ERG/200801

Achieving a ten percent greenhouse gas reduction by 2020

Response to
The Nova Scotia Department of Energy's Consultation Paper
Nova Scotia's Renewed Energy Strategy and Climate Change Action Plan

Larry Hughes, PhD
Energy Research Group
Department of Electrical and Computer Engineering
Dalhousie University
Halifax, Nova Scotia, Canada

larry.hughes@dal.ca
http://lh.ece.dal.ca/enen

11 January 2008

Acknowledgements: The author would like to thank Mr. Alain Joseph, a member of the Energy Research Group for his comments, suggestions, and contributions to this report. The report was edited by Ms. Sandy Cook.

Achieving a ten percent greenhouse gas reduction by 2020

1 Introduction

In April 2007, Nova Scotia's *Environmental Goals and Sustainable Prosperity Act* received Royal Assent. It was heralded by provincial politicians and many Nova Scotians as proof of the province's leadership role in environment matters. Central to the act is the government's commitment to reducing greenhouse gas emissions (Environment Act, 2007):

> *2) To achieve the long-term objectives set forth in subsection (1), the Province's environmental and economic goals are to ensure*
> *…*
> *(e) greenhouse gas emissions will be at least ten per cent below the levels that were emitted in the year 1990 by the year 2020, as outlined in the New England Governors and Eastern Canadian Premiers Climate Change Action Plan of 2001*

Although the province's commitment is a laudable goal, few people have asked what a ten percent reduction would mean and how it could be achieved. This report gives examples of what this reduction would mean to the province and questions whether such a target is achievable.

2 What is the goal?

In 1990, Nova Scotia emitted a total of 19.5 megatonnes[1] of greenhouse gases (or CO_2e[2]) (Environment Canada, 2007). Simple arithmetic shows that a ten percent decrease in greenhouse gases would amount to 1.95 Mt, giving a reduction target of 17.55 Mt. Had Nova Scotia been required to meet Canada's Kyoto reduction commitment of six percent below 1990 levels by 2012, the decrease would have been 1.17 Mt with a target of 18.33 Mt.

According to Natural Resources Canada, Nova Scotia's greenhouse gas emissions are expected to increase to 27.8 Mt by 2020 (NRCan, 2005). The Nova Scotia Department of Energy also assumes this level of emissions by 2020 in its background paper (NS Energy, 2007a). Figure 1

[1] A megatonne or Mt is one million tonnes or 1,000,000 tonnes. Since a tonne is 1,000 kg, a megatonne is 1,000,000 tonnes × 1,000 kg or 1,000,000,000 kg (one billion kg). 19.5 Mt is 19.5 billion kg.

[2] CO_2e or carbon dioxide equivalent. CO_2e refers to a basket of greenhouse gases with different global warming potentials, all equated to that of CO_2. For example, methane has a GWP of 21, which means a tonne of methane has a global warming potential equivalent to 21 tonnes of carbon dioxide.

shows NRCan's projections, a six percent reduction target (the Kyoto target for Nova Scotia), and the ten percent reduction target (as described by the Environmental Goals and Sustainable Prosperity Act).

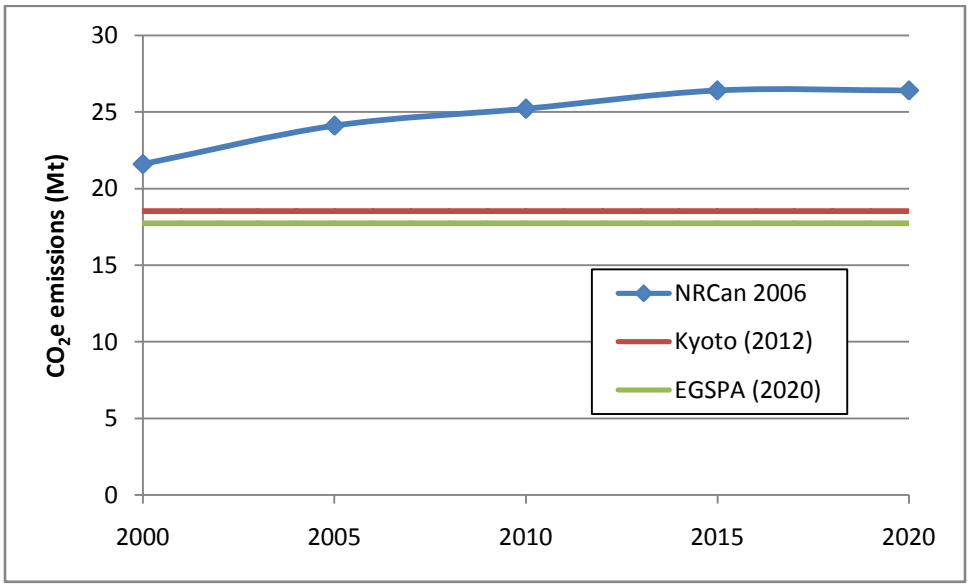

Figure 1: Nova Scotia's projected greenhouse gas emissions and reduction targets

Assuming that the projected growth in greenhouse gas emissions used by the province is correct, then by 2020, the province would have to reduce its emissions by 8.3 (27.8 – 19.5) Mt.

The figure of 8.3 Mt implies that all reduction would begin in 2020. Assuming that the province was to begin its emission reductions now, the size of the required reduction would be less, since more growth is projected by the province under the NRCan scenario. Emissions data is available from both Environment Canada and NRCan for 2005; Table 1 shows the reductions for either the Environment Canada or the NRCan data if the province capped emissions at 2005 levels.

Table 1: Reduction values if emissions capped at 2005 levels

Source	2005 emissions	Reduction value
NRCan	24.1 Mt	4.6 Mt
Environment Canada	22.7 Mt	3.2 Mt

The difference between NRCan's and Environment Canada's 2005 emissions can be explained, in part, by the fact the NRCan's value is an estimate, whereas Environment Canada's is based

upon 2005 data obtained from Statistics Canada.

The remainder of this report considers how the 2020 emission target could be achieved using the 2005 data, with 4.6 Mt being the maximum reduction value and 3.2 Mt, the minimum. It is important to remember that these are simply estimates and the actual reduction required by the province may differ from these values.

3 Meeting the target

This section uses the two reduction values to show how the 2020 emission target could be met by modifying the consumption of four fuels that are widely used in Nova Scotia: coal (for electrical generation), gasoline, diesel, and light fuel oil or LFO (for home heating).

Table 2 shows the different energy sources and their associated greenhouse gas intensities, expressed in terms of kilograms per unit of production (MWh, for electricity) or consumption (litres, for liquid fuels); for example, gasoline has a greenhouse gas intensity of 2.34 kg/L. The total reductions required by each of these energy sources to meet the two reduction values are determined by dividing the reduction values by the intensity; for example, to achieve a 4.6 Mt reduction would mean a reduction of 5,105 GWh of electricity generated from coal or 1,966 ML of gasoline. The rightmost column lists the total production or consumption of these energy sources in Nova Scotia (2006 for electricity and 2005 for the liquid fuels).

Table 2: Reductions required to meet the ten percent target[3]

Energy source	GHG intensity	Reductions per source		Nova Scotia totals
		4.6 Mt	3.2 Mt	
Coal	901 kg/MWh	5,105 GWh	3,552 GWh	9,128 GWh
Gasoline	2.34 kg/L	1,966 ML	1,368 ML	1,228 ML
Diesel	2.71 kg/L	1,697 ML	1,181 ML	813 ML
LFO	2.81 kg/L	1,637 ML	1,139 ML	795 ML

3.1 Coal

The province could meet its 2020 greenhouse gas reduction target using coal alone. A 56

[3] The units used in this table are as follows: kg-kilogram; MWh-megawatt-hour; GWh-gigawatt-hour (1,000 MWh); L-litre; and ML-megalitre (one million litres).

percent or a 39 percent reduction in the volume of electricity generated from coal would be equivalent to 4.6 Mt and 3.2 Mt of greenhouse gases, respectively. The volume of electricity lost (between 3,552 GWh and 5,105 GWh) would have to be accounted for, either by reducing electrical consumption, replacing the coal with another energy source, or some combination of the two.

The following are three reduction scenarios:

- In their $5 million Demand Side Management proposal in 2005, NSPI was projecting a reduction of 71 GWh (NSPI, 2005).
- If NSPI's $5 million was spent on compact fluorescent lighting for those homes with less than five bulbs, a reduction of up to 133 GWh could be achieved (Hughes, 2005).
- It has been suggested that NSPI's proposed DSM program will save in excess of 3,000 GWh per year by 2029—about 30 percent of NSPI's expected total generation (NS Energy, 2007b). This value would appear to be extremely optimistic, since it exceeds the actual DSM results of most, if not all, utilities across North America. For example, BC Hydro, which generates over 51,000 GWh per year (NSPI generates about 11,500 GWh), has reductions of only 449 GWh (Summit Blue, 2006). For the purposes of this report, it is assumed that the best case scenario for energy reduction would be 500 GWh.

The following are three replacement scenarios:

- The proposal for 300 MW of tidal power capacity in the Minas Basin could produce about 1,300 GWh of electricity at 50 percent capacity factor. There is nothing to suggest that this size of tidal plant will be in operation by 2020, given how little is known about the site at present.
- A single 1 MW wind turbine operating with a 25 percent capacity factor would produce about 2.2 GWh per year. The province's target of 500 MW of wind could replace about 1,000 GWh of electricity from coal. Given wind's intermittency and the subsequent need for backup sources of energy, the total non-greenhouse gas energy produced by wind would probably be less.
- A single 1,000 MW nuclear reactor, operating at 80 percent capacity factor would generate

about 7,000 GWh of electricity.

Taking the most optimistic values of reduction and replacement (ignoring the nuclear reactor), one finds that a total of 2,800 GWh could be available by 2020. This is almost 80 percent of the volume of electricity associated with the lower reduction value (3,552 GWh), and is about 55 percent of the upper reduction value (5,105 GWh).

3.2 Liquid fuels

None of the liquid fuels, by themselves, could meet the reduction values. For example, if Nova Scotians stopped consuming gasoline entirely (about 1,228 ML), they could almost meet the 3.2 Mt target for gasoline (1,368 ML). Such a reduction scenario is highly unlikely, given the province's overwhelming reliance on the automobile and the political ramifications of such a suggestion.

3.3 Combinations of fuels

From the above discussions, it is apparent that the province's ten percent target cannot be met by concentrating on reducing consumption of a single energy source, or replacing the source with non-carbon sources, or both. Instead, policies are required that focus on reducing consumption and replacing a number of energy sources.

3.3.1 Reaching the 4.6 Mt value

The following section illustrates the challenges associated with reaching the 4.6 Mt value using combinations of the different energy sources. Table 3 shows the total greenhouse gas quantities of each energy source (in Mt) for various scenarios (note that "Electricity" refers to the reduction and replacement total discussed in section 3.1, and is held constant at 2.5 Mt for each scenario). "Total" refers to the sum of each column.

Table 3: Greenhouse gas scenarios (Mt)

Energy source	100 percent	50 percent	28.4 percent	10-36 percent
Electricity	2.5	2.5	2.5	2.5
Gasoline	2.9	1.4	0.8	1.0
Diesel	2.2	1.1	0.6	0.8
LFO	2.2	1.1	0.6	0.2
Total	9.8	6.2	4.6	4.6

The "100 percent" scenario is the extreme case of reducing all energy sources to zero, which would reduce greenhouse gas emissions by 9.8 Mt. The "50 percent" scenario reduces the energy sources by 50 percent each, reducing greenhouse gas emissions by 6.2 Mt.

The "28.4 percent" scenario reaches the 4.6 Mt value by reducing all liquid fuel consumption by 28.4 percent. This would require, for example, gasoline consumption to fall by over one-quarter, implying that road travel would decrease by about this amount. More importantly, it reduces light fuel oil consumption by over one-quarter—an unlikely event, given the need for light fuel oil for home heating.

The "10-36 percent" scenario attempts to address the previous one by holding home heating fuel reduction to 10 percent and having an equal reduction for gasoline and diesel. In this case, road transportation fuels would have to decrease by about 36 percent each—again, an unlikely possibility, given the political ramifications associated with discouraging road transportation.

3.3.2 Reaching the 3.2 Mt value

Reaching the 3.2 Mt value is considerably easier than the 4.6 Mt value because most of the target has been achieved with the reduction and replacement of electricity for coal (2.5 Mt). This target can be reached with 10 percent reductions in all the liquid fuels—something that would probably be politically acceptable and technically achievable.

4 Concluding Remarks

Nova Scotia has 13 years (2008 to 2020, inclusive) to reduce between an estimated 3.2 Mt and 4.6 Mt of greenhouse gases. The report has shown that to be achieved, significant reduction and replacement programs are needed to offset the loss of electricity from coal-fired electrical

generation. On the reduction side, NSPI's electrical consumption must be reduced by 500 GWh— not an impossible task, given that NSPI's consumption fell by about 1,100 GWh in 2006 because of industrial action. However, reducing emissions this way cannot be construed as a prudent government reduction strategy.

Replacement is also optimistic. The 300 MW of tidal power capacity is still in its infancy and, more importantly, there is much to learn about the technology and how it will function in the Minas Basin. It is still too early to say whether NSPI can actually support 500 MW of intermittent wind on its grid and whether the turbines will offset as much greenhouse gas as this report suggested.

Although the 3.2 Mt reduction is technically achievable, the same cannot be said for the 4.6 Mt reduction. In the 4.6 Mt case, significant changes would be required in both transportation and heating—two politically sensitive areas.

From this analysis, it is safe to say that existing government policies will not result in Nova Scotia meeting the ten percent greenhouse gas emission reduction target by 2020. If it is met, it will because of any or all of the following:

- Increased cost of energy. World energy prices are expected to rise dramatically over the next decade, causing consumers to reduce consumption. These cost increases will have a greater effect than existing government policies.
- Energy shortages. If world production of oil and other energy products falters because of rising demand, many Nova Scotians will be forced to find alternatives to travel and heating. This can be expected to result in a reduction in greenhouse gas emissions.

  Both escalating energy costs and energy shortages will also impact Nova Scotia's industrial sector, especially those industries that are energy intensive. Again, this can be expected to result in an unplanned reduction in greenhouse gas emissions.

  Alternatively, if Nova Scotians are unable to afford or access supplies of fuel oil, they may be forced to rely on more electricity, meaning that NSPI would not be able to reduce its reliance on coal. In this situation, greenhouse gases from coal would invariably increase.

- Purchase of emissions credits. Purchasing emissions credits is presented in the energy strategy renewal document as a means of achieving the ten percent reduction target. However, emissions credits simply drain the province of its limited wealth and do little to protect the consumer from the inevitable changes that will have to be made in the future.
- Purchase of electricity from outside the province. This, like purchasing emissions credits, will help neighbouring provinces like New Brunswick and Newfoundland and Labrador, which are pushing major nuclear and hydroelectric projects. It also raises energy security issues, given the size of the intertie between Nova Scotia and New Brunswick.

The province's approach to meeting its ten percent reduction target is based primarily on the assumption that most of reduction can be achieved from tidal and wind power picking up the slack with the removal of coal-fired electrical generation. Furthermore, the province overlooks the fact that the emissions that emission reductions must also take place in two politically sensitive areas: transportation and space heating.

If the province is to meet this target, it will need better policies that those that have been put forward in its Energy Strategy Renewal.

5 Bibliography

Environment Act. (2007). *Environmental Goals and Sustainable Prosperity Act.* Nova Scotia: S.N.S., c.7.

Environment Canada. (2007). *National Inventory Report: 1990–2005, Greenhouse Gas Sources and Sinks in Canada.* Ottawa: Greenhouse Gas Division.

Hughes, L. (2005). *Comments and recommendations regarding NSPI's Conservation and Energy Efficiency Plan 2006.* Dalhousie University. Halifax: Energy Research Group.

NEB. (2007). *Canada's Energy Future: Reference Case and Scenarios to 2030.* Calgary: National Energy Board.

NRCan. (2005). *Canada's Energy Outlook: The Reference Case 2006.* Analysis and Modeling Division. Ottawa: Natural Resources Canada.

NS Energy. (2007). *Climate Change in Nova Scotia: A background paper to guide Nova Scotia's Climate Change Action Plan.* Halifax: Nova Scotia Department of Energy.

NS Energy. (2007a). *Climate Change in Nova Scotia: A background paper to guide Nova Scotia's Climate Change Action Plan.* Halifax: Nova Scotia Department of Energy.

NS Energy. (2007b). *Consultation Paper: Nova Scotia's Renewed Energy Strategy and Climate*

Change Action Plan. Halifax: Nova Scotia Department of Energy.

NSPI. (2005). *Conservation and Energy Efficiency Plan 2006.* Halifax: Nova Scotia Power Incorportated.

Summit Blue. (2006). *Nova Scotia Power Inc: DSM Report Summer 2006 Final Report.* Boulder, CO: Summit Blue Consulting, LLC.