Scotia (see figure 1). The hydrogen would be combusted in fuel cells, producing both electricity and heating water for district heating. The estimated cost of such a project is less than 2 cents per kilowatt-hour (electric).

The proposed pipeline would have to be extended up the Labrador coast to collect the hydrogen from the wind farms. Hydrogen can be stored in any of a number of salt mines found throughout Nova Scotia.

6 Concluding Remarks

This paper has shown that in Atlantic Canada, existing energy sources and demand do not meet the three elements associated with sustainable energy as outlined in *Our Common Future*. The paper has proposed a sustainable energy path that can be achieved by reducing existing energy demand and replacing fossil fuels by hydrogen using local, renewable energy sources for hydrogen production.

The proposed energy path meets *Our Common Future*'s three elements of sustainable energy. First, energy efficiency and conservation are achieved through demand reduction. Second, the reduction in fossil fuel emissions could improve public health through the related decrease in greenhouse gases and low level ozone. Third, the use of renewable rather than fossil fuels offers an improvement in environmental protection.

There are other positive benefits, notably to Atlantic Canada's economy. Money is kept in the region: through employment, both in the construction of the power stations as well as in the manufacture of the necessary equipment; and by reducing the dependance on foreign oil. The reduction of fossil fuel usage also means that Canada could achieve the 20 per cent reduction in carbon dioxide emissions called for by the Toronto Conference on the Changing

Atmosphere.

As with so many other areas of the sustainable society, these changes must be instituted now if the benefits are to be reaped in the future. Similar plans have been proposed elsewhere (for example, [12, 21, 22]): there is every reason to implement them in Atlantic Canada.

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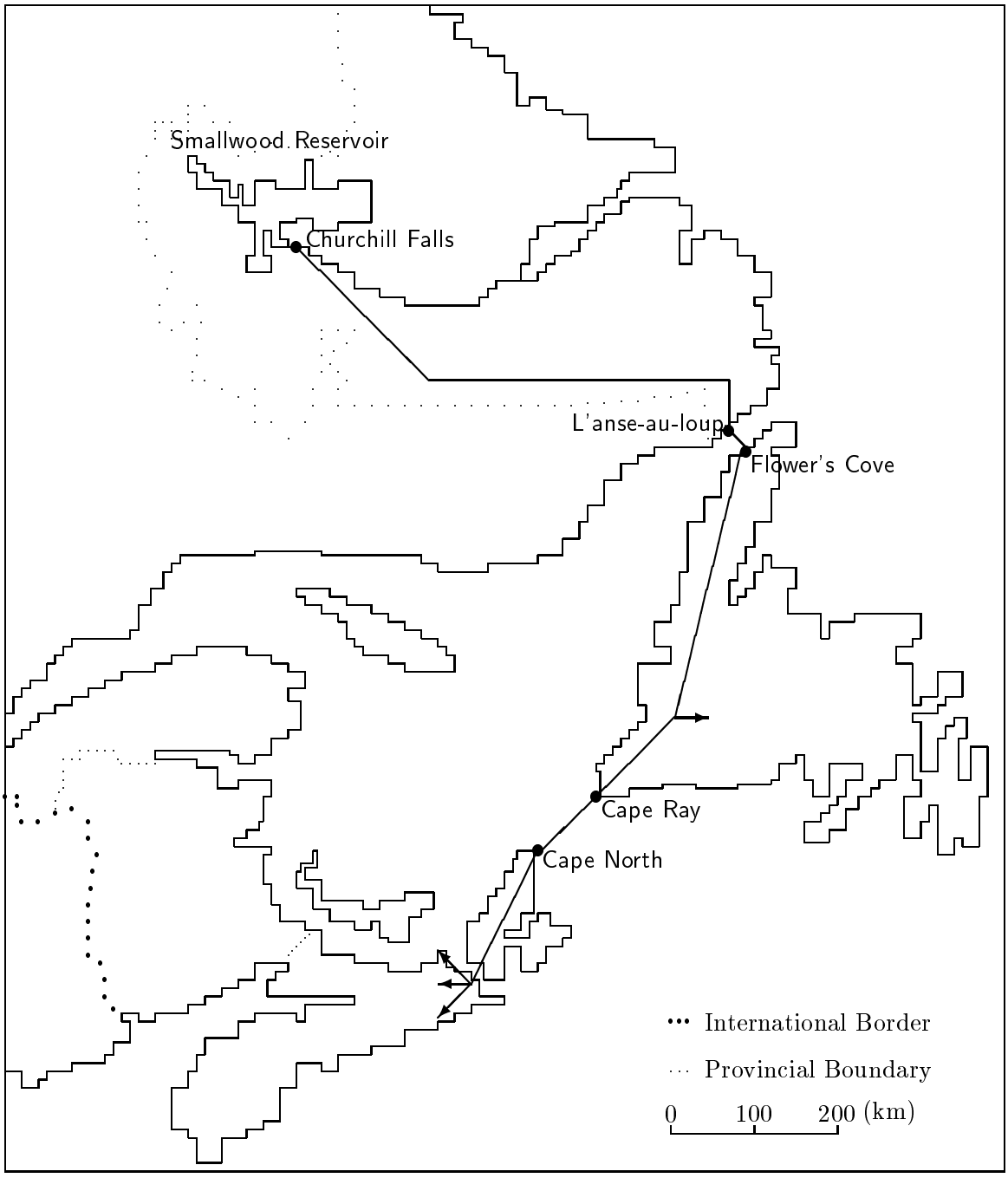
		Low Price Case			High Price Case		
	1986	1988	2005	Increase	1988	2005	Increase
Residential	111.5	115.5	131.7	14%	114.6	128.4	12%
Commercial	53.9	56.3	66.1	17%	56.1	69.4	24%
Industrial	167.2	179.4	212.4	18%	182.7	265.0	45%
Road	116.7	121.5	147.1	21%	121.2	155.2	28%
Air, Rail, Marine	39.2	46.9	52.4	12%	46.4	53.6	16%
Transport (Total)	155.9	168.5	199.4	18%	167.6	208.8	25%
Non-energy	15.3	15.1	19.7	30%	15.0	21.2	41%

Table 1: Sectoral Demand (Petajoules)

		Low Price Case			High Price Case		
	1986	1988	2005	Increase	1988	2005	Increase
Oil	370.5	406.0	498.8	23%	408.3	513.9	26%
Natural Gas	0.0	0.0	0.0	0%	0.0	0.0	0%
NGL	0.5	0.7	0.8	14%	0.7	0.9	28%
Ethane	0.0	0.0	0.0	0%	0.0	0.0	0%
Coal	83.8	95.2	183.4	93%	95.2	212.2	123%
Electricity (all)	298.8	314.3	475.8	51%	316.7	531.7	68%
Electricity (hydro)	146.4	148.0	159.0	7%	147.9	199.7	35%

Table 2: Primary Energy Sources (Petajoules)


Smallwood Reservoir
Churchill Falls
L'anse-au-loup
Flower's Cove
Cape Ray
Cape North
International Border
Provincial Boundary
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