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Energy Security in Nova Scotia

By Larry Hughes

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Glossary

b/d – barrels per day
BCF – Billion Cubic Feet
CAPP – Canadian Association of Petroleum Producers
CBM – Coal Bed Methane
Emera – The parent company of NSPI
ETS – Electric Thermal Storage
GAAP – Generally Accepted Accounting Principles
GJ – Gigajoule or one billion (10^9) joules (a unit of energy)
HST – Harmonized Sales Tax (Nova Scotia's sales tax: 8% provincial plus 6% federal)
ha – hectare
IEA – International Energy Agency
kWh – Kilowatt-hour (a unit of energy)
LDV – Light Duty Vehicle, typically an automobile, light truck, or SUV
Mt – megatonne or million tones
MW – Megawatt (a unit of power)
NAFTA – North American Free Trade Agreement
NRCan – Natural Resources Canada
NSPI – Nova Scotia Power Incorporated
PJ – Petajoule or a million billion (10^{15}) joules (a unit of energy)
PV – Photovoltaic (usually solar panels that generate electricity from the sun)
RES – Renewable Energy Standard
RPS – Renewable Portfolio Standard
RPP – Refined Petroleum Products
S.N.S. – Statue of Nova Scotia
t/ha – Tonnes per hectare
TCF – Trillion Cubic Feet

Summary

This report examines energy security in Nova Scotia: the province's vulnerability and how this vulnerability can be overcome. World energy prices are rising because of increasing demand and tighter supply. As a result, energy security — the availability of a regular supply of energy at an affordable price — is becoming an issue in many jurisdictions. This report reviews Nova Scotia's 1) existing sources, suppliers and supplies of energy; 2) existing energy services; and 3) potential indigenous energy supplies. The report examines energy demand reduction strategies, specifically energy conservation and energy efficiency, and it examines strategies to replace imported energy with provincial supplies.

Ultimately, the success or failure of an energy security policy depends upon energy supply and the associated energy infrastructure. Although the need for energy security in Canada is downplayed due to the country's immense energy wealth, the fact that this wealth is unevenly distributed means that some regions are more vulnerable than others to the impact of rising energy costs and supply shortfalls.

Nova Scotia is particularly energy insecure. Ninety percent of the energy consumed in Nova Scotia is obtained from sources outside the province, with most originating outside of Canada. Sixty-three percent of the province's energy supply is derived from petroleum products, 25 percent from imported coal, with less than 2 percent from provincial offshore natural gas and less than 6 percent is obtained from renewables.

The infrastructure available to access energy resources is also unevenly distributed across Canada. For example, all natural gas and oil pipelines from Western Canada end in Ontario and Quebec — they do not extend into the Maritimes. Similarly, the Maritimes have limited access to Quebec's hydroelectricity.

Nova Scotia's inadequate energy connections to the rest of Canada means that it will be difficult for the rest of the country to help Nova Scotia should energy shortages occur in the province. This, coupled with Canada's NAFTA energy-export obligations, means that access to Western Canadian energy supplies — notably crude oil — would require supply cuts across Canada. Despite these shortcomings, Canada is the only member of the International Energy Agency that has not established national legislation or regulations to ensure a 90-day supply of oil as specified by the International Energy Program's oil stockholding requirements

Nova Scotia's reliance on imported energy makes it vulnerable to changes in world energy prices and supply shortfalls. Further, Nova Scotia's present energy infrastructure is ill-prepared for the growing intensity of extreme weather events exacerbated by climate change. Although energy security should be an issue in Nova Scotia, government policies are doing little to address it.

To achieve energy security in industrialized, net-energy importing countries, the World Bank recommends four priorities: avoid disruption of energy supplies, diversify energy supply sources, maintain energy infrastructure, and reduce dependence on imported energy supplies through technology.

Nova Scotia's energy policies do not focus on energy security. The provincial government's energy strategy document, *Seizing the Opportunity,* concentrates on the promotion and exploitation of off-shore natural gas and crude oil, and export to the United States. In fact, the existing energy strategy document discusses energy security in the United States and how Nova Scotia can help contribute to it!

Natural gas and liquefied natural gas (LNG) cannot be considered as reliable sources of energy for the province. First, the supply of indigenous natural gas from Sable is declining rapidly. Annual production has decreased by over 30 percent, from a high of 193 billion cubic feet in 2002 to 133 billion cubic feet in 2006. The possible addition of natural gas from Deep Panuke will only increase production marginally. Second, before LNG is imported, there must be an LNG regasification facility and a source of LNG: Anadarko has mothballed its proposed LNG facility at Bear Head because no supplier could be found, and little has been said in months about the 4Gas/Maple corporate consortium's proposal. For natural gas to make any significant contribution to energy security in the province, natural gas infrastructure needs to be in place; however, the lack of an adequate and secure supply cannot justify the construction of infrastructure.

The uncertainty surrounding Nova Scotia's offshore natural gas exploration and production, the lack of natural gas distribution infrastructure in Nova Scotia and the inability to find suppliers of LNG, make it clear that Nova Scotia should not base its future energy security on natural gas.

As part of its greenhouse gas reduction strategy, the Province has developed renewable energy policies that promote wind energy as an alternative to Nova Scotia Power Inc.'s (NSPI's) reliance on coal for electrical generation. The intermittent nature of wind, coupled with the difficulties of generating accurate wind forecasts, means that to successfully integrate large volumes of wind energy, a utility requires rapid response generation facilities, such as hydroelectricity or natural gas turbines. With limited hydroelectricity and natural gas, NSPI argues that there are limits to what it can reasonably accommodate. If this is true, the Province should be looking for other ways of using energy generated from intermittent sources such as the wind.

Nova Scotia has a reasonable solar resource when compared with other regions in Canada, offering the potential for both electrical generation using photovoltaic panels and thermal heating. Given the costs associated with solar electrical generation, solar thermal is the most likely route to contribute to energy security.

The report argues that instead of concentrating on supply, the Province should examine how the energy is used — energy services — and then match the service to the appropriate supplies.

A good example is space heating — the second largest consumer of energy in the province — much of which is met by imported oil products. By using electric thermal storage heaters — which can be charged periodically — with intermittent supplies of wind-generated electricity, the province would be able to reduce its reliance on imported fuel oil for space heating and increase the penetration of wind energy.

Space and water heating in the residential and commercial-institutional sectors exceeds all other energy needs except for transportation, requiring about 27 percent of Nova Scotia's energy demand. Some reduction in demand could be achieved by making new and existing buildings much more energy efficient, but this would still leave consumers vulnerable to the rising energy prices.

To gain any degree of energy security, space and water heating replacement must focus on fuels and technologies that will decrease reliance on imported energy, and increase the use of indigenous energy sources. For example, by orienting all new buildings on an east-west axis to maximize the energy derived from solar sources, the buildings could meet upwards of 75 percent of their heating demand from solar energy. Demand can also be replaced through the use of wind generated electricity being converted and stored (electric thermal storage) for heating use at a later time.

The highest demand for energy in the province is in the transportation sector (42 percent) followed by the commercial-institutional and the industrial sectors (both at 20 percent). Residential demand comprises 17 percent of energy demand.

Projected transportation energy demand for 2020 could be reduced by 20 percent through decreasing the maximum speed limit to 90 km/hr, vehicle maintenance and tune-ups, improving vehicle fuel economy and some changes in transportation use such as more car pooling and ride sharing and increased use of bicycles and public transport.

Demand for imported energy can be replaced by use of, for example, other fuels such as ethanol that could be produced in Nova Scotia. One of the limitations of ethanol is that its production requires energy inputs; if the energy yield is low or is supplied by non-indigenous sources, the energy security benefits are questionable. The use of ethanol as the primary source of transportation fuel raises a number of other concerns. It would require the conversion of much of the cropland in the province to the production of ethanol. The production of significant amounts of ethanol would in turn drive up the cost of food, and it would erode any chance that the province could achieve food security for limited gains in energy security.

The overwhelming reliance on road transportation for the movement of goods requires the construction and maintenance of roadways, activities that will increase in price as the cost of products such as asphalt rise in step with the price of crude oil. Shifts in the mode of transportation — for example, replacing road transport with rail — offers a number of advantages, perhaps the most important in the context of energy security being the fact that rail is not restricted to liquid fuels as it can also be powered by electricity.

Given Nova Scotia's present energy mix, achieving energy security will require long-term policies that consider not only the supply but also the service, answering the questions, "Can less energy be used for this service?" and "Is there an indigenous energy source that can be employed in place of the one being used for this service?" In other words, all provincial energy policies must be based upon reduction and replacement.

At present, this is not being done; neither the energy strategy nor the Province's existing policies are addressing the issue of energy security in Nova Scotia. Nova Scotia (and most of Canada for that matter) has done little in the way of developing policy to address the issue of energy security. Actions must begin now if Nova Scotians are to be protected against the rising energy prices and supply shortfalls.

Achieving energy security will require legislation and regulations; the following are examples of what will be needed for transportation and heating:

- Programs to handle short-term energy shortages during the heating season. As the cost of energy for heating rises, a growing number of individuals and families will be in need of emergency assistance to stay warm if they are unable to meet the cost of heating their homes. For example, schools and other public buildings could be opened to act as emergency "heat shelters"; this is analogous to the "cooling shelters" opened during the summer months in several U.S. cities in order to offer a respite from oppressively high temperatures.
- Require all new buildings (commercial institutional, and residential) in the province to meet at least 50 percent of their heating requirements from the sun.
- A prescriptive, enforced building code is needed; for example,
  - to maximize solar gain, buildings are to be oriented on an east-west axis;
  - to reduce the major causes of building heat loss by for example insulating basements and attics (residential) and heat retaining windows (residential and commercial).
- Reduce maximum highway speeds from 100 and 110 kilometers per hour to 90 kilometers per hour.
- Encourage modal shifts through the availability of new bus and rail services from rural and suburban centers to regional hubs. To improve the availability of these services, all new communities should be built in a clustered fashion to allow non-motorized access to bus or rail stations.
- Institute a program to improve agricultural and forestry lands, with the intention of increasing their yields of both food and energy crops. This program must include a review of Nova Scotia's existing and potential indigenous energy sources; for example, idle or fallow land must be examined for its possible use for food or energy.
- Fund a thorough, in-depth review of Nova Scotia's present energy situation and then develop reduction and replacement wedges for a 20-year plan with goals of meeting all of Nova Scotia's heating requirements from indigenous sources and having scheduled commuter services available to all Nova Scotians.

Nova Scotia's record on addressing climate change, like its efforts on energy security, is poor at best. Many of the actions described in this report to address energy security issues will help reduce Nova Scotia's greenhouse gas emissions. Everything possible should be done to ensure that replacement energy sources minimize their impact on the environment.

1 Introduction

In December 2001, the Nova Scotia government released its long-promised energy strategy document, *Seizing the Opportunity* (NS Petroleum Directorate 2001). The primary focus of the energy strategy was offshore natural gas, as the Sable Offshore Energy Project (SOEP) had come on-stream in late 1999 and was promoted as the beginning of Nova Scotia's dream of transforming itself from a "have-not" province to a "have" province (NS Petroleum Directorate 2001).

Since those heady days, things have not gone as planned:

- Natural gas production from SOEP peaked in late 2001 and the promised 25 years of production have been reduced by about half (Myrden 2004). The recent addition of a compressor deck will increase production volume; however, it will not increase the size of the Sable reserve nor extend its life (Emera 2006b).
- With rising rig costs, lack of significant discoveries, and regulatory issues, the offshore has been all but abandoned by exploration companies, with offshore licenses being forfeited and no calls for licenses since December 2004 (CNSOPB 2004a; CNSOPB 2004b).
- The Electricity Marketplace Governance Committee (EMGC) report listed 89 recommendations for changing the way the electricity is generated and sold in the Province; to date the only recommendations that have been implemented are those that benefit Nova Scotia Power as part of the 2004 Electricity Act (EMGC nd).
- Electricity rates have been increased by Nova Scotia Power (NSPI) four times since 2001 (see Table 1). The increase since the inception of the provincial energy strategy has been almost 21 percent for all rate classes, while residential has increased over 25 percent.
- The absence of a mandatory provincial Renewable Portfolio Standard (RPS), coupled with the Energy Strategy's voluntary targets for electricity from renewable sources, has restricted the growth of independent power producers (IPPs) in the province. The recently

TABLE 1 NSPI rate increases since 2001 (not adjusted for inflation) (Emera 2003; Emera 2006a; NSUARB 2006; NSUARB 2007)

Date	Average	Residential
2002	3.1%	3.0%
2005	5.3%	7.1%
2006	8.6%	9.9%
2007	3.8%	5.3%
Total	**20.8%**	**25.3%**

proposed renewable energy standard (RES), Nova Scotia's version of RPS, has a 5 percent "new renewables" target for 2010, increasing to 10 percent by 2013. The RES prohibits NSPI from bidding on the first five percent; however, on the second 5 percent NSPI can meet the target itself, excluding IPPS (NS Energy 2006a).

- The penetration of natural gas into the provincial economy has been far below initial expectations. The original franchise, awarded to Sempra Energy of California in 1999, was to have made natural gas available to 62 percent of Nova Scotia households and all 18 counties by 2007 (NS Petroleum Directorate 2001). Sempra departed in 2001 after determining it was impossible to meet the conditions of the franchise. Two years later a new franchise for the distribution of natural gas to 6 of 17 counties was awarded to Heritage Gas (Industry Canada 2006). With only a few hundred consumers connected to their network, it seems unlikely that Heritage Gas will meet its target of making natural gas available to 20,000 Nova Scotia homeowners and 6,500 businesses by 2010 (Industry Canada 2006).

In the five years since the energy strategy was released, two major issues have gained prominence in the energy sector: climate change and the cost of energy. Figure 1 shows the increase in energy costs, electricity demand, greenhouse gas emissions, and the consumer price index (CPI) between 1996 and 2005.[1] The price of energy has outstripped the CPI and despite the rise in energy prices, both electricity demand and greenhouse gas emissions continue to grow as well.

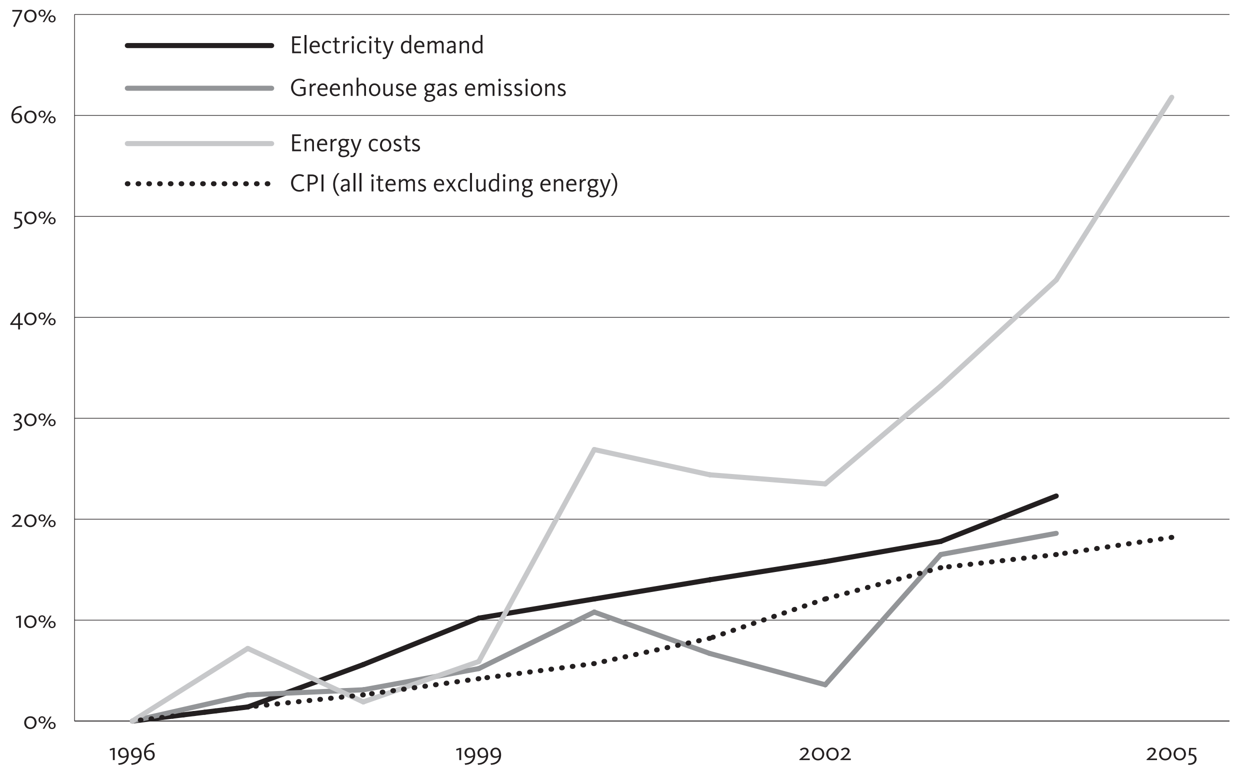
The Province's reaction to climate change and the cost of energy has been timid, largely dictated by NSPI's overwhelming reliance on coal for electrical generation and the hope that sufficient supplies of natural gas would be found both onshore and offshore to improve the provincial economy while helping to reduce greenhouse gas emissions. As a result, the Province has no comprehensive policy in place to deal with either of these issues.

What seems to have been lost on the provincial government is the fact that energy means more to Nova Scotians than wishful thinking about the offshore, misspent royalties, and limited employment opportunities for Nova Scotians; energy is what heats, feeds, lights, and moves Nova Scotians. Major disruptions in the supply of energy to the province will influence all sectors of the economy, with potentially catastrophic consequences.

Although climate change is undoubtedly the more important of these two issues, it is the rising cost of energy that will have the greatest near-term impact on Nova Scotians. The seemingly unexpected changes in the province's energy scene emphasize the need for a comprehensive energy security strategy.

This report reviews Nova Scotia's current energy supplies and demands, highlighting the problems associated with its overwhelming reliance on imported energy. An analysis of the province's energy resources and services shows that an energy use reduction campaign, coupled with indigenous supplies can help meet many of the province's energy needs, notably in space heating and transportation. However, the report also shows that indigenous supplies are limited and must be used wisely.

FIGURE 1 Growth in energy cost, electricity demand, greenhouse gases, and the CPI for Nova Scotia (Stats Can 2007a; Env Can 2006)



2 Energy Security

Security, the freedom from risk or danger, is commonly used in reference to personal or national security. Our view of security has expanded in recent years to include "food security" when referring to a nation's ability to feed itself, and "water security" when confronted with the issues of declining water quality. Over the past decade, increasing energy costs, together with rising demand and tight production, has resulted in a new type of security, commonly referred to as "energy security."

Broadly speaking, energy security is defined as the availability of a regular supply of energy at an affordable price (Costantini 2005; IEA 2001a). The World Bank has refined this definition to mean those activities that allow countries to produce and use energy sustainably at reasonable cost in order to:

- Facilitate economic growth and, through this, poverty reduction; and
- Directly improve the quality of people's lives by broadening access to modern energy services. (World Bank 2005)

Achieving energy security varies between countries and within countries, usually depending upon the state of development and the availability of indigenous energy supplies. For example, the priorities of industrialized, net-energy importing countries are:

- Avoid disruption of energy supplies;
- Diversification of energy supply sources;
- Security concerns for energy infrastructure;
- Technological solutions to reduce dependence on imported supplies. (World Bank 2005)

Ultimately, the success or failure of an energy security policy depends upon energy supply and the associated energy infrastructure. Ideally, a jurisdiction has adequate energy supplies with an infrastructure that allows the supplies to be distributed so that the demand of all energy services is met. However, history has shown that the failure of supply, the loss or the absence of infrastructure, can negatively impact the energy security of a jurisdiction.

A growing number of energy-poor countries are becoming increasingly reliant on a dwindling number of energy-rich countries for their supplies, as shown in the following examples.

2.1 OECD Europe

Imports accounted for more than one-third of OECD Europe's natural gas supplies in 2003. This is expected to grow to one-half by 2015 and two-thirds by 2030 (EIA 2006). Russia presently supplies about two-thirds of Europe's natural gas imports (EIA 2006). Europe's reliance on Russian natural gas was brought into sharp focus early in January 2006 when the Russian government and the Russian energy giant, Gazprom, cut supplies of natural gas to Ukraine, simultaneously reducing the flow to much of the European Union. The requirement that energy security have both energy supply and infrastructure was illustrated in Ukraine, where the unavailability of supply rendered the infrastructure ineffective.

Europe's dependence on foreign energy supplies has been growing, primarily because of the declining production of oil and natural gas from the North Sea (Heinberg 2006); the need for natural gas is due in part to significant investments in natural gas infrastructure. New supplies of natural gas from Norway to northern Europe and LNG to Spain and the U.K. are being touted as the means of helping the region to improve its energy security (Brooks 2006).

Recent European transportation proposals intended to reduce reliance on diesel fuel and reduce transportation-related greenhouse gas emissions has resulted in increased demand for biofuels (EU 2005; EU 2006). Since Europe has limited biofuel potential, it has opted to use palm oil from Malaysia and Indonesia to meet its biofuel requirements; in turn, Malaysia and Indonesia are clearing large areas of jungle for palm oil plantations (Pearce 2006).

2.2 China

China's rise to prominence in world energy markets can be traced back to 1993, when it moved from being a net exporter to a net importer of crude oil (BP 2006). Since then, China's energy demand has grown by almost 130 percent, making it the world's second largest consumer of crude oil, surpassing Japan in 2003 (BP 2006). China's approach to energy security has been to create companies, such as CNOOC (China National Offshore Oil Corporation) and Sinopec (China Petroleum and Chemical Corporation), which enter into exploration and extraction agreements with countries, some of which are boycotted by western governments for various political and human rights' reasons, including Sudan, Iran, and Burma.

For the most part, China's approach to acquiring energy assets or supplies has been "softly-softly," although tensions between major importing nations are becoming more apparent as demand puts extra pressure on supply. Two recent examples of energy-related tensions involving China include CNOOC's attempted purchase of the U.S. multinational Unocal in 2005 which was blocked by the U.S. government (Goodman 2005) and the ongoing dispute with Japan over oil and natural gas in the East China Sea (Faiola 2005). The driving force behind China's energy security policies is its push to modernize its economy and maintain future energy supplies.

2.3 United States

The United States is the world's largest importer and consumer of both crude oil and natural gas (BP 2006). It is also experiencing a marked decline in the production of domestic crude oil and natural gas (BP 2006; Deffeyes 2005), although reserve size is somewhat stable, being driven by increasing existing reserve size — reserve growth — rather than significant new finds (Schmoker 2000). Not surprisingly, the U.S. government is actively pursuing policies to maintain (or increase) levels of domestic supply. For example, it is:

- Attempting to expand the exploration, development and exploitation of unexplored areas of the United States. This policy is demonstrated by the continued pressure to open the Arctic National Wildlife Reserve (ANWR) to exploration (EIA 2004). There is also growing pressure to lift the moratorium on offshore oil and natural gas exploration on the U.S. continental shelf (EIA 2005).
- Encouraging the commercial exploitation of oil and natural gas resources in North America, in particular, Alberta's tar sands and bitumen reserves (McKenna 2005).
- Employing military force to keep sea-lanes and pipelines open, most notably in the Persian Gulf and Iraq. U.S. military presence in other parts of Central Asia is seen as a means of protecting crude oil supplies from these regions (Beehner 2005).
- Enacting the Energy Policy Act of 2005, part of which requires petroleum companies to blend increasing volumes of "renewable fuels" with gasoline and diesel between 2006 and 2012 (Energy Policy Act 2005). As a result of this legislation, many U.S. farmers are growing corn, not for food but for ethanol. Whether the ethanol program is energy policy or farm policy is unclear, as the Energy Return Over Energy Invested — EROEI — is low compared to other fuels (Shapouri 2004) and the principal beneficiaries are agribusinesses (Dircksen 2006).

The Biofuels Security Act of 2007, introduced earlier this year, requires all vehicles sold in the U.S. to be "flex-fuel," operating with up to 85 percent ethanol (E85) by 2017. The volume of renewable fuels is to increase from 7.5 billion gallons per year in 2012, to 20 billion gallons by 2020, and to 60 billion gallons by 2050. At least half the gasoline stations in the U.S. are to offer ethanol by 2017 (U.S. Congress, Senate 2007).

Over the past year, a number of significant concerns have arisen because of the U.S. corn-ethanol program, including the increasing cost of animal feed (Hargreaves 2007), the cost of corn-flour in Mexico (Sauser 2007), and air emissions associated with the production of ethanol (Clayton 2006).

As with Europe, U.S. energy policy is intended to maintain existing infrastructure. For example, refined petroleum products and ethanol help maintain the automobile and highway network, while natural gas is needed for electrical generation and residential and commercial space heating.

2.4 Canada: An energy "superpower"

Canadian Prime Minister Stephen Harper is calling Canada an "energy superpower," implying that energy security is not an issue in Canada (Taber 2006). At first glance, this would seem to be a reasonable interpretation, based on the seeming abundance of natural resources found in Canada: coal, oil, natural gas, uranium, and hydroelectricity. However, many of these resources are now in decline; conventional crude oil is rapidly being replaced by synthetic crude and bitumen production in Alberta, while natural gas production from existing wells continues to decrease, as does the initial productivity from new wells (NEB 2006).

Given the size of the country, it should not be surprising that Canada's energy wealth is not uniformly distributed. For example, hydroelectricity is produced primarily in British Columbia, Manitoba, Ontario, Quebec, and Labrador, while the major oil and natural gas generating provinces are Alberta, Newfoundland and Saskatchewan. Although Canada is a net exporter of crude oil and oil products, and produces enough to meet its own demands, Canada exports about half its oil production, meeting much of eastern Canada's demand from imports.

Not only are the resources distributed unevenly across the country, the infrastructure available to access these resources is also uneven. For example, all oil and natural gas pipelines from Western Canada terminate in Ontario and Quebec, respectively — they do not extend into Atlantic Canada. Similarly, Atlantic Canada has limited access to Quebec's hydroelectricity. Despite these shortcomings, Canada is the only member of the International Energy Agency that has not established national legislation or regulations to ensure a 90-day supply of oil as specified by the International Energy Program's oil stockholding requirements (IEA 2001b).

3 Achieving energy security

An energy security policy can be divided into three distinct parts: review, reduce and replace — the three Rs (Hughes 2007a).

With this review in place, it is then possible to determine the best possible approaches to meeting the requirements for the jurisdiction's energy services.

3.1 Review

The first step in achieving energy security requires a review of the following:

- Existing sources, suppliers, and supplies of energy. This part of the review gives an indication of which energy supplies may be a problem; for example, those coming from unstable regions or those known to be in decline.
- Existing energy services. A review of the jurisdiction's existing energy demand for energy services should be divided into the different categories that make up the demand. For example, rather than simply "transportation demand" the data could be divided by vehicle type.
- Potential indigenous energy supplies. The review must consider the various energy supplies that are available to the jurisdiction, both nationally and locally.

3.2 Reduce

Achieving energy security requires a reduction in the demand for the jurisdiction's energy services. Broadly speaking, this can be accomplished in two ways:

- Energy conservation. The consumer's use of the service declines, resulting in a decrease in energy demand. Examples of conservation include turning down a thermostat to reduce the energy needed to heat a space, driving an automobile at a slower speed, and turning off lights when no one is in a room.
- Energy efficiency. The consumer's use of the service remains unchanged or increases, but the technology associated with the service improves, resulting in a decrease in energy demand. Examples of energy efficiency include insulating

a building to reduce heat loss thereby allowing the consumer to maintain the building's temperature while using less energy; abandoning one mode of transport for another, less energy intensive one; and replacing incandescent bulbs with lower wattage compact fluorescents or light emitting diodes with the same number of lumens.

Of these two approaches, energy efficiency can be problematic, as improving energy efficiency need not necessarily lead to actual energy reduction since there are no incentives to reduce consumption. For example, if improving a service's energy efficiency results in economic savings that are then used to increase energy consumption in other services, then the efficiency gains will have done little or nothing to improve the jurisdiction's energy security (Reynolds 2007). Although price rises have been shown to cause a drop in energy use for those on a low-income, whether this will occur in society at large as prices increase has yet to be seen (Indeco 2004). Reduction can be allowed to occur through "demand destruction" or it can be addressed through policies that encourage it before rising energy prices make serious impacts on society.

3.3 Replace

Although reduction is an essential component in any energy security policy, its impact is limited by the fact that society requires a minimum level of energy to function. Therefore, in addition to reducing demand, achieving energy security will also require the replacement of imported energy supplies with indigenous ones. It requires an analysis of each service and its demand to ensure that the energy requirements are met; this can be done during the review. The replacement energy source need not be the same as the energy it is replacing, in fact in many cases it might not be. Consider for example, finding a replacement for furnace oil; without local sources of crude oil, other indigenous energy sources, such as solar thermal or biomass combustion, would be required.

To be effective, replacement policies must take into account the energy requirements of all sectors of the economy and then match them with the most appropriate energy source(s).

Depending upon the jurisdiction, replacement may also include upgrading existing infrastructure. The types of infrastructure in question range from the electrical transmission and distribution system to the transportation network (upgrading public transportation infrastructure to allow modal shifts).

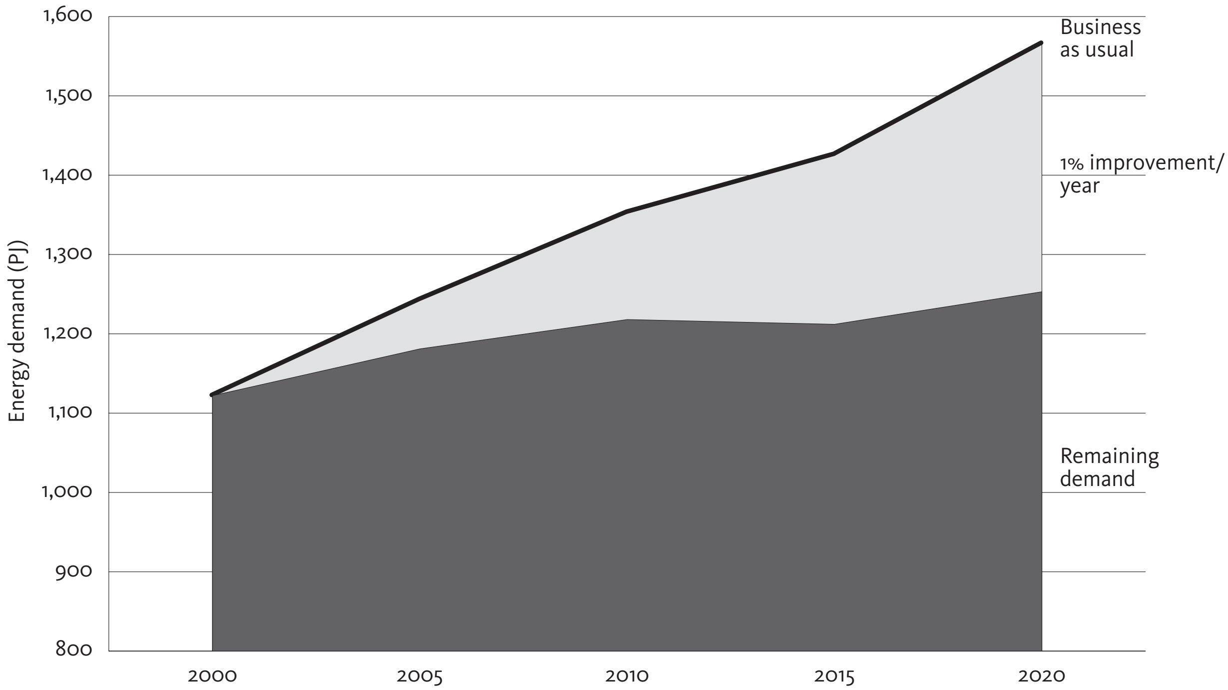
Although it is possible to have policies based on reduction or replacement alone, those focused on both are most likely to succeed, especially in jurisdictions with limited indigenous energy sources:

- Reduction without replacement may reduce demand, but if much of the demand is still being met from non-indigenous sources, energy security can be compromised.
- Replacement without reduction may offset the use of non-indigenous supplies; however, the absence of reduction may mean that the indigenous supplies are not receiving optimal use. This may result in energy shortages that must be met from imported sources, once again, compromising energy security.

3.4 Achieving reduction and replacement: wedges

Improving a jurisdiction's energy security cannot be achieved overnight, given the existing investments in energy supply and infrastructure. Reduction and replacement policies will require long-term goals or targets that are measurable and realistic with annual interim targets. Over time, the impact of each activity grows from nothing

FIGURE 2 **Sample wedge: Improving Canada's automotive energy demand** (NRCan 2006)



to some maximum, forming a wedge; collectively, these reduction or replacement wedges should reflect the decline in energy consumption and the increase in indigenous energy use. Wedges or triangles have been proposed elsewhere for the stabilization of greenhouse gas emissions (Pacala and Socolow 2004).

Figure 2 shows NRCan's projected energy demand for cars and light trucks between 2000 and 2020, marked "Business as usual." If a 1 percent per year improvement in fuel economy could be achieved, demand would show a 20 percent decline by 2020; this is represented as a reduction wedge in Figure 2.

4 Nova Scotia's energy requirements

Like most jurisdictions in the industrialized world, petroleum products and electricity are central to all sectors of Nova Scotia's economy. Examining these energy sources and the services they support will highlight the energy security issues facing the province.

4.1 Final demand

In 2004, Nova Scotia's final energy demand was met from refined petroleum products,[2] and electricity — used in all sectors except transportation and renewables — in particular, and by wood for heating in the residential and for process heat in the industrial sector, totaling about 203 petajoules.[3] The final demand by sector is shown in Figure 3.

In 2003, residential fuel oil consumption was about 10 PJ higher than in 2004, while commercial-institutional was about 10 PJ lower; this change is attributed to the way Statistics Canada now calculates the sale of fuel oil.[4] Regardless of where the volume of consumption is recorded, refined petroleum products in the commercial-institutional, residential, and public administration sectors are used almost exclusively in space-heating. A large part of the electrical demand in these sectors is employed in heating hot water (OEE 2007).

4.2 Primary energy demand

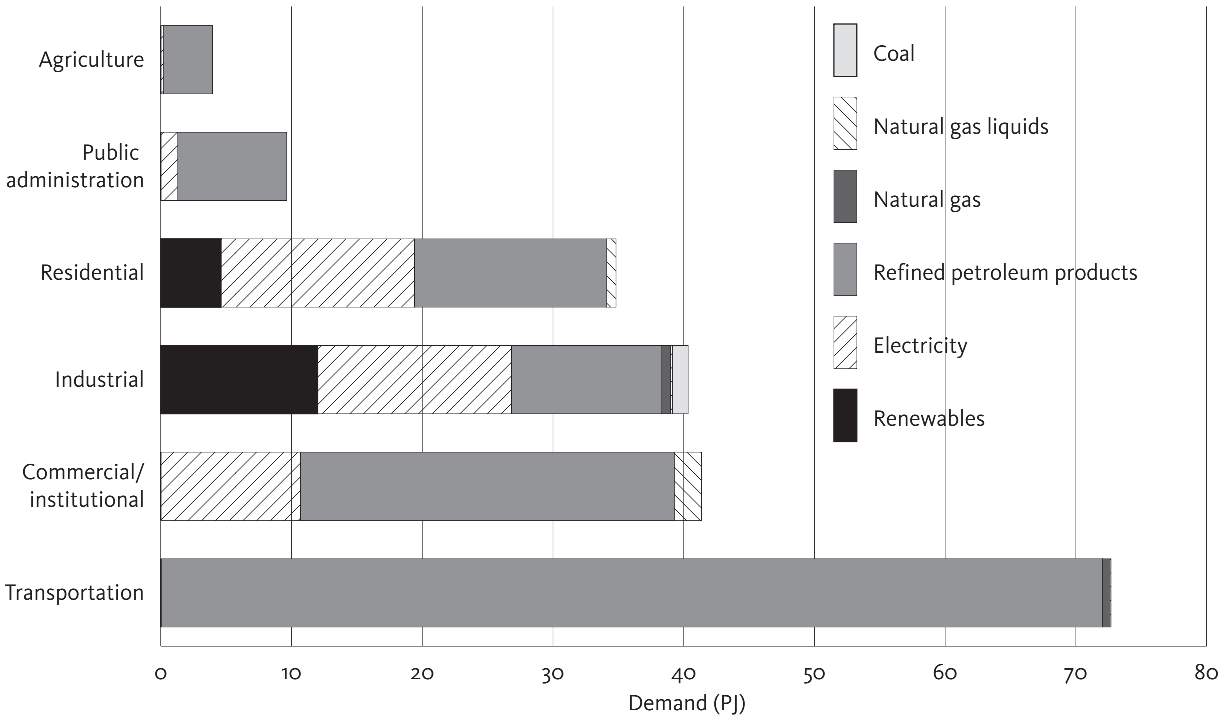
In final demand, electricity is presented as a single energy source, concealing the fact that a variety of sources, such as coal, oil, natural gas, and primary electricity can be used in its production.[5] Nova Scotia's final demand for electricity in 2004 was about 41.84 PJ. This was generated from a variety of sources, as shown in Table 2.

By excluding the energy needed to generate electricity, the final energy demand does not present the total energy requirements of a ju-

TABLE 2 **Fuel sources used for electrical generation in Nova Scotia** (Stats Can 2007b)

Fuel	Utility (PJ)	Industry (PJ)
Coal	78.24	0.0
Refined petroleum products	39.33	0.148
Primary electricity	2.68	0.0
Natural gas	1.04	0.004
Total	**121.45**	**0.152**

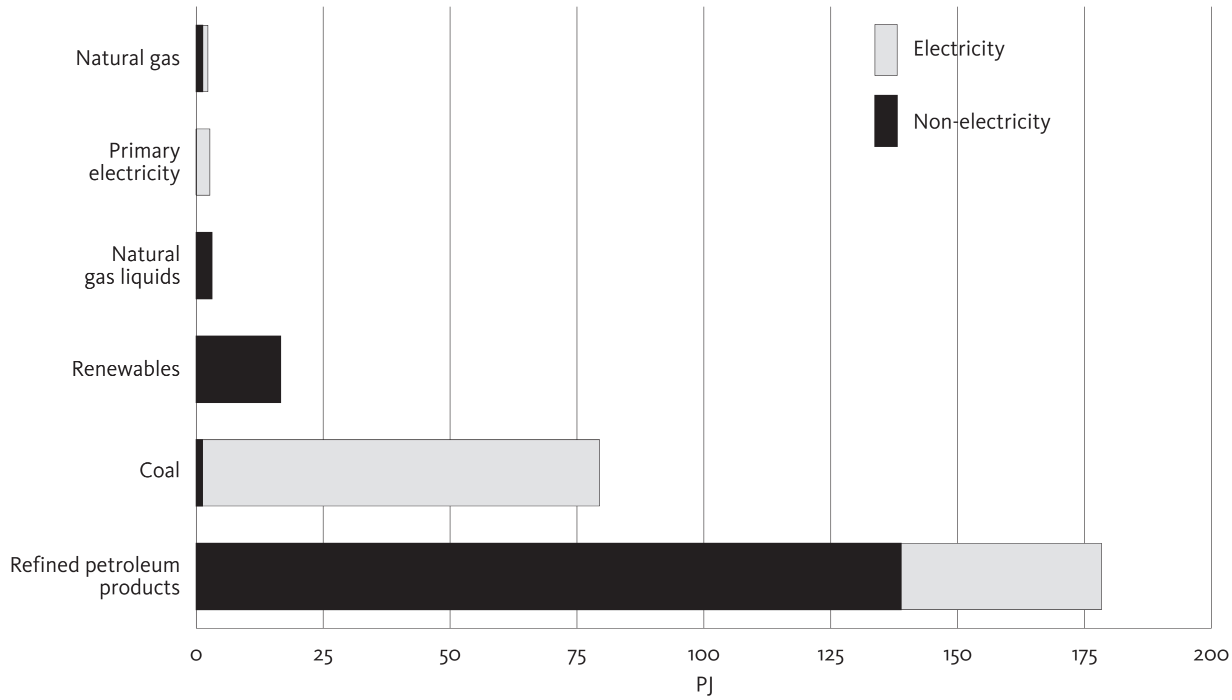
FIGURE 3 **2004 Nova Scotia final energy demand** (NRCan 2006; Stats Can 2007b)



risdiction. To understand the total energy requirements of a jurisdiction — the primary energy demand — it is necessary to include the fuel sources used for electrical generation with the energy required for the final demand, excluding the electricity generated. The primary energy demand includes both primary electricity — from hydroelectric and nuclear sources — and the energy used for thermal generation, notably coal, oil products, and natural gas. Figure 4 shows the primary demand for Nova Scotia in 2004, with the energy required for non-electrical demand and that needed to generate electricity.

In 2004, Nova Scotia's primary energy demand was about 282.4 PJ. Slightly over 90 percent of this demand was met from refined petroleum products and coal. Relying so heavily on these two fuel sources has obvious implications with respect to greenhouse gas emissions; what is not so apparent are the implications for energy security in the province.

FIGURE 4 **Nova Scotia's primary energy demand in 2004** (NRCan 2006; Stats Can 2007b)



5 Energy security and Nova Scotia

Nova Scotia's primary energy demand is met almost exclusively from sources outside the province, as shown in Table 3.

In this section, Nova Scotia's prospects for energy security are examined with respect to its reliance on imported energy. The provincial government's plans for energy security are considered in terms of the energy security discussion in the Energy Strategy as well as that of the World Bank.

5.1 Crude oil and refined petroleum products

Identifying the quantities of refined petroleum products supplied to Nova Scotia by different sources is problematic given the interchangeable nature of oil. Despite this, some observations can be made with respect to each supplier:

- North Sea. Oil production in the North Sea peaked in 1999 at 2.91 million barrels per day (b/d). By 2004 production had declined to 2.03 million b/d, a depletion rate of about 11 percent per year (BP 2006). The loss of production will impact Nova Scotia through rising prices and declining availability.
- Hibernia. About half of the crude oil produced from Hibernia, in Newfoundland and Labrador's offshore, is shipped to the Atlantic Provinces, most notably to the Irving refinery complex in Saint John; the remainder is supplied to Quebec and the United States. Production from the Hibernia fields: Hibernia, White Rose and Terra Nova, appears to have peaked, in part due to production problems with Terra Nova. Although PetroCanada has recently renewed production from Terra Nova, its rate of 110,000 b/d is not expected to reach the 160,000 b/d achieved in 2004 (Reuters 2006). Hebron — the fourth Hibernia field — will be delayed because of a royalties dispute between the Government of Newfoundland and Labrador and the consortium planning to develop Hebron.
- Middle East. With the exception of two "oil shocks" in the 1970s, Middle Eastern producers have been reliable suppliers of crude oil to the West. However, regional

TABLE 5 **Nova Scotia's coal resources** (NS Petroleum Directorate 2001)

Coal Resources	Mining Method Status	Reserves (million tonnes)	Sulphur (approx. %)	Ash (approx. %)
Prince Colliery (Point Aconi)	Underground inactive, CBDC	15	3.5	12
Donkin Resource Block	Underground inactive, resource available	>200	4.5	12
Sydney Coal Field	Surface (reclamation), 2 active, resource available	11.5	3–6	8–18
Pictou Coal Field	Surface (reclamation), 2 active, 1 complete resource available	5.3	0.8–3	12–30
Western Cape Breton	Surface (reclamation), inactive	1.2	1–7	6–15
Springhill Coal	Surface (reclamation), inactive, resource available	>2	1–3	10–15
Totals	Underground	215		
	Surface	20		

instability, growing competition between nations for Middle Eastern oil, increasing internal demand for oil products by producing nations, and the reliance on revenues from the sale of oil products by Middle Eastern governments, mean it is inevitable that oil prices will rise.

- Venezuela. Venezuela's production of conventional crude oil is declining and non-conventional sources such as the Orinoco heavy oil are difficult and expensive to refine (BP 2006; Hydrocarbons-Technology 2006). This fact, coupled with the ongoing war-of-words between Venezuela and the United States, means that Venezuela may become an unreliable supplier of oil products.
- United States. Nova Scotia receives most of its petroleum coke for electrical generation from refineries on the U.S. Gulf coast, much of which is obtained as a by-product of refining Venezuelan crude oil; in addition to the problems between the U.S. and Venezuela (see above), there are other concerns associated with relying on petcoke:
  - The growing demand for petroleum coke for electrical generation in the United States has increased its price (Energy Ventures 2006). There is no reason to assume that the price of petroleum coke should decline as the demand for electricity rises in the United States.
  - The refineries on the Gulf coast are exposed to extreme weather events, notably hurricanes. In September 2005, Hurricane Katrina caused massive damage to many Gulf coast refineries, removing over 60 percent of their production capacity, which included petcoke. As a result, in 2006, NSPI was unable to purchase petcoke, forcing it to use more expensive coal (Emera 2007).

Imperial Oil has a refinery in Dartmouth; this fact is taken by some to be a sign of Nova Scotia's energy security. Infrastructure, such as the Dartmouth refinery, is only half the story as energy security requires both infrastructure and a supply of energy. Should the supply of crude oil cease, the refinery would be of little use to Nova Scotians. It is also important to note that the presence of the refinery does not guarantee a supply of petroleum products to Nova Scotians: the refinery's output will be sold to those who can afford it.

5.2 **Coal**

Nova Scotia meets about two-thirds of its electricity demand by relying on coal, most of which is imported from three countries: Columbia, Venezuela and the United States. Nova Scotia Power (NSPI), as part of its legal requirement to reduce SO_2 emissions, is seeking coal from other low-sulphur suppliers, including Russia and Indonesia.

World coal prices have doubled since 2002 and there appears to be little reason for these prices to drop significantly as there is a growing reliance on coal for electrical generation in many countries, including India and China (Energy Ventures 2006). The cost of coal to NSPI has increased from $202.9 million in 2001 to $260.9 million in 2005 (Emera 2006a), although NSPI has been able to avoid some of the cost increases by engaging in long-term contracts.

One of Nova Scotia's coal suppliers, Columbia, has come under criticism in recent years over the treatment of workers in its coal fields; the coal extracted from these fields has been referred to as "blood coal" (ARSN 2006). Nova Scotia's reliance on Columbian coal raises energy security issues since strikes or other civil conflict in Columbia over coal production could lead to curtailment of supplies.

Supplies of coal from Venezuela to Nova Scotia, like oil products, could be affected by increasing tensions between the United States and Venezuela.

Nova Scotia's coal resources are discussed in section 6.2, below.

5.3 **Natural gas**

Nova Scotia's natural gas supplies are discussed in section 6.1, below, and include a discussion of Nova Scotia's liquefied natural gas efforts in section 6.1.5.

5.4 **Relying on the rest of Canada**

Nova Scotia has limited energy infrastructure connecting it to the rest of Canada. To make matters worse, oil products from western Canada flow as far as Ontario, while western natural gas stops in Quebec. As supplies of North American crude oil and natural gas dwindle, reliance on overseas suppliers is increasing; Quebec and much of Ontario receive crude oil from suppliers outside Canada. In order to meet Quebec's need for natural gas, PetroCanada has entered into a deal with Russia's Gazprom to examine the potential for shipping LNG from St. Petersburg to Gros Cacouna in Quebec (Pelletier 2004). None of these supplies are intended for Nova Scotia.

What infrastructure there is will do little to help Nova Scotia, and the rest of the Maritimes for that matter, should there ever be a major energy supply shortage:

- The natural gas pipeline connecting Nova Scotia to New England. With virtually no distribution network within the province, Nova Scotians would be unable to benefit from natural gas.
- The 350 MW (electricity) interconnection between Nova Scotia and New Brunswick (NEB 2005). If Nova Scotia's electricity demand exceeded what NSPI could supply and New Brunswick was unable to export electricity to Nova Scotia, the demand could not be met and blackouts would occur.

During the 1980s and 1990s, as part of the federal government's program to get Nova Scotia "off oil," coal mining in Cape Breton was subsidized to offset the cost of electricity in the province. When this program ended in 2001, NSPI stopped purchasing Cape Breton coal, opting to import coal from overseas instead.

If Nova Scotia were to face an energy shortfall in oil, coal, or both, it would be necessary to ship fuels from elsewhere:

- Canada. Shipping crude oil and coal from Canadian sources to Nova Scotia could be done by sea; for example, from the West Coast, via the Panama Canal or down the St. Lawrence (although it is frozen for part of the year). Alternatively, fuels could be shipped by rail; however, the availability of sufficient rolling stock may limit adequate supplies. A more pressing question would be whether Nova Scotia's energy needs could be met by Canadian supplies in view of Canada's NAFTA energy export requirements and its inability to meet its own oil demand.
- United States. Although the United States is a member of the International Energy Agency (IEA) and, like Canada, belongs to NAFTA, it would seem unlikely that the United States would help Canada if it meant shortages in its own country.
- Overseas. When an energy shortage occurs in an IEA member country, other members are obliged to help alleviate the shortfall. This occurred for about 60 days after hurricane Katrina hit New Orleans in August 2005, shutting down almost all of the Gulf of Mexico's oil and natural gas production. In order to offset supply shortages in the United States, IEA member countries — Europe in particular — drew down strategic stockpiles, while Canada — without a strategic reserve — simply increased its supply of oil products to the United States.

If energy shortages were short-term and localized, other IEA members might possibly be able to assist parts of Canada to overcome shortages. However, if the shortages were long-term and worldwide, it seems inconceivable that IEA member countries would put their own citizens at risk in order to help Canada.

5.5 Energy security in the Nova Scotia Energy Strategy

Seizing the Opportunity refers to energy security and security of energy supply in several places, focusing on three broad areas: natural gas and U.S. markets, electricity, and energy efficiency.

5.5.1 Natural gas and U.S. markets

When the Energy Strategy was written, many proponents of natural gas were overstating the size of the resource; this euphoria is reflected in *Seizing the Opportunity*. For example, in the chapter entitled, "Using Nova Scotia Resources," the belief in plentiful natural gas encouraged the following Statement of Principle:

> Gaining the full benefit from offshore development means obtaining significant economic value from natural gas and natural gas liquids through commercial transactions for business and residential use in Nova Scotia and export of the surplus. (Using Nova Scotia Resources, Volume 2, Page 3)

It goes on to claim that natural gas "enhances the security of our energy supply." Sadly, the reverse is true in both cases: almost all the natural gas from Sable has been exported, with little left over for business or residential use. As a result, natural gas has done little to enhance Nova Scotia's energy security.

One of the key points made in *Seizing the Opportunity* is Nova Scotia's proximity to U.S. markets; for example:

> Nova Scotia's geographic position puts us close to key markets, and its political stability offers security of supply for our natural gas customers and potentially for future electricity exports. (Volume 1, Page 9)

References are also made to the need for natural gas storage facilities to handle the vast quantities of natural gas that would be stored to meet the seasonal demand in New England:

> Underground storage facilities enabled by the Underground Hydrocarbon Storage Act will help improve the security of supply for the gas transportation system and allow the pipeline delivery system to operate more efficiently. (Using Nova Scotia Resources, Volume 2, Page 16)

Once again, the emphasis is on supplying natural gas to the United States rather than meeting the energy demands of Nova Scotians.

In an assessment of the factors making Nova Scotia a good place for exploration and development of energy resources, the Energy Strategy ranks "Security of Supply" as "High," for the following reason:

> Nova Scotia is a safe and reliable source of energy for the province, Canada and the United States, which has increasing value in a world that is more concerned about security issues. (Energy Fiscal and Taxation Policy, Volume 2, Page 6)

With declining offshore production, there is little in the way of energy security that the province offers to itself, Canada, or the United States.

5.5.2 Electricity

The Energy Strategy also mentions the need for energy security in the electrical sector. Electricity, as with natural gas, has an underlying focus on exports:

> Nova Scotia will work with New Brunswick to encourage the maximizing of opportunities for electricity exports, expansion of transmission capacity, development and implementation of security issues, and introduction of new technologies to promote the long-term growth of both provinces' electricity industries. (Electricity, Volume 2, Page 19)

Nonetheless, the need to meet Nova Scotia's electricity needs is recognized:

> On a broader scale, the provincial government's responsibilities include ensuring that electricity is available and competitively priced. Ensuring a diversity of fuel sources and security of supply are also important public responsibilities, as is monitoring the introduction of technology, environmental improvements, and new electricity sources such as wind. (Electricity, Volume 2, Page 3)

It is debatable whether the provincial government can claim success on any of these points, as electricity rates have increased almost 21 percent since the Energy Strategy was released in 2001.

Interestingly, there is a tacit recognition that when it owned Nova Scotia Power, the Province had some degree of control over provincial energy security:

> Concerns over the price and security of fuel supply for electrical power generation in the province led the provincially owned electrical utility to construct new coal-fired power generating plants, which provided increased coal markets for Nova Scotia's mining industry. (Coal, Volume 2, Page 6)

5.5.3 Energy efficiency

The Energy Strategy includes a chapter on energy efficiency as a means of reducing Nova Scotia's energy demand to improve the province's energy security. Much of the discussion on efficiency and security focuses on the poor state of Nova Scotia's energy efficiency programs; for example:

> Energy efficiency programs were reduced in the 1990s in a climate of stable energy prices and reduced concerns about security.

> (Conservation and Efficiency, Volume 2, Page 8)

There is also an admission that there was a "lack of concern" over energy security and the impact of energy on the environment during the 1990s:

> Many of the barriers to energy efficiency have changed little in the past decade: lack of access to information on energy efficiency choices, the lack of availability or high cost of energy efficient products, price signals that do not adequately reflect the real cost of energy to consumers, the lack of capital to undertake energy efficiency projects, and a general lack of concern about the security of energy supplies and the impact of energy use on the environment. (Conservation and Efficiency, Volume 2, Page 8)

5.6 **Legislation**

5.6.1 NAFTA

All energy-related decisions taken by Canada that affect energy exports to the United States are subject to NAFTA Chapters Six, *Energy and Basic Petrochemicals*, and Twenty-one, *Exceptions* (NAFTA 2002a; NAFTA 2002b). These chapters limit the actions that can be taken by the federal government in an attempt to meet the energy needs of Canadians. Perhaps the most worrying is Article 605 (a), which states that any supply restrictions imposed by Canada must

> not reduce the proportion of the total export shipments of the specific energy or basic petrochemical good made available to that other Party relative to the total supply of that good of the Party maintaining the restriction as compared to the proportion prevailing in the most recent 36-month period for which data are available prior to the imposition of the measure, or in such other representative period on which the Parties may agree.

This article prohibits Canada from reducing energy shipments to the United States in order to meet Canadian demand. Short of war or an international emergency (Article 2102 (b) (ii)), meeting increased Canadian demand would require greater production or more imports, either of which may be a problem. Nova Scotia is in an untenable situation with no pipeline to the rest of Canada and Canadian crude oil production unable to meet Canadian demand.

5.6.2 Federal

The federal "Energy Supplies Emergency Act" was passed during the late 1970s in response to the second world "oil shock"; it is:

> An Act to provide a means to conserve the supplies of energy within Canada during periods of national emergency caused by shortages or market disturbances affecting the national security and welfare and the economic stability of Canada. (ESEA 1985)

The Act describes an Energy Supplies Allocation Board and its duties, which include the assignment, rationing and pricing of energy products. It can rescind environmental legislation to ensure energy production; this is of interest in Nova Scotia as there is provincial legislation in place intended to reduce NSPI's emissions of sulphur, mercury and nitrogen compounds.

5.6.3 Nova Scotia

Other than what is discussed in the Energy Strategy, there does not appear to be any legislation, pending or enacted, that deals with energy security. The recently announced provincial government agency, Conserve Nova Scotia, does not refer to energy security in the description of its activities

> Conserve Nova Scotia a new government agency dedicated to helping Nova Scotians

learn how to use energy more efficiently. The agency inspires Nova Scotians to reduce energy waste and achieve greater energy efficiency through programs and policies. Conserve Nova Scotia is the central government agency dedicated to conservation and energy efficiency measures in the residential, commercial and industrial sectors in Nova Scotia. (CNS 2006)

At best, Conserve Nova Scotia offers limited rebates on an ad hoc and piecemeal basis. There is no overarching policy coordinating or directing Nova Scotia's energy future.[6]

5.7 World Bank recommendations

The World Bank recommendations for achieving energy security in industrialized, net energy importing jurisdictions are described above in section 2 (Energy security). How well Nova Scotia meets these is considered here:

- **Avoid disruption of energy supplies**
  Nova Scotia's overwhelming reliance on imported energy means that it is vulnerable to energy supply disruptions. These can vary from short-term events such as industrial action, as happened in Norway in 2005 and civil unrest, as is happening in Nigeria, to longer-term situations such as the rapid decline in North Sea oil production and China's continuing demand for energy.

  There are a number of ways in which Nova Scotia's imported supplies of energy products could be interrupted:

  – Products destined for one market can be diverted to another if greater revenues can be obtained elsewhere. Suppliers are under no obligation to a particular market, as recent events have shown; LNG destined for the UK has been diverted to the US, Spain and Korea, as these countries were willing to pay a higher price (Guardian Unlimited 2005). In another case, a supplier refused to supply Prince Edward Island with gasoline since the price increase was greater than the provincial regulatory board permitted; within a few hours of the refusal, the price was allowed to rise (IRAC 2005).

  – Energy supply is influenced by events almost anywhere in the world. For example, although Nova Scotia does not rely on Nigeria for oil, the civil unrest in Nigeria has forced up the world oil prices.

- **Diversification of energy supply sources**
  Nova Scotia can boast of a diversity of energy supply sources including the Middle East, the North Sea, South America and the United States. However, its reliance on two primary energy sources, oil and coal, make it particularly vulnerable to price or supply volatility in either of these products. Since both oil and coal are subject to world energy prices, Nova Scotia is unable to insulate itself from changes in these. In addition to price rises, Nova Scotia's reliance on imported oil and coal make it vulnerable to shortfalls caused by production problems in any supplier country. Imported energy is also subject to transportation costs, something that will become more of a problem as bulk carriers are in tight supply, once again, because of rising energy demand, particularly in China and India (Poten and partners2004).

  Given the growing world demand for the energy sources on which Nova Scotia is so highly dependent, energy security will require more than simply diversifying supply sources; Nova Scotia will be forced to adopt new, indigenous sources of energy to meet its energy requirements. Existing provincial government programs to reduce energy demand have limited funding, as discussed below, and are being offset by other actions that will increase the demand for energy.

In addition to the above, coal and oil are not readily interchangeable. If coal prices were to drop and those of oil to rise, Nova Scotia would not be in the position to substitute low-price coal for high-price oil: few oil furnaces operate on coal, oil-fired power stations cannot be switched easily to coal, and almost all transportation services are unable to use coal.

- **Security concerns for energy infrastructure**
Nova Scotia's energy infrastructure is limited to a refinery, some coal and oil transshipment terminals, and its electrical generation, transmission and distribution grid.[7] Other than the typical levels of security, fencing, and security guards at major installations, there is little protection in place to guard against criminal or terrorist attack.

A more pressing security issue is the impact of extreme weather events on energy infrastructure. In late 2003, a category 2 hurricane hit parts of Nova Scotia, leaving many Nova Scotians without electricity for upwards of a week. Repairs were performed by crews from NSPI and other regional electrical utilities. If the hurricane had impacted more of the Maritimes, repairs would have taken longer because of an insufficient number of trained personnel. Similarly, in February 2004, a snowfall in the range of 50 to 70 cm fell in 24 hours; again, it took repair crews several days to get electricity back to all Nova Scotians (Env Can 2004).

Nova Scotia's present energy infrastructure is ill-prepared for the growing intensity of extreme weather events exacerbated by climate change. Whether it makes sense to upgrade the existing electrical system, for example, by burying distribution lines in urban areas, or to develop an entirely new one can only be answered when the provincial government decides to implement a provincial energy security strategy.

- **Technological solutions to reduce dependence on imported supplies**
The provincial government's "Smart Energy Choices for Nova Scotians" program offers three equipment rebates and two energy audit programs. [8] Rebates are available for the purchase of Energy Star oil furnaces, EPA approved woodstoves, and solar thermal panels. The Province is also running two versions of the "EnerGuide for Houses" program, formerly financed by NRCan. These are all short-term programs, with little thought given to, for example, the impact of widespread adoption of woodstoves on fuel wood supplies.

The contradictory nature of energy politics in Nova Scotia is illustrated by the fact that in addition to these programs, the provincial government may be inadvertently encouraging the use of energy through its decision to rebate the 8 percent sales tax on space heating fuels and electricity.[9]

6 Nova Scotia's indigenous energy sources

Despite its overwhelming reliance on imported energy, Nova Scotia does have access to indigenous sources of energy. This section presents an overview of these energy sources.

6.1 Natural gas

6.1.1 The Sable Offshore Energy Project

Nova Scotia's natural gas supply comes from the Sable Offshore Energy Project which consists of a series of five natural gas fields located about 225 kilometres off the east coast of Nova Scotia in the Atlantic Ocean. Originally, the Sable project was divided into two tiers of three fields each (see Table 4).

The individual production profiles of each field and Sable's total production for its first seven years of production are shown in Figure 5. Sable's monthly production peaked in November 2001, at 512,241,110 cubic metres or 18.1 billion cubic feet (BCF). Production in March 2007, the most recent data available at the time of writing this report, was down to 334,891,000 cubic meters (11.825 BCF).

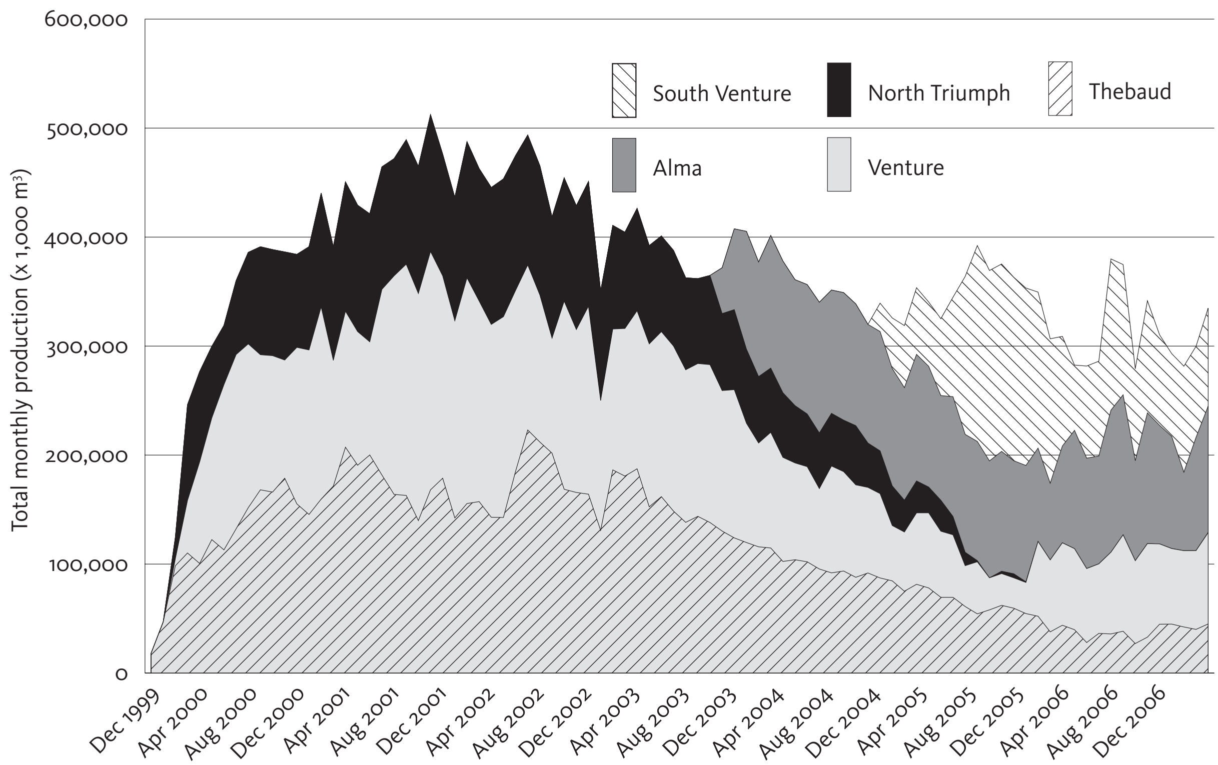
The addition of the two Tier II fields has not been able to offset the decline of the three Tier I fields. Some of the recent shortfall can be attributed to decreased production during the addition of a compression deck to the main Sable production platform; this is expected to increase monthly production by between 33 million and 100 million cubic metres. Not surprisingly, this will hasten the demise of the Sable fields.

The total volume of the fields, i.e., the size of the reserve, has undergone considerable revision over the past several years, ranging from a high of about 3.6 trillion cubic feet (TCF) soon after production began in December 1999 to 1.36 TCF in February 2004 (Myrden 2004). As

TABLE 4 **Sable's fields and production dates** (Exxon-Mobil 2005)

Tier	Field	Date of initial production
I	Thebaud	December 1999
I	Venture	February 2000
I	North Triumph	February 2000
II	Alma	November 2003
II	South Venture	December 2004
II	Glenelg	Abandoned [10]

FIGURE 5 **Sable production** (from CNSOPB 2007)



of December 2006, total production had reached about 1.11 TCF.

6.1.2 Deep Panuke

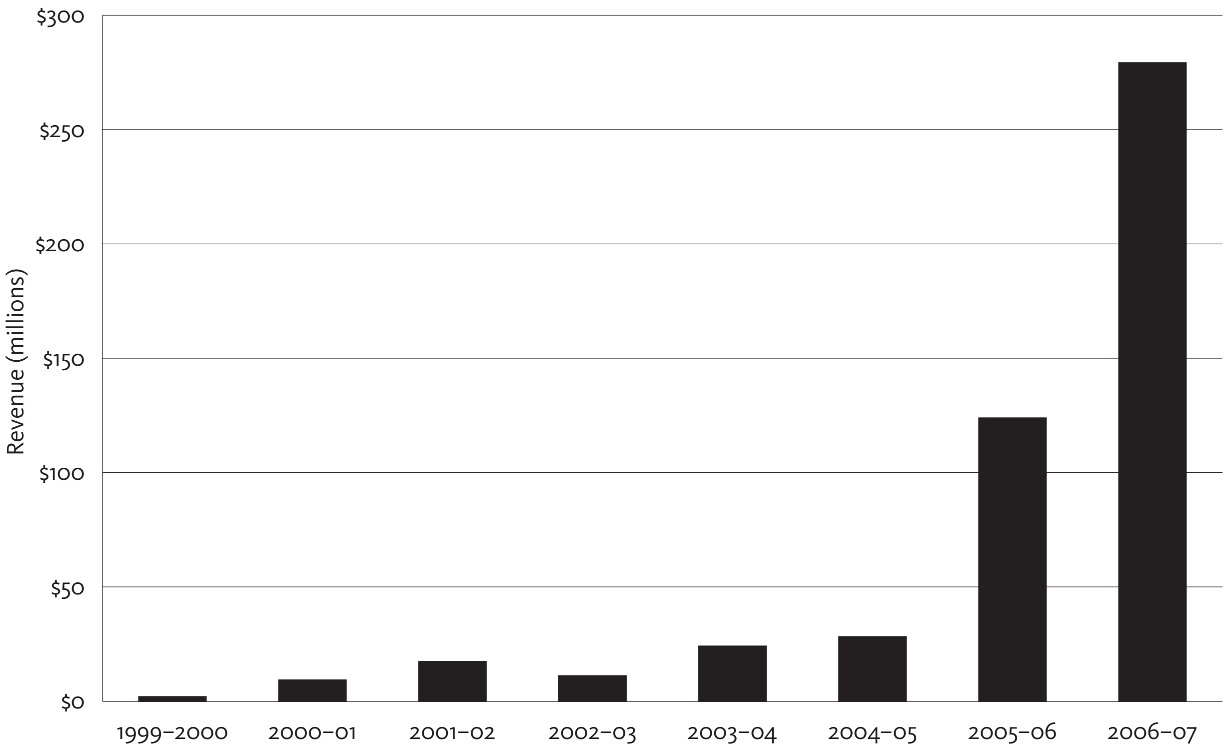
A second offshore natural gas field, Deep Panuke, is undergoing a lengthy review process by its leaseholder EnCana. The field has an on-again off-again history, with EnCana originally announcing that it would develop the field, then requesting (and re-requesting) a delay in its decision. In June 2006, EnCana and the Province jointly announced a new royalty regime for Deep Panuke, which was taken as a sign that Deep Panuke would go ahead with development. The EnCana board will make the final decision by December 2007 (PO 2006).

Deep Panuke is a small field, with an estimated size of less than one TCF, and contains sour gas; i.e., the gas has a high sulphur content. If the project proceeds, its output will be fed into the Maritime and New England (M&NE) pipeline, carrying natural gas from Nova Scotia to New England (Proctor 2006).

6.1.3 Coal bed methane

Coal bed methane (CBM) has been found by Corridor Resources in significant quantities in New Brunswick and is being fed into the M&NE pipeline (CAPP 2006). With considerable coal reserves in Cape Breton and northern parts of Nova Scotia, a number of firms are searching for CBM sites (NS Petroleum Directorate 2001). In keeping with previous optimistic views of anything dealing with Nova Scotia indigenous energy resources, the Energy Strategy states that “Some industry estimates suggest that Nova Scotia’s CBM resource may measure in the trillions of cubic feet” (NS Petroleum Directorate 2001).

FIGURE 6 **Sable royalties 1999–00 to 2006–07 (06–07 are estimates)** (MacDonald 2006)



6.1.4 Royalties

Nova Scotia receives royalties from companies exploiting its offshore oil and natural gas resources; all royalties are determined by the Offshore Petroleum Royalties Act and its associated regulations (NS Energy 1999). In the case of the Sable Offshore Energy Project, royalties are tiered, increasing over time as the project matures; variations in the price of natural gas also have a significant impact on the royalties obtained. Figure 6 shows the actual and estimated royalties from the Sable project.[11]

Since Nova Scotia is a recipient of equalization payments, the royalties obtained from the offshore are taken into account when determining the Province's level of equalization (Canada-Nova Scotia 1986). As a result, any increase in royalties would effectively decrease federal equalization payments to Nova Scotia. The original agreement between the governments of Canada and Nova Scotia reduced equalization payments by an amount equal to 81 percent of the offshore royalties obtained by the Nova Scotia government.

Royalties from the offshore were a contentious issue for Premier Hamm who led his "Campaign for Fairness" for much of his tenure as premier, arguing that Nova Scotia's offshore royalties should not be included in the equalization formula. Premier Hamm's complaints were largely ignored by the federal government until Newfoundland and Labrador's premier, Danny Williams, took on the federal government with an aggressive campaign in 2004–05 over the issue of offshore royalties (CBC 2004). In early 2005, Premier Williams' campaign was successful, forcing the minority federal government to negotiate the "Atlantic Accord", which effectively removed offshore royalties from the equalization for both Newfoundland and Labrador and Nova Scotia for a period of eight years, with an option for an additional eight years (NS Finance 2005).

Central to the Atlantic Accord is the Offshore Offset Agreement, requiring the federal government to make a one-time payment of $830 million to the government of Nova Scotia in 2005–06 to be used as a cash payment on the provincial debt. In exchange, the provincial government is required to "produce surpluses at least equal to that portion of the $830 million recognized under GAAP as revenue earned from the Offshore Offset" over the eight years of the agreement (NS Finance 2005). Despite rising royalty revenues from the offshore, the Province is having difficulties with its budget (NS Finance 2007).

Much of the above discussion is now academic, as the 2007 federal budget offered Nova Scotia (and Newfoundland and Labrador) a stark choice: keep the Atlantic Accord and continue receiving payments based the old equalization formula or accept a cap on royalties — that is, scrap the Atlantic Accord — and receive higher equalization payments under a new equalization formula. As many people rightly observe, this runs counter to the spirit of the original agreement and promises made by Prime Minister Harper prior to the 2006 federal election.

Nova Scotia has been given one year to decide whether to maintain the Atlantic Accord or accept a cap on royalties. At the time of writing, it is unclear what the province will do. Regardless of what decision is finally taken, royalties from Sable will peak in a few years, meaning that the dreams of becoming a "have" province because of offshore riches are as elusive as ever.

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Nova Scotia has been given one year to decide whether to maintain the Atlantic Accord or accept a cap on royalties. At the time of writing, it is unclear what the province will do. Regardless of what decision is finally taken, royalties from Sable will peak in a few years, meaning that the dreams of becoming a "have" province because of offshore riches are as elusive as ever.

6.1.5 Infrastructure, exploration, LNG and Irving

Regardless of the availability of offshore natural gas and coal bed methane in Nova Scotia, very few Nova Scotians are using natural gas for heating or cooking. About 10 percent of the natural gas from Sable is available for use in Nova Scotia, primarily by Nova Scotia Power for electrical generation and for limited industrial applications. Heritage Gas and the provincial government are advocating construction of a natural gas pipeline under Halifax harbour to carry natural gas from the Dartmouth side of the harbour to peninsular Halifax (Altagas 2007). The belief is that once natural gas reaches Halifax, a small cogeneration facility will be constructed by HRM to generate electricity and supply heat to two universities and the hospitals. With natural gas in place, so the thinking goes, many residential consumers will opt in, thereby justifying the Province's emphasis on natural gas in its 2001 Energy Strategy.

With Sable in rapid decline and Deep Panuke's limited size, it seems folly to encourage the uptake of natural gas as an energy source. The province's counter-argument to this is that having a natural gas pipeline to New England, liquefied natural gas (LNG) suppliers will come to Nova Scotia to build LNG regasification facilities. The Province views this as a positive step because having the M&NE pipeline filled with natural gas from LNG, will increase the time available for companies to resume offshore exploration.

There are a number of problems with this line of reasoning:

- The lack of offshore exploration can be attributed to several issues: the high cost of exploring in Nova Scotia's deep water, high rig costs, and the worldwide scarcity of deep-water rigs. These, coupled with the fact that very few commercial quantities of natural gas have been found in Nova Scotia's offshore waters, are discouraging exploration.
- Clearly some natural gas exists in the Nova Scotia offshore; the absence of commercially viable amounts may mean that these small fields, referred to as stranded gas, are simply too small and too expensive for companies to pursue. The belief, promoted by Offshore/Onshore Technologies Association of Nova Scotia (OTANS), that small fields will attract small companies assumes that they are able to find sufficient funds to undertake the exploration (Dawe 2004). To date this has not happened.
- There are fewer and fewer countries in the world where multinational companies such as Shell, Exxon-Mobil and BP can operate without the interference of national governments. An excellent example of this is Sakhalin Island, off Russia's Pacific coast, where Shell and Exxon are fighting the elements, the Russian government, and the oil giant, Gazprom, to ensure the extraction of natural gas and crude oil (MosNews 2006a; MosNews 2006b). Since neither the Canadian nor Nova Scotian governments are threatening to expropriate energy companies working in Nova Scotia's offshore, it is reasonable to assume that if the offshore had considerable reserves of natural gas, these large multi-national companies would be here doing business.

With the decline of natural gas from Nova Scotia's offshore and limited onshore discoveries, the provincial government is searching for sources of natural gas both to keep the pipeline active and to maintain commercial interest in the offshore.

This has led the provincial government and the Department of Energy to push for the development of liquefied natural gas (LNG) facilities in the province:

- In 2004, the Province announced that Anadarko Petroleum was to construct an LNG regasification facility in Bear Head.[12] After failing to secure a long-term supplier of LNG throughout 2005, Anadarko put the site up for sale in 2006; a potential buyer was found but this sale collapsed in late 2006. In February 2007, Anadarko announced that it was abandoning the Bear Head site (EnergyOnline 2007).
- In late December 2005, Keltic Petrochemical and 4Gas[13] (a subsidiary of Petroplus) announced that they would jointly create a LNG regasification facility (4Gas) and a petrochemical plant (Keltic) (Clarke 2006).[14] Since then, Keltic has sold its interest in the LNG facility, opting instead to pursue its interest in the petrochemical plant (Guysborough 2006). At present, it is unclear whether Petroplus or 4Gas have found any suppliers of LNG.

Overshadowing Nova Scotia's push for LNG is Irving's "energy hub" being created in Saint John where, in addition to expanding their refinery, Irving is working with Repsol to build an LNG regasification facility. Unlike Anadarko or 4Gas, Repsol has a supply of LNG, in this case from Trinidad and Tobago.

The Saint John facility is of concern to the Nova Scotia government for three reasons. First, it has put Saint John and New Brunswick ahead of Nova Scotia in the LNG "game." Although at least three sites in the region are pushing for LNG facilities (Bear Head and Goldboro in Nova Scotia and Saint John in New Brunswick), only Saint John has been successful. One concern in Nova Scotia is that there may be no further LNG development if Saint John proves successful.

Second, Irving has partnered with Emera (the parent company of Nova Scotia Power) to build the Emera-Brunswick pipeline from Saint John to the Maine border, bypassing the Maritime and Northeast pipeline that carries natural gas from Guysboro to New England. Without natural gas from Saint John, the volume of natural gas in the Maritime and Northeast pipeline will continue to decline, making the Maritime and Northeast pipeline less economic to operate, and apparently less attractive for other potential suppliers to use.

The third reason is related to the second, and is based upon the belief that if major energy shortages were to occur in Nova Scotia, natural gas from New England or Saint John could be shipped to Nova Scotia via the M&NE pipeline. This scenario is being promoted by the Nova Scotia government (NS Energy 2006b). The likelihood of this occurring is remote, not only because the United States is "gas hungry" and unlikely to share its supply of natural gas, but because Nova Scotia lacks a significant natural gas infrastructure and distribution network. Quite simply, there is no point in supplying natural gas to a jurisdiction that lacks the infrastructure to distribute it.

Given the uncertainty surrounding Nova Scotia's offshore natural gas exploration and production, the lack of natural gas distribution infrastructure in Nova Scotia, and the inability to find suppliers of LNG, it should be clear that Nova Scotia should not base its future energy security on natural gas.

TABLE 5 **Nova Scotia's coal resources** (NS Petroleum Directorate 2001)

Coal Resources	Mining Method Status	Reserves (million tonnes)	Sulphur (approx. %)	Ash (approx. %)
Prince Colliery (Point Aconi)	Underground inactive, CBDC	15	3.5	12
Donkin Resource Block	Underground inactive, resource available	>200	4.5	12
Sydney Coal Field	Surface (reclamation), 2 active, resource available	11.5	3–6	8–18
Pictou Coal Field	Surface (reclamation), 2 active, 1 complete resource available	5.3	0.8–3	12–30
Western Cape Breton	Surface (reclamation), inactive	1.2	1–7	6–15
Springhill Coal	Surface (reclamation), inactive, resource available	>2	1–3	10–15
Totals	Underground	215		
	Surface	20		

6.2 Coal

Between 1980 and 2001, Nova Scotia was producing an average of 2.8 million tonnes of coal per year (Stats Can 2007c). Almost all of the province's coal mines were closed in 2001 (PCO 2001) and production is currently less than one tenth of its peak (Emera 2006b). Recently, there has been renewed interest in reopening at least one of the mines, Donkin, because of its sizeable reserves (CBC 2005). Nova Scotia's coal has one major drawback, notably its sulphur content, as shown in Table 5.

At present, about 360,000 tonnes of coal are being mined in Nova Scotia, most of which is purchased by NSPI, Nova Scotia's single largest consumer of coal at about 2.84 Mt per year (Emera 2006a). Assuming no exports, accurate reserve data, and the dedication of all coal mined to electrical generation, then at Nova Scotia's present rate of consumption, there are about 82 years of coal available. This decreases to 60 years when assuming an annual growth in coal demand of 1 percent per year.

In theory, coal could be used to meet all of Nova Scotia's energy needs — electricity, heating, liquid fuels, and so on. Using bituminous coal with an energy content of about 27.8 GJ per tonne, to meet the province's demand of 281 PJ would require about 10.1 Mt per year which naïvely assumes no energy loss in the conversion of coal to these other fuel types. If the province's energy demand remained constant, Nova Scotia's coal reserves would last about 23 years.

It is worth noting that Nova Scotia now has sulphur reduction legislation in place, requiring provincial SO_2 emissions to halve, from 189,000 tonnes in 1995–1999 to 94,500 tonnes by 2010 (NS Environment 2005). NSPI is responsible for reducing the majority of the emissions from 145,000 tonnes (1995–99) to 72,500 tonnes (2010). At present, this is being achieved with the purchase of expensive low-sulphur coal from Venezuela, Columbia and the United States. In order to use less expensive higher-sulphur coal, NSPI is proposing the addition of a Flue Gas Desulphurization (FGD) unit at their Lingan coal-fired thermal power station at a cost of about $170 million (NSPI 2005).

6.3 Hydroelectricity (including tidal)

With the exception of one or two small, privately owned generating stations, all of Nova Scotia's hydroelectric capacity is produced by NSPI. Every potential commercial-scale source of hydroelectric power in the province has been tapped. NSPI also operates the Annapolis tidal generating facility. All told, the available hydroelectric and tidal capacity comes to about 400 MW (NSPI 2006a).

Electrical production from the province's hydroelectric facilities varies from year to year, depending upon demand, fuel prices and precipitation. Total annual electrical energy production from these facilities is in the range of 3 to 4 PJ or about 1,000 GWh.

Tidal barrage and tidal current technologies have both been studied extensively, a result of Nova Scotia's proximity to the ocean and the Bay of Fundy. In the 1970s, two large barrage projects were examined in detail: a 3,800 MW site on Cobequid Bay and an 1100 MW site on the Cumberland Basin (Joseph nd); neither project proceeded, due to the capital costs and anticipated environmental impacts. More recently, the Electric Power Research Institute (EPRI) released a report proposing the use of tidal flow (or tidal current) devices in the Minas Channel and Minas Passage, with a projected total capacity between 262 and 333 MW (Hagerman 2005). Both funders of the project (the Province and NSPI) have recommended that any implementation be taken slowly (NSPI 2006c).

The energy available from a proposed commercial 10 MW tidal current plant is estimated to be 30,000 MWh or about 0.1 PJ (Hagerman 2005): if this was increased to 333 MW, the plant would produce 3 to 4 PJ.

6.4 Biomass

Biomass is obtained from two sources, agricultural and forest products. It is the "ideal" energy source because if done properly it can be renewable and, in addition to being a solid fuel, can also be liquefied and gasified. With the availability of agricultural and forest products in Nova Scotia, biomass is a potential indigenous energy source.

Agricultural biomass includes such "energy crops" as corn for ethanol or soy beans for biodiesel, harvest residues including corn stover for combustion or ethanol, manure and organic municipal solid waste for methane, and byproducts from rendering, used for liquid fuels (Sims 2002). In the 2001 census, Nova Scotia had 407,046 ha of agricultural land; 100,000 ha was crops, 65,000 ha was pasture, and the remaining was either treed or in transition out of agriculture (WLRI 2004). The census also showed that the province produced about 496,000 metric tonnes of hay, 40,000 tonnes of grain, and 25,000 tonnes of corn residues (WLRI 2004).

Forestry biomass focuses on "woody biomass" and includes energy crops such as fast-growing hybrid poplars and willow coppicing and residues from harvesting or the production of wood products. Although yields vary by species, products include: pelletized wood, easy to transport for combustion in residential, commercial, industrial and electrical generation; liquid fuels, primarily ethanol; and gasification for electrical generation.

In 2002, Nova Scotia had about 3.9 million hectares of forested land and produced 6.07 million cubic metres of solid wood, or about 4.33 million tonnes,[15] 5.18 million cubic metres was softwood and 880,000 cubic metres of hardwood (WLRI 2004). The provincial registry of buyers shows 1.5 million tonnes of wood residues in 2003 (WLRI 2004).

As an example of Nova Scotia's biomass potential, the entire solid wood harvest has an energy content of about 65 PJ, which is equivalent to about one quarter of the province's primary energy demand. This raises the first of two issues regarding biomass: much of what is produced in Nova Scotia is already being used in other applications, from animal feed (hay and grain) to the production of forestry products (lumber and paper products). It is unlikely that all 65 PJ would be available for energy use.

The second issue deals with the problem of sustainability: can Nova Scotia's ecosystems support the potential agricultural and forestry practices that will be needed to support both existing industries and a bio-energy industry?

These economic and ecological issues must be addressed before any large-scale bio-energy industry is developed (Mahendrappa 2005).

6.5 Other renewables

In addition to hydroelectricity and biomass, Nova Scotia has numerous examples of geothermal ("earth heat"), solar and wind energy:

6.5.1 Geothermal

Horton High School in Greenwich, several buildings connected to an abandoned mine in Springhill, and an office tower in Halifax all meet some of their heating and cooling needs from geothermal sources. The siting and technical requirements of geothermal energy means that it is best suited to new-builds rather than retrofits.

6.5.2 Solar

Nova Scotia has a reasonable solar resource when compared with other regions in Canada (see Table 6), offering the potential for both electrical generation using photovoltaic panels and thermal heating.[16] Given the high installation costs associated with photovoltaic solar panels, it would appear unlikely that there will be anything more than a cursory uptake of this technology without some form of assistance (REN21 2006). Solar thermal is another matter, since the range of methods for obtaining and storing heat from the sun runs from simple building-orientation (passive solar) to heat capture and storage technologies (active solar).

Solar, like geothermal, is best applied to purpose-built construction, given the need for proper site selection and building orientation. The benefits of south-facing windows throughout the Halifax heating season of October to May are shown in Figure 7. During this period, a south-facing window transmits 359 kWh/m² (Wood 2006), whereas the west-facing window transmits 188 kWh/m² (54.4 percent of south-facing) and the east-facing window transmits 204 kWh/m² (56.8 percent of south-facing).[17] The north-facing window receives the least amount of sunlight, transmitting 106 kWh/m² or 29.5 percent of the south-facing window.

TABLE 6 **South-facing window size required to receive 40 GJ of heat during the heating season** (CMHC 1989)

Location	Area (m²)
Winnipeg	14.1
Swift Current	14.6
Edmonton	14.9
Fredericton	16.0
Ottawa	16.1
Halifax	*17.4*
Montreal	17.4
Charlottetown	17.4
Toronto	18.9
St. John's	22.0
Vancouver	23.2

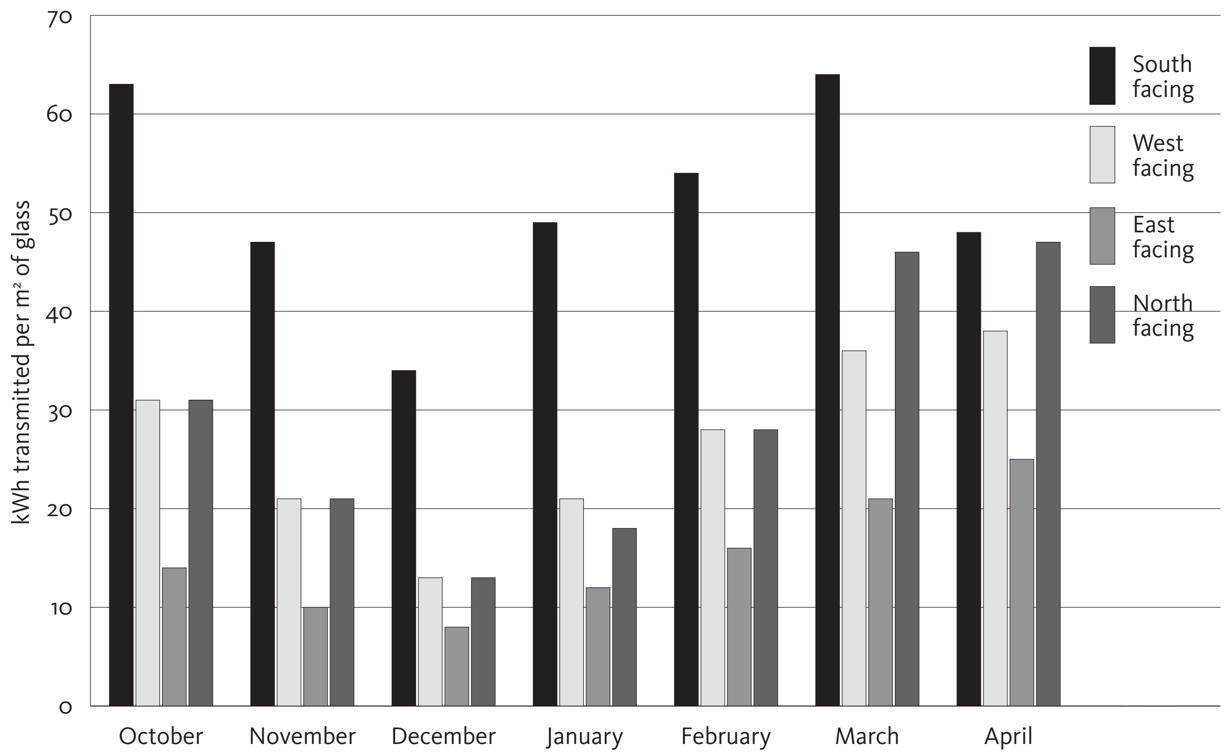
Although retrofitting buildings for solar is possible, the layout of roadways, building design, siting of neighbouring buildings, and geography can limit the amount of usable solar energy.

Simple orientation can increase the solar gain of a building, potentially replacing some of the energy required to heat it. To achieve significant levels of replacement, seasonal storage is required, where solar energy is stored as heat, typically underground, and then drawn upon during the heating season (Hughes 2007b).

6.5.3 Wind

Over the past quarter-century, the technology for generating electricity from the wind has evolved from small multi-kilowatt turbines to multi-megawatt machines. As the cost of electricity from traditional sources increases, the attractiveness of wind power increases as well, primarily because it has no fuel costs. Since

FIGURE 7 **Solar gain for windows in the Halifax region as a function of orientation** (Wood 2006)



wind does not rely on fossil fuels, it does not emit greenhouse gases.

Despite these advantages, wind is not without its faults. Wind's detractors point to bird and bat deaths, noise and the destruction of scenic vistas. From an electrical generation standpoint, the issue is how to deal with wind's intermittency; that is, a wind turbine can generate electricity only when there is sufficient wind available. At all other times, there is no output. The energy actually produced by a wind turbine divided by the theoretical maximum (that is, the product of the turbine's maximum rated power and the number of hours in a year) is referred to as the turbine's "capacity factor." The capacity factor depends upon things such as the turbine's design, its location and the annual variations in the weather. A "good" capacity factor is above 30 percent.

Regardless of a turbine's capacity factor, there is always a need to handle the times when there is no output. Since a turbine's electricity output can fall to zero in a very short period, it is necessary to use a secondary generation technology that can be switched on rapidly, such as hydroelectric and gas turbines, to ensure a continuous supply of electricity. Wind advocates point to the fact that since most electricity suppliers maintain spinning reserve,[18] wind should be allowed to supply as much electricity as is being generated by the spinning reserve. Under ideal circumstances, relying on hydroelectricity or gas turbines for backup would probably permit a high penetration of wind; however, seasonal precipitation variations in filling hydroelectric reservoirs, the cost of gas turbine fuels, the wear-and-tear associated with ramping turbines up and down, and the fact that the capacity factor of most wind turbines is closer to 25 percent, means that using wind energy introduces problems that most electricity suppliers would prefer not to face.

At the other extreme, wind's second major shortcoming is coincidence; that is, the output from wind may or may not coincide with demand. Ideally, the output matches the demand; however, if the output falls short, it is necessary for the energy supplier to have sufficient standby capacity to meet the shortfall ("top-up"), while if the output exceeds the demand, there should be a mechanism whereby the excess can be sold ("spill"). Since most electricity suppliers want to charge a premium for top-up and pay less than market price for spill, wind-electricity producers are often put in an untenable position.

The most commonly discussed alternative for using backup power to handle top-up and spill is for the wind producer to incorporate some form of intermediate storage of electricity, usually hydrogen (from electrolysis) or storage batteries. Another interesting approach is to convert the electricity into thermal energy, saving it in thermal storage heaters, and using it on demand for heating purposes. This technique can overcome the intermittency problems associated with wind because the thermal energy is used as a bridge between the times when the wind is available (Hughes et al. 2006).

Nova Scotia appears to have considerable potential for utilizing the wind to generate electricity. The Energy Strategy and the subsequent Energy Marketplace Governance Committee report both outlined methods of incorporating renewable energy into Nova Scotia's electrical mix through a provincial Renewable Portfolio Standard (EMGC nd).[19]

To encourage wind development, several events occurred, all based on the Energy Strategy and the EMGC report. The first was that NSPI agreed to voluntarily allow up to 50 MW of renewable capacity to be connected to its grid and would purchase the energy produced. Second, NSPI's transmission grid would be opened to allow Independent Power Producers (IPPs) to sell electricity directly to any or all of the six municipal utilities that presently purchase most of their electricity from NSPI, about 1.6 percent of NSPI's total annual sales. In exchange, the provincial government created the Electricity Act of 2004, which allowed the municipal utilities to purchase electricity from IPPs (Electricity Act 2004). This Act made NSPI Federal Energy Regulatory Commission (FERC) compliant, meaning that NSPI could sell electricity to NB Power and energy suppliers in the United States, meeting requirements of the New Brunswick regulator (EMGC nd).

On one hand, NSPI is exceeding the "letter" of its voluntary agreement, allowing more than 50 MW of renewables to connect to the grid, as required by the Energy Strategy. On the other, it is debatable whether NSPI is living up to the "spirit" of the agreement, as the price offered per kilowatt-hour by NSPI is less than it would cost most IPPs to produce the electricity and considerably less than it demands for its residential "green power" (Hughes 2002). NSPI has committed to purchasing 282 GWh of electricity from renewables; to date, it is purchasing less than half that amount (Emera 2006a), in part because IPPs are not being paid fair value for their production.

The EMGC report also called for the development of a provincial renewable portfolio standard (RPS); regulations have recently been proposed, requiring all provincial energy suppliers (read "NSPI") to ensure that 5 percent of their production is from "new" renewables by 31 December 2010 and ten percent by 31 December 2013 (NS Energy 2006a). NSPI has agreed that it can achieve the 5 percent target, but has issued a report arguing that many of the problems associated with wind mentioned above means that the 2013 target cannot be met (NSPI 2006b).

NSPI asserts that it cannot increase the amount of wind energy in its existing grid because of potential instabilities. This is probably correct, but could be addressed with upgrades to the transmission and distribution network. However, this is not the point of the RPS; NSPI is not being asked to increase the amount of wind energy, it is being asked to increase the amount of *renewable energy*. With this in mind, other forms of renewable energy, including tidal and biomass, could be incorporated into the mix, allowing NSPI to meet the 10 percent target.

Based on NSPI's past record, it is clear that both legislation and regulations, enforced through an independent body, will be needed to force NSPI to adopt renewable energy.

6.6 **Nuclear**

Nuclear energy, the generation of electricity from steam created by the heat released from the fission of uranium compounds, is enjoying a resurgence in popularity as a result of rising electricity demand and climate concerns. Proponents of nuclear energy point to Canada's uranium reserves and its reactor technology as a means of helping the country achieve energy security and reduce greenhouse gas emissions, whereas opponents question the size of the reserves, radionuclides escaping from mill tailings, greenhouse gases associated with mining and construction, cost overruns, reactor safety, waste disposal, and nuclear proliferation.

Nuclear power is not permitted in Nova Scotia. More specifically, NSPI is not permitted to build a nuclear power plant, as the Nova Scotia Power Privatization Act of 1992 states:

> 8 (a) a provision that the primary object of the Company is to develop in the Province the use of power on an economic and efficient basis and for this purpose to engage in the Province and elsewhere in the development, generation, production, transmission, distribution, supply and use of electricity, water, sun, wind, steam, gas, oil or other products or things used or useful in the production of power and the Company shall not construct a generating plant that utilizes nuclear energy to produce electricity. (Nova Scotia Power Privatization Act 1992)

Although the Act explicitly lists "water, sun, wind, steam, gas, and oil" as acceptable means of generating electricity, nowhere in the Act is coal mentioned. One of the principal reasons Nova Scotia prohibited NSPI's inclusion of nuclear in its energy mix was to protect Nova Scotia's coal industry in the early 1990s.

Nova Scotia's indigenous supply of uranium appears to be limited (O'Reilly 2005); however, Canada has significant uranium deposits in northern Saskatchewan. By supplying nuclear reactors in Nova Scotia with Canadian uranium, the province could reduce its demand for imported coal and oil for electrical generation.

7 Achieving energy security in Nova Scotia

Improving a jurisdiction's energy security, like reducing greenhouse gases, will be an enormous, long-term task. This section considers what could be achieved by applying the three 'R's (review, reduce, replace) to space heating and transportation in Nova Scotia by 2020.

7.1 Nova Scotia's energy demand to 2020

In early October 2006, NRCan released its energy outlook for Canada and the provinces to the year 2020. Nova Scotia, as with most other provinces, is projected to increase its energy demand between 2005 and 2020. According to these projections, Nova Scotia's final demand will increase by 12.8 percent, from 197 PJ to 226 PJ (see Figure 8).

Table 7 shows Nova Scotia's projected increase in final demand by sector between 2005 and 2020. The largest growth, 23.7 percent, occurs in the commercial-institutional sector;[20] however, part of this growth can be attributed to the fact that NRCan is basing its estimations on data from Statistics Canada, which has shifted a significant portion of residential fuel oil demand into the commercial sector. This means that some of the growth in the residential sector energy demand will be included in the commercial-institutional sector.

By 2020, the greatest demand for energy will remain in the transportation sector (96 PJ), with

TABLE 7 **Projected growth in final demand: 2005–2020** (NRCan 2006)

Sector	2005 Demand (PJ)	Percent	2020 Demand (PJ)	Percent	Growth
Residential	34.1	17.3%	37.3	16.5%	8.60%
Commercial-Institutional	39.9	20.2%	52.3	23.1%	23.70%
Transport	82.9	42.0%	96	42.5%	13.60%
Industry	40.3	20.4%	40.5	17.9%	0.50%
Total final demand	197.2	100.0%	226.1	100.0%	12.80%

FIGURE 8 **Nova Scotia's projected final energy demand to 2020** (NRCan 2006)

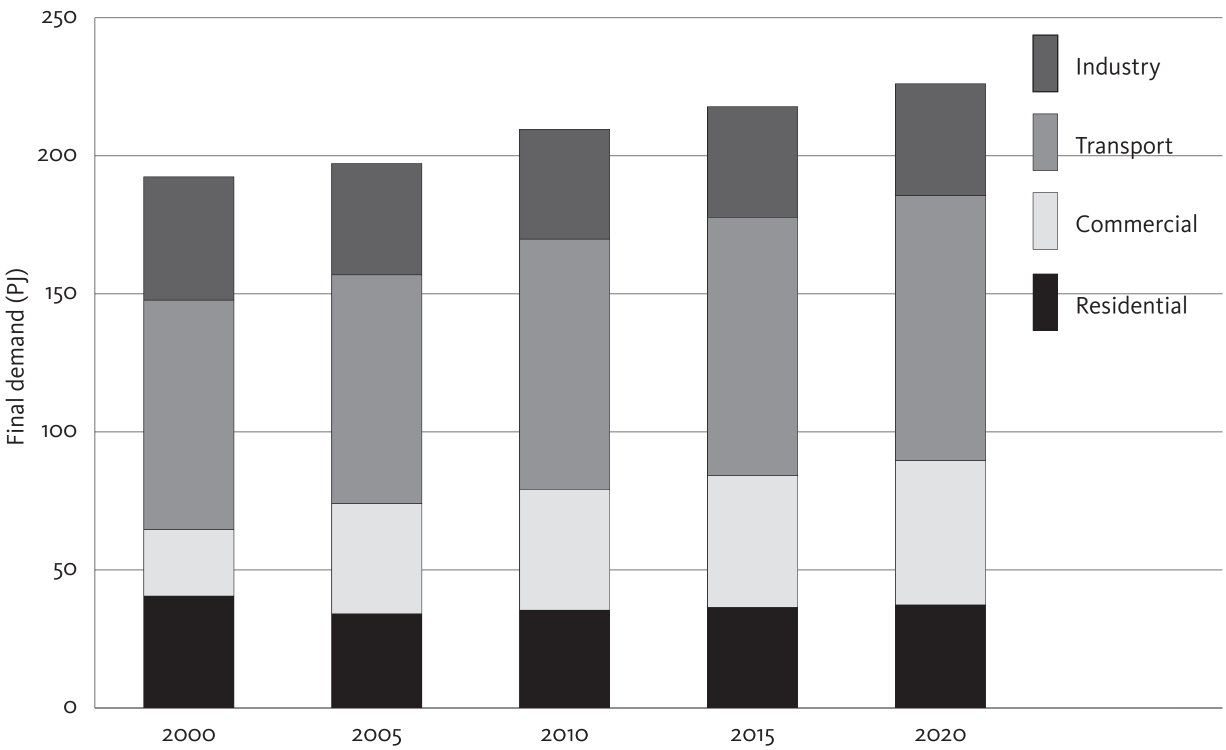


TABLE 8 **Space and water heating demands** (NRCan 2006)

	Residential			**Commercial-Institutional**			**Combined**	
	Percent of demand (2004)	**2005 (PJ)**	**2020 (PJ)**	**Percent of demand (2004)**	**2005 (PJ)**	**2020 (PJ)**	**2005 (PJ)**	**2020 (PJ)**
Total sector demand	–	34.1	37.3	–	39.9	52.3	74.0	89.6
2004 space heating	57.9%	19.7	21.6	53.9%	21.5	28.2	41.2	49.8
2004 water heating	22.3%	7.6	8.3	9.2%	3.7	4.8	11.3	13.1
Total heating demand	80.2%	27.3	29.9	63.1%	25.2	33.0	52.5	62.9

commercial-institutional (52.3 PJ) surpassing industry (40.5 PJ).

7.2 Heating: Residential and commercial-institutional

In Nova Scotia, space and water heating require the most energy in the residential sector, while they are typically the first and third, respectively in the commercial-institutional sector. By combining these, the total space heating demand for the province can be obtained.

Table 8 shows NRCan's projections for Nova Scotia's residential and commercial-institutional sectors for 2005 and 2020. The space and water heating requirements for these years are obtained by applying NRCan's 2004 percentage of total demand for heating to the projected total sector demands for 2005 and 2020.

The combined space and water heating energy demand totals are 52.5 PJ and 62.9 PJ for 2005 and 2020, respectively. In both years, these totals exceed all other energy demands in the province except transportation (see Table 7), requiring about 27 percent of Nova Scotia's final energy demand. NRCan's projections for the growth in the number of households in the residential sector and the total floor space in the commercial-institutional sector are shown in Table 9.

Since NRCan projects that most of the space and water heating demands will continue to be met through fuel oil and electricity, applying reduction and replacement wedges (see section 3.4) to space and water heating demand could make contributions to achieving energy security in the province.

TABLE 9 **NRCan's projections for households and floor space** (NRCan 2006)

Activity	2005	2020
Residential households	375,000	413,200
Commercial-Institutional floor space (million m^2)	16	22

7.2.1 Demand reduction

In order to be effective, space and water heating demand reduction must be a requirement for all new buildings and be applied retroactively to existing buildings.

Figure 9 shows the combined energy demand for heating in the residential and commercial-industrial sectors in Nova Scotia for the years 2000

FIGURE 9 **NRCan projection and reduction wedges**

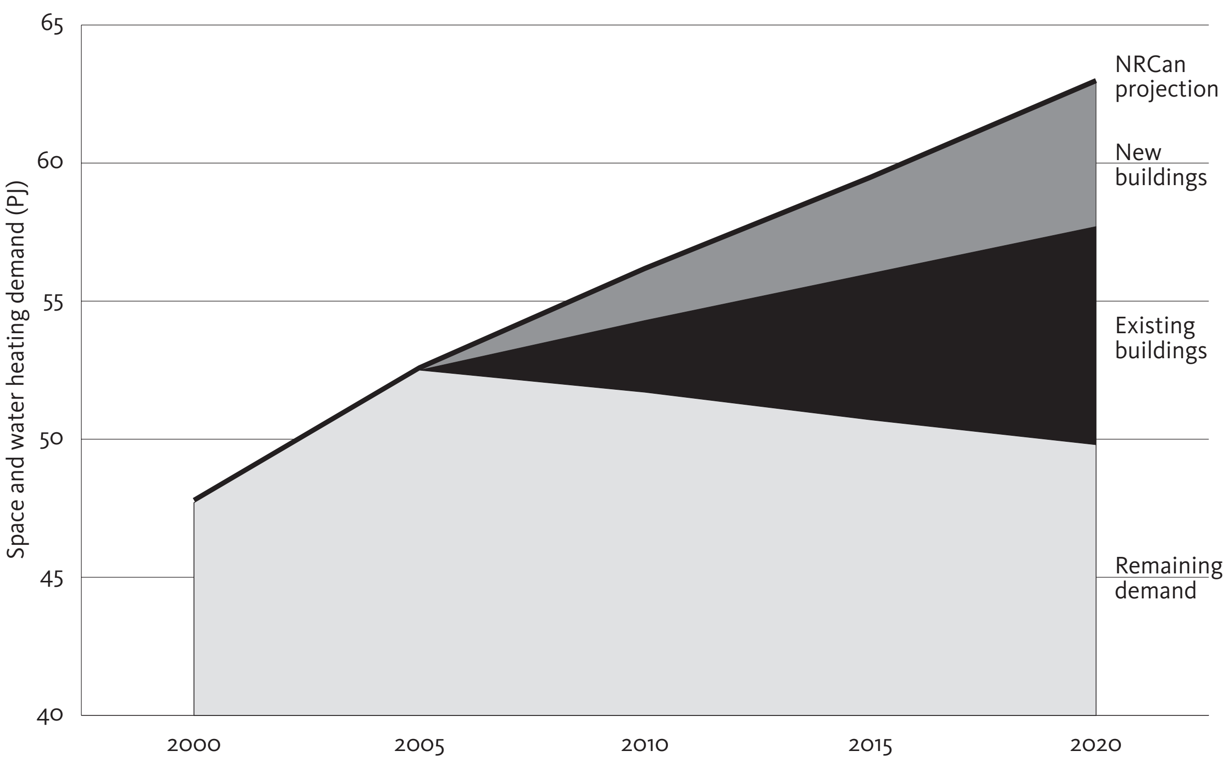


FIGURE 10 **Demand replacement from various wedges**

through 2020 using NRCan's data; the value for 2000 is the actual value, while the data for 2005 to 2020 are projections.

Space and water heating demand reduction are achieved using two wedges:

- The new-building wedge. This is applied to all new residential and commercial-institutional buildings constructed between 2005 and 2020, and assumes that these buildings reduce their space and water heating demand through the use of energy-efficient building practices. The wedge, labeled "New buildings" in Figure 9, shows the result if new buildings could achieve a 50 percent energy reduction. In this scenario, by 2020 the maximum possible reduction would be 5.2 PJ below NRCan's projections or about 8.3 percent of the combined sectors' heating demand.

  A total of 38,200 residential buildings and six million m^2 of commercial-institutional floor space would be affected by the new-building wedge (NRCan 2006).
- The existing-building wedge. This wedge is applied retroactively to existing buildings (i.e., those constructed before 2005), requiring these buildings to reduce their space and water heating demands through the application of energy-reduction practices; i.e., conservation and efficiency measures. The wedge, labeled "Existing buildings" in Figure 9, assumes that all buildings in Nova Scotia will reduce their heating requirements by an average of 1 percent a year between 2005 and 2020. By 2020, the space and water heating demand reduction would be about 7.9 PJ or 12.5

percent of the total energy demand of the combined sectors.

The 1 percent reduction would be about 0.525 PJ per year, based upon the combined 2005 space and water heating demand of 52.5 PJ (see Table 8). There are any number of ways in which this could be achieved; for example:

- The average Nova Scotian requirements for space and water heating in 2005 were about 98 GJ per household (NRCan 2006). If selected households were chosen to meet a 50 percent reduction in their heating demand (49 GJ), about 10,700 households would have to be upgraded each year in order to meet the 0.525 PJ target.
- In the commercial-institutional sector, the heating requirements in 2005 were about 1.03 GJ/m^2. In this sector, meeting the 0.525 PJ reduction target by halving the heating requirements of selected buildings (to 0.515 GJ/m^2), would impact about one million m^2.

The demand reduction target of 50 percent described in this section for new and some existing buildings exceeds the EnerGuide 80 and R-2000 standards of about 27 percent reduction (OEE 2005). Achieving a 50 percent reduction in energy consumption, although possible, would be a challenge.

What is important to note in the proposed heating wedges is not the absolute numbers, but the enormity of the task at hand: even if the reduction targets outlined here could be achieved, the total impact, although significant, would be about 21 percent, meaning that 79 percent of Nova Scotia's space and water heating requirements would still be subject to the vagaries of the rising energy prices.

7.2.2 Demand replacement

If the levels of demand reduction described in the previous section could be achieved, the residential and commercial-institutional space and water heating demand would still be about 49.8 PJ in 2020. To gain any degree of energy security, space and water heating replacement must focus on fuels and technologies that will increase the use of indigenous energy sources. Figure 10 shows a space and water heating replacement scenario based on renewables.

In this example, all new buildings are assumed to be built on an east-west axis to maximize their solar gain; as a result, the buildings meet 75 percent of their heating demand from solar energy. Employing solar to meet the needs of existing buildings is difficult because not all buildings have an ideal orientation to take advantage of solar energy; however, here it is assumed that solar makes a 1 percent per year penetration into the existing building market. In existing buildings, it is assumed that a combination of retrofits for space heating and solar-thermal panels for hot water is used to achieve this wedge. By 2020, solar for new and existing buildings meets about 11.4 PJ or 23 percent of the province's heating needs after reduction, at 8 and 15 percent, respectively.

As discussed in section 6.5.3, electricity generated from the wind can be converted to thermal energy and stored for heating use at a later time. [21] The technology for storing electricity as heat is well-known and widely available; it is commonly referred to as Electric Thermal Storage (ETS). ETS systems come in a variety of configurations, from wall units to heat one or two rooms, to central furnaces to heat entire buildings. Electrical energy is stored as heat in the ceramic blocks of the ETS unit and released over time on demand; since all the electricity is stored as heat, ETS is considered to be 100 percent efficient. ETS units are presently used by about 1 percent of NSPI's residential customers who are charged on a special time-of-use rate (NSPI 2006d). Figure 10 includes a wind-heating wedge which is expected to supply 15 PJ or 30 percent of the province's heating demand by

2020. About 1,900 MW of wind capacity, operating at a capacity factor of 25 percent, would be needed for this wedge.

A district heating wedge is also included in this scenario.[22] This makes the smallest contribution of 0.7PJ or 1.5 percent of the province's heating demand. This seemingly low number is based upon fact that there are few communities in Nova Scotia with sufficient density to justify the wholesale adoption of district heating.

The final wedge in this scenario is for biomass; the target being about 10 PJ or 20 percent of the heating required by 2020. According to NRCan, about 10 percent of Nova Scotia's heating services are met from biomass; this wedge includes the 10 percent and adds an additional 10 percent during the 15 year period.

The proposed wedges fall short of meeting all the heating requirements of the province, in part because it is unrealistic to assume that a complete restructuring of the province's heating services could be achieved in 15 years. The remaining demand would be met from existing sources.

There is an uneven distribution of energy supplies and infrastructure in the province; for example, biomass is not readily available in some urban centers and the strength of the electrical grid varies throughout the province.

Therefore, reduction policies would best be implemented by location; for example:

- Rural. Since many rural communities already rely on wood for heating, this wedge would be based on direct biomass combustion for heating.
- Suburban. A wedge for suburban communities with low housing densities and good grid connections would use wind-electric and thermal storage units for heating.
- Urban. Where densities warrant, a wedge for wood-fired cogeneration facilities producing electricity and hot water — for district heating — would be developed.

7.3 Transportation

Transportation has the largest final demand of all Nova Scotia's economic sectors. With few exceptions, annual growth has been steady, driven primarily by the private automobile and the movement of goods by truck. According to NRCan's projections for Nova Scotia's transportation sector, energy demand will increase by 15.8 percent, from 82.9 PJ to 96.0 between 2005 and 2020.

The energy demand in the transportation sector includes all modes using hydrocarbons or electricity for fuel, notably marine, surface (road and rail), air, and pipelines, in addition, lubricants are included in this sector. Of these, road consumes about 75 percent of the energy used in the transportation sector, of which light duty vehicles (LDVs), typically light trucks, minivans and automobiles are responsible for about 48 percent of the transportation energy demand (NRCan 2006). The remainder of this section considers reduction and replacement in road transportation only, focusing on light duty vehicles.

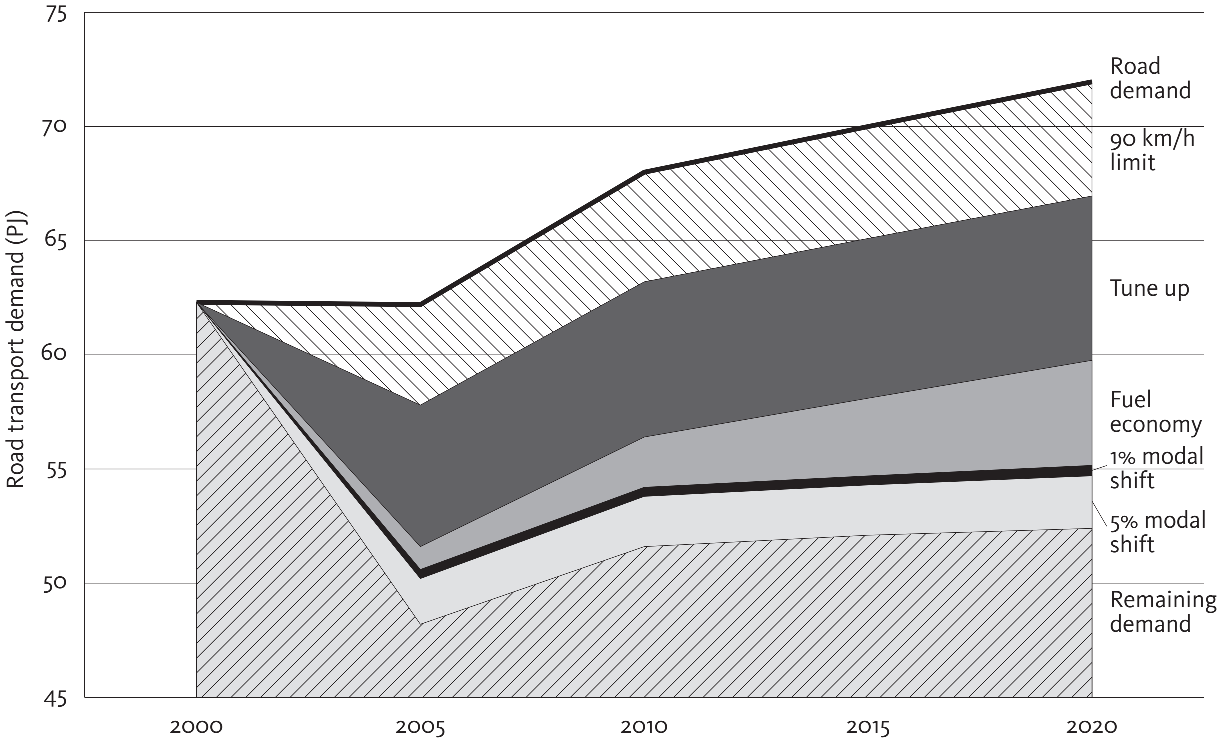
7.3.1 Reduction

Figure 11 shows NRCan's projections for road transportation energy demand in Nova Scotia, increasing from about 62.3 PJ in 2000 to 72 PJ in 2020.

There are a number of wedges that can be applied to light duty vehicles, all of which are widely know, but seldom used (EPA 2007a). Applying these to all road vehicles could result in the reductions described below.

The first wedge is the imposition of a 90 km/h speed limit on all highways. Requiring all road vehicles to reduce their maximum speed to 90 km/h on highways would see an average 7 percent reduction in fuel consumption (EPA 2007b).

FIGURE 11 **Road transportation energy demand projection and reduction wedges**



By 2020, this wedge could decrease transportation energy demand by about 5 PJ. In addition to reduced energy demand, there are societal benefits associated with lower highway speeds, such as lower costs associated with vehicular accidents.

Vehicle maintenance can make significant improvements in fuel economy; the second wedge in Figure 11 is for vehicle tune-up and maintenance, where an average 10 percent improvement is assumed for all vehicles (EPA 2007c). By 2020, vehicle maintenance could reduce transportation energy demand by 7.2 PJ. It is assumed that by 2010, all vehicles undergo tune-up and maintenance.

Improving vehicle fuel economy, combined with an increasing penetration of new vehicles into the market, is another form of reduction in the transportation sector. Since the rate of vehicle replacement is typically slow, the fourth wedge (fuel economy) in Figure 11 assumes that there is a .5 percent energy improvement per year due to the addition of new vehicles. By 2020 there would be a 4.6 PJ reduction in transportation demand because of improved vehicle fuel economy.

A modal shift is the act of changing the way a good or a person is transported from one location to another; access is not changed. Someone abandoning their automobile in favour of taking a bus to work is an example of a modal shift, as are car-pooling and ride-sharing. Modal shifts have happened in the past — businesses that once transported their goods by train now ship by truck. Encouraging modal shifts can mean the addition of new — or upgrading existing — infrastructure; for example, bicycle right-of-ways can encourage the use of bicycles for active transportation. The fourth and fifth wedges in Figure 11 show the impact of two modal shifts, from LDVs to other modes; 1 percent modal shift results in a savings of about 0.45 PJ, while a five percent modal shift has a savings of 2.3 PJ.

Central to any modal shift is the availability of an alternate mode (or modes) to the potential user. This can be a problem in that the alternative offered may not have the same access as the original mode. For example, a commuter in a private automobile may be able to drive from home to office with no need to walk for more than a few minutes; however, a commuter service such as a bus or train may not be able to offer the same convenience, with departure and arrival points a considerable distance from the commuter's home and office.

One of the ways the potential lack of convenience can be overcome is to ensure that all new residential communities are designed so that they can take advantage of commuter services. This is normally achieved by increasing the density associated with the community, thereby allowing commuters to walk or bicycle to their local commuter station. Mixed-use neighbourhoods and compact urban forms are two ways to address this issue (Bernick 1996).

Other methods of transportation demand reduction include:

- Trip-chaining, in which one trip visits several destinations before returning to the place of origin, rather than multiple round trips from the origin to each destination.
- Telecommuting, the use of information technology to allow workers to reduce the need for commuting to their offices, has long been promoted as a means of reducing both traffic and energy in the transportation sector (Williams 2003). To date it has met with limited success because few occupations allow their workers to work from home or a centralized location, other than their office.

If the above wedges were applied, the anticipated 2020 transportation energy demand would reduce from 72 PJ to 52.4 PJ.

7.3.2 Replacement

In the transportation sector, replacement can be achieved replacing imported fuels with indigenous sources; for example:

- Fuel replacement I: Ethanol. A widely discussed alternative to imported transportation fuels is biofuel, such as ethanol, as a replacement for gasoline. Ethanol is gaining widespread acceptance in the United States and is one of the cornerstones of the Canadian federal government's green energy program (CRFS 2006). The objective is to improve energy security through growing crops that can be converted into ethanol and then mixed with varying quantities of gasoline to produce products ranging from E5 (5 percent ethanol or gasohol) to E85 (85 percent ethanol). A number of US vehicle manufacturers have started producing "flex-fuel" vehicles that can run on various gasoline-ethanol fuel mixtures from straight gasoline (no ethanol) to E85.

  One of the limitations of ethanol is its lower energy density: a litre of ethanol has about two-thirds the energy content of that found in a litre of gasoline. This means that a vehicle running on E85 will require more fuel than the same vehicle powered by gasoline alone.

  It is instructive to consider the area of Nova Scotia's farmland that would be required to produce sufficient ethanol to meet an E5 or E85 target. In 2005 Nova Scotians consumed about 1.228 billion litres of gasoline; Table 10 shows the percentage of Nova Scotia farmland required if Nova Scotia's gasoline demand was to be replaced by an equivalent

TABLE 10 **Percentage of Nova Scotia farmland needed for E5 and E85**

	Gasoline replaced (litres)	Equivalent volume of ethanol	5 t/ha		10 t/ha	
			Area (ha)	Farmland	Area (ha)	Farmland
E5	61,419,350	91,670,672	42,937	10.5%	21,469	5.3%
E85	1,044,128,950	1,558,401,418	729,930	179.3%	364,965	89.7%

volume, in terms of available energy, of E5 and E85, with varying crop yields.

Since ethanol's energy density is lower than that of gasoline, it is necessary to produce a greater volume of ethanol than the gasoline it replaces in order to achieve the same energy output. In Table 10, it is assumed that corn is the ethanol feedstock, producing 427 litres per tonne (DOE 2006). The total area of Nova Scotia's farmland, 407,045 hectares (Stats Can 2001), required to meet this demand varies from 5 percent (10 t/ha for E5) to almost 180 percent (5 t/ha for E85). Although E5 takes less land than E85, it also replaces less gasoline. This calculation also assumes that all of Nova Scotia's farmland is suitable for producing high yields of corn. However, since over half of the farmland is classified as "other," much of which is used for growing Christmas trees, it is unlikely that such volumes of ethanol could ever be produced. It is also important to note that the production of ethanol requires energy inputs; if the energy yield is low or the energy is supplied by non-indigenous sources, the energy security benefits are questionable.

Table 10 also highlights the concern expressed by many that converting cropland to ethanol production reduces the available land for food production, driving up the cost of food products (Stigset 2006). Although Nova Scotia cannot feed itself, abandoning food production in favour of ethanol production erodes any chance that the province could achieve food security and gains little in the way of energy security.

- Fuel Replacement II: Coal-to-liquids. Coal-to-liquid is another fuel replacement technique that is being discussed as a means of improving energy security, primarily in the United States (Wisenberg 2006). The process, commonly known as Fischer-Tropsch, yields about 500 litres per tonne of coal. Applying this process to Nova Scotia's 2005 demand for gasoline (1.228 billion litres) would require about 2.5 million tonnes of coal per year. If Nova Scotia coal was to be used to replace coal imports for electrical generation requirements (3 million tonnes) and liquid fuels (2.5 million tonnes), it would require about 5.5 million tonnes per year, meaning that Nova Scotia's known coal reserves would be exhausted in about 40 years.

  Fischer-Tropsch can also be used in wood-to-liquids production. The yield of this process has been shown to be about 210 litres of liquid fuel per tonne of biomass (Zerbe 1991). If this process were used to produce gasoline in Nova Scotia using the province's forest harvest would produce about 0.900 billion litres. This is three-quarters of Nova Scotia's 2005 demand for gasoline (1.228 billion litres).
- Fuel Replacement III: Hydrogen. Hydrogen, used in conjunction with fuels cells, is often promoted as the ideal solution to our transportation energy requirements as the tailpipe waste product is only water. Despite this advantage,

hydrogen has a number of limitations. Most notably, it does not exist in a readily accessible form in nature, meaning that it must be produced, typically through the steam reformation of natural gas or the electrolysis of water. Both of these approaches imply either an abundant supply of natural gas or electricity, neither of which Nova Scotia has readily available.

Another argument for the production of hydrogen is that it can be stored and subsequently regenerated through a fuel cell to produce electricity. Although this is true, there are considerable parasitic losses between the production of the hydrogen, its storage, and regeneration, meaning that only 21 to 25 percent of the original electricity is available for use (Bossel 2006).

There are other transportation reduction and replacement wedges that must be developed, particularly in goods transportation. The overwhelming reliance on road transportation for the movement of goods requires the construction and maintenance of roadways, activities that will increase in price as the cost of products such as asphalt rise in step with the price of crude oil. A modal shift — from road transport to rail — offers a number of advantages; for example, a reduction in energy demand. There is also the potential for replacement: rail is not restricted to liquid fuels, it can also be powered by electricity.

The need to make energy security central to all major transportation infrastructure projects is illustrated by Halifax Regional Municipality's decision to purchase two high-speed ferries to move passengers from Bedford to downtown Halifax. The $30 million ferries will operate on imported diesel fuel, possibly supplemented with biodiesel made from the oils of anchovies and sardines from South America (Fitzpatrick 2004). Despite the obvious energy security issues associated with imported diesel and biodiesel produced from imported fish waste, an alternative to the ferry, a commuter rail link between Bedford and Halifax was rejected, in part, because of CN's access charges. The short-term gains associated with the ferries will be offset should supplies of diesel become restricted, whereas a commuter rail system could be converted to electricity.

7.4 Discussion

Space and water heating and vehicular transportation account for almost 60 percent of Nova Scotia's final energy demand. This section has shown how reduction and replacement wedges could be used to increase the use of indigenous energy sources, including coal, biomass, wind, tidal, and solar.

A number of issues remain outstanding:

- The remaining 40 percent of Nova Scotia's final energy demand (industrial, agricultural, and other residential, commercial-institutional) have not been addressed. Where possible, indigenous energy sources need to be found to meet the energy demand in these sectors. As energy costs increase, existing enterprises may go out of business, meaning that energy requirements, and employment patterns and opportunities will undoubtedly change over time. Fortunately, new opportunities will arise with the need for people with skills in energy services industries.
- The costs associated with some of the infrastructure have not been discussed. For example, an electric thermal storage (ETS) unit for a typical house costs on the order of $6,000 (Steffes 2006). Ensuring that this technology is available to all Nova Scotians, regardless of income, will require grants or low-interest loans from the province. The cost of infrastructure should be taken as an incentive to

push to maximize reduction, since increasing reduction reduces the need for replacement.

- As countries become aware of the need for energy security, they, like Nova Scotia, will be looking for solutions to the problem. The competition for infrastructure may well reach the same level as that for energy supply; a good example is the growing demand for wind turbines, causing prices to increase and delivery times to lengthen (Mulick 2006).
- It will be necessary to determine the best use of different energy sources available for the various replacement schemes; this is especially true for biomass, as it is the most versatile renewable energy resource. As an example, the 49.8 PJ needed for heating replacement could be met entirely by forest biomass; however, this would require about 3.3 Mt of biomass or about 77 percent of Nova Scotia's total annual forest harvest.[23] Any replacement policy dealing with biomass would need to determine the optimal allocation of energy resources.

8 Climate change

Nova Scotia, as with all other regions of the world, is faced with the twin threats of energy security and climate change. In the near term, price rises and supply shortages will make energy security the dominant issue facing Nova Scotians, while the effects of releasing anthropogenic greenhouse gases, notably carbon dioxide, and the impact of climate change are longer-term issues.

Nova Scotia's record on addressing climate change, like its efforts on energy security, is poor at best (Hughes 2005a). Many of the actions described in this report to address energy security issues will help reduce Nova Scotia's greenhouse gas emissions. How the problem of rising energy prices and shortages will affect global greenhouse gas emissions is an entirely different matter and subject to debate. However, since energy security must inevitably be addressed, everything should be done to ensure that replacement energy sources minimize their impact on the climate.

The replacement scenario described in the previous section for residential and commercial-industrial heating services, based on renewable energy sources, would make a sizeable contribution to the reduction of greenhouse gases in the province. The replacement scenario for the transportation sector would be more challenging, as the replacement liquid fuels are created with carbon-intensive technologies.

Policies developed to address climate change will also be based on the three 'R's, as it is necessary to review how Nova Scotia impacts the climate and to develop policies that reduce and replace those activities or processes that contribute to anthropogenic climate change. This is especially true based on the size of targets that are now being suggested by many scientists and politicians (New Scientist 2007).

9 Concluding Remarks

As world supplies of energy become more difficult and more expensive to produce and world demand for energy products increases, it is generally agreed that energy prices will continue to increase and become more volatile, creating shortages in many jurisdictions. Countries without access to supplies of indigenous energy will be particularly vulnerable to these rises and shortages, potentially putting their citizens and economy at risk. Many governments — from China to the United States — and organizations — such as the IEA and World Bank — have recognized this problem and have introduced energy security policies that attempt to ensure sustainable supplies of reliable, uninterrupted and affordable forms of energy.

To achieve energy security in industrialized, net-energy importing countries, the World Bank recommends four priorities: avoid disruption of energy supplies, diversify energy supply sources, maintain energy infrastructure, and reduce dependence on imported energy supplies through technology.

It is tempting to assume that because Canada is a net-exporter of energy products, provinces such as Nova Scotia automatically have security of energy supplies. In Nova Scotia's case, nothing could be further from the truth. Almost 90 percent of Nova Scotia's primary energy is imported, particularly refined petroleum products and coal from regions of political instability (the Middle East, Venezuela, and Columbia) or declining production (the UK). Nova Scotia, and the rest of the Maritimes for that matter, has no direct access to Western Canadian natural gas or crude oil, meaning that declines in imports cannot be easily offset by Canadian supplies.

Although energy security should be of concern to all Nova Scotians, there is little in the government's Energy Strategy that addresses the issue. What little is said about energy security refers primarily to how Nova Scotia's once vaunted offshore natural gas industry can help the United States; little thought is given to the needs of Nova Scotians.

With Nova Scotia's present energy mix, achieving energy security will require long-term policies that consider not only the supply but also the service, answering the questions, "Can less energy be used for this service?" and "Is there an indigenous energy source that can be employed in place of the one being used for this service?" In other words, all provincial energy policies must be based upon reduction and replacement.

At present, this is not being done; neither the Energy Strategy nor the Province's existing policies are addressing the issue of energy security in Nova Scotia. Consider the following:

- The decision to rebate the provincial portion of the sales tax on all energy services to the residential sector. This policy, proposed by both the provincial Conservatives and NDP during the last provincial election, is intended to help all Nova Scotians meet their energy costs. According to the Province, the program will require an estimated $75 million, while the average Nova Scotian family will save $200 a year on their energy costs. As fair as this may appear, it does little to help those on a low-income who received $250 from the Keep the Heat program to assist with their oil heating costs in 2005–06.[24] A more progressive approach would be to offer a guaranteed price of fuel to those Nova Scotians in need (Hughes 2006).

  By rebating the tax on residential energy, the overall cost of energy declines, allowing individuals to maintain or even increase their energy consumption. Such a policy does nothing to encourage reduction or replacement, the two key elements in an energy security program.
- The purchase of high efficiency oil-burning furnaces is being encouraged by the availability of a $200 subsidy. Although this may lead to a reduction in energy consumption as the high efficiency furnace may consume less fuel oil, it does nothing to help replace the consumption of imported fuel oil. Furthermore, the costs offset by the subsidy will be lost as the price of fuel oil increases.
- Homeowners that purchase up to $5,000 worth of solar thermal panels (including HST) qualify for a 10 percent rebate on the purchase price. This is an example of a replacement policy, encouraging homeowners to replace all, or part, of their water-heating energy requirements (usually from fuel oil or electricity) with solar heated water. Although this is intended to encourage the adoption of solar energy for heating, the program allows participants to use the panels for "year-round pool heating."
- A $200 rebate on the purchase of EPA approved wood stoves. This is another example of a replacement policy; ideally supplanting non-indigenous energy sources such as fuel oil or electricity generated from imported energy products with indigenous supplies. However, if the wood used in the stove must be transported a considerable distance or if the wood supply is not sustainably harvested, the benefits of the replacement may cause long-term problems. Problems can also occur if suppliers cannot keep up with demand, as occurred in the 2005–06 winter when there was a North America-wide demand for wood pellets, resulting in regional shortages (Forestweb 2006).
- In January 2007, Conserve Nova Scotia announced its EnerGuide 80 program for new house construction (CNS 2007). Rather than pushing for new homes to meet the EnerGuide 80 standard now, the program offers a number of interim targets, "Beginning in 2009, all new homes could be required to achieve an energy rating of 72. In 2010, the minimum rating would increase to 77. In 2011, the minimum would be 80." This may seem reasonable since it allows contractors about four years to learn whatever new skills are needed to build houses to the EnerGuide 80 standard; however, according to NRCan's CANMET

(what does this stand for?) Energy Technology Centre, in 1997 the average newly constructed conventional home in Atlantic Canada achieved an EnerGuide rating of 72.3, while R2000 homes received an EnerGuide rating of 80.1 (Wood 2006). In other words, since 1997, most new homes probably met the 2009 target and those built to the R2000 standard already exceeded the 2011 target. There appears to be little justification for such a delay when most contractors apparently already have the necessary skills.

Achieving energy security will require legislation and regulations; the following are examples of what will be needed for transportation and heating:

- Programs to handle short-term energy shortages during the heating season.

  As the cost of energy for heating rises, a growing number of individuals and families will be in need of emergency assistance to stay warm if they are unable to heat their homes. For example, schools and other public buildings could be opened to act as emergency "heat shelters"; this is analogous to the "cooling shelters" opened during the summer months in several U.S. cities in order to offer a respite from oppressively high temperatures.
- Require all new buildings (commercial, institutional and residential) in the province to meet at least 50 percent of their heating requirements from the sun.

  A prescriptive, enforced building code is needed; for example,
  - to maximize solar gain, buildings are to be oriented on an east-west axis;
  - to reduce the major causes of building heat loss, including basements and attics (residential) and windows (residential and commercial).
- Reduce maximum highway speeds from 100 and 110 kilometers per hour to 90 kilometers per hour.
- Encourage modal shifts through the availability of new bus and rail services from rural and suburban centres to regional hubs.

  To improve the availability of these services, all new communities should be built in a clustered fashion to allow non-motorized access to bus or rail stations.
- Institute a program to improve agricultural and forestry lands, with the intention of increasing their yields of both food and energy crops.

  This program must include a review of Nova Scotia's existing and potential indigenous energy sources; for example, idle or fallow land must be examined for its possible use for food or energy.
- Fund a thorough, in-depth review of Nova Scotia's present energy situation and then develop reduction and replacement wedges for a 20-year plan with goals of meeting all of Nova Scotia's heating requirements from indigenous sources and having scheduled commuter services available to all Nova Scotians.

As world supplies of low-cost, easily accessible energy sources decline, energy security is becoming an issue in many jurisdictions. Although the need for energy security in Canada is downplayed, due to the country's immense energy wealth, the fact that the wealth is unevenly distributed means that some regions are more vulnerable to the impact of rising energy costs and supply shortfalls.

This report has discussed the problem of energy security in Nova Scotia, focusing on heating and transportation. To illustrate the problem, NRCan's projections to 2020 were used; whether these projections are correct is not the issue, the overwhelming reliance on expensive, imported energy makes Nova Scotia energy *insecure*. A series of long-term policies are needed to reduce and replace Nova Scotia's reliance on energy in general and imported energy in particular.

Time is not on our side, we need leadership and we need it now.

References

ARSN 2006. "Addicted to Blood Coal." Atlantic Regional Solidarity Network. Reprinted from Colin Campbell. *Maclean's* March 20. http://www.arsn.ca/macleans1.htm. Accessed 12 December 2006.

Altagas 2007. *Investor Update.* Altagas Utility Group Inc. January. http://www.altagasutilitygroup.com/PDF/AUGI_investor_presentation_Jan-07.pdf. Accessed 1 March 2007.

BEDB 2006. *Biomass Energy Data Book.* Oakridge Tennessee: ORNL, September. http://cta.ornl.gov/bedb/pdf/Biomass_Energy_Data_Book.pdf. Accessed 14 December 2006.

BP 2006. *BP Statistical Review of World Energy,* June.

Beehner, L. 2005. "Asia: U.S. Military Bases in Central Asia." *Council on Foreign Relations.* July 26. http://www.cfr.org/publication/8440/#3. Accessed 11 February 2007.

Bernick, M. and R. Cervero 1996. *Transit Villages in the 21st Century.* New York: McGraw-Hill.

Bossel, U. 2006. "Does a Hydrogen Economy Make Sense?" *Proceedings of the IEEE* 94, 10 (October).

Brooks, M. 2006. "Is it all over for nuclear power?" *New Scientist,* April 26.

CAPP 2006. *Atlantic Canada Natural Gas Industry Update.* Canadian Association of Petroleum Producers, May 18. http://www.capp.ca/raw.asp?x=1&dt=PDF&dn=87190. Accessed 5 February 2007.

CBC 2004. *Offshore royalty offer a 'slap in the face': Newfoundland premier.* CBC News, December 22. http://www.cbc.ca/canada/story/2004/12/22/offshore-williams041222.html. Accessed 12 February 2007.

CBC 2005. *N.S. coal mining to be revived by Australian multinational Xstrata—sources.* Alison Auld and Michael Tutton. (CP) December 13. http://www.cbc.ca/cp/business/051213/b121386.html. Accessed 11 February 2007.

CMHC 1989. *Passive Solar House Designs for Canada.* Ottawa: Canada Mortgage and Housing.

CNS 2006. Conserve Nova Scotia. http://www.conservens.ca/. Accessed 28 February 2007.

CNS 2007. *EnerGuide for New Houses.* Conserve Nova Scotia. http://www.gov.ns.ca/energy/AbsPage.aspx?siteid=1&lang=1&id=1591. Accessed 28 February 2007.

CNSOPB 2004a. *Board will not proceed with Call for Bids.* Canada-Nova Scotia Offshore Petroleum Board, December 6. http://www.cnsopb.ns.ca/archives/news_dec-06-4.html

CNSOPB 2004b. *Board will not proceed with Call for Bids*. Canada-Nova Scotia Offshore Petroleum Board, June 17. http://www.cnsopb.ns.ca/archives/news_jun-17-4.html

CNSOPB 2007. *Total Production.* Canada-Nova Scotia Offshore Petroleum Board. http://www.cnsopb.ns.ca/activityreports/pdf/production_report.pdf. Accessed 3 March 2007.

CRFS 2006. *Climate Change Solution: Made in Canada*, Canadian Renewable Fuels Strategy. Executive Summary, July. http://www.studio255.com/crfa/pdf/CR_Energy_Strategy_Summary_EN.pdf. Accessed 14 December 2006.

Canada-Nova Scotia 1986. *Canada-Nova Scotia Offshore Petroleum Resources Accord*, [Halifax NS] : 26 August.

Clarke, C. 2006. *North American Prospectors' Exchange — Team Canada Luncheon.* Speaking Notes for The Hon. Cecil Clarke, Minister of Energy, Province of Nova Scotia, February 1. http://www.gov.ns.ca/energy/AbsPage.aspx?id=1535&siteid=1&lang=1. Accessed 1 March 2007.

Clayton, M. 2006. "Carbon cloud over a green fuel." *Christian Science Monitor*, March 23.

Costantini, V., et al. 2005. "Security of energy supply: Comparing scenarios from a European perspective." *Energy Policy* 35 (2005).

DOE 2006. *Theoretical Ethanol Yield Calculator.* United States Department of Energy, Energy Efficiency and Renewable Energy, January 20. http://www1.eere.energy.gov/biomass/ethanol_yield_calculator.html. Accessed 14 May 2007.

Dawe, N. 2004. "Offshore Perception and Reality." *Chronicle-Herald,* September 1.

Deffeyes, K. 2005. *Beyond Oil — The view from Hubbert's Peak.* New York: Hill and Wang.

Dircksen, J. 2006. *Ethanol: Bumper Crop for Agribusiness, Bitter Harvest for Taxpayers.* National Taxpayers Union Policy Paper 121, July 20. http://www.ntu.org/main/press_papers.php?PressID=855&org_name=NTU. Accessed 11 February 2007.

Electricity Act, S.N.S. 2004, c.25.

Energy Policy Act of 2005, Pub.L. No 109-58, 119 Stat. 594.

Env Can 2004. *White Juan — February 18th and 19th 2004.* Environment Canada. http://www.atl.ec.gc.ca/weather/severe/2003-2004/whitejuan_e.html. Accessed 12 December 2006.

Env Can. 2006. *National Inventory Report: 1990–2004, Greenhouse Gas Sources and Sinks in Canada.* Environment Canada. Greenhouse Gas Division. No. En-4/2004E. March.

EIA 2004. Energy Information Administration. Office of Integrated Analysis and Forecasting. *Analysis of Oil and Gas Production in the Arctic National Wildlife Refuge.* SR/OIAF/2004-04. March. http://www.eia.doe.gov/oiaf/servicerpt/ogp/pdf/sroiaf(2004)04.pdf. Accessed 11 January 2007.

EIA 2005. Energy Information Administration. Office of Oil and Gas. *Overview of U.S. Legislation and Regulations Affecting Offshore Natural Gas and Oil Activity,* September. http://www.eia.doe.gov/pub/oil_gas/natural_gas/feature_articles/2005/offshore/offshore.pdf. Accessed 11 January 2007.

EIA 2006. *International Energy Outlook 2006.* Energy Information Administration. DOE/EIA-0484, June.

EIA 2007. *Energy Information Administration Glossary.* http://www.eia.doe.gov/glossary/index.html. Accessed 7 February 2007.

EMGC nd. *Final Report.* Nova Scotia Electricity Governance Marketplace Committee.

EPA 2007a. *Driving more efficiently.* Environmental Protection Agency. http://www.fueleconomy.gov/feg/driveHabits.shtml. Accessed 28 February 2007.

EPA 2007b. *Gas mileage tips.* Environmental Protection Agency. http://www.fueleconomy.gov/feg/drive.shtml. Accessed 28 February 2007.

EPA 2007c. *Keeping your car in shape.* Environmental Protection Agency. http://www.fueleconomy.gov/feg/maintain.shtml. Accessed 28 February 2007.

ESEA 1985. Energy Supplies Emergency Act, R.S.C. 1985, c.E-9. http://www.canlii.org/ca/sta/e-9/. Accessed 3 March 2007.

EU 2005. *Biomass Action Plan.* Commission of the European Communities. SEC (2005) 1573. Brussels, December.

EU 2006. *An EU Strategy for Biofuels.* Commission of the European Communities. SEC (2006) 142. Brussels, February.

Emera 2003. *What Counts — 2002 Annual Report.* Halifax NS: Emera Corporation.

Emera 2006a. *2005 Annual Financial Report.* Halifax NS: Emera Corporation.

Emera 2006b. *National Energy Board Brunswick Pipeline Application Hearing Order GH-1-2006.* Emera-Brunswick Argument in Chief, December.

Emera 2007. *2006 Annual Financial Report.* Halifax NS: Emera Corporation.

EnergyOnline 2007. *Bear Head LNG project mothballed.* LCG Consulting, February 9. http://energyonline.com/Industry/News.aspx?NewsID=7128&Bear_Head_LNG_Project_Mothballed. Accessed 1 March 2007.

Energy Ventures 2006. *Testimony of Energy Ventures Analysis Inc.* Direct Evidence of NSPI for NSUARB. October.

ExxonMobil 2005. *Sable Project — Operations.* http://www.soep.com/cgibin/getpage?pageid=1/0/0. Accessed 3 March 2007.

Finance 2006. *Nova Scotia Offshore Arrangements.* Canada: Department of Finance, 11 July. http://www.fin.gc.ca/FEDPROV/nsae.html. Accessed 14 December 2006.

Faiola. A. 2005. "Japan-China Oil Dispute Escalates Relations Already Uneasy as Tokyo Accuses Beijing of Tapping Disputed Fields." *Washington Post Foreign Service,* October 22.

Fitzpatrick, J. 2004. *Smart Food — Open to the World.* Province of Nova Scotia. http://www.novascotiallife.com/AbsPage.aspx?ID=278&siteid=1&lang=1. Accessed 28 February 2007.

Foran, S. 2006. Personal communication. December 18, 2006.

Forestweb 2006. *North American pellets market heating up as oil prices soar,* January 9. http://www.forestweb.com/iiFeed/clients/canfor/feed.taf?nID=578153568&feed=xTranet. Accessed 21 February 2007.

Goodman, P. 2005. "China tells Congress to back off businesses. *Washington Post Foreign Service*, July 5.

Guardian Unlimited 2005. "Cold reception for pipeline project." *Guardian,* November 8. http://money.guardian.co.uk/news_/story/0,1456,1637062,00.html. Accessed 12 December 2006.

Guysborough 2006. "Keltic Petrochemicals to hold open house." Municipality of the District of Guysborough. *Fall Newsletter.* http://www.municipality.guysborough.ns.ca/pdfs/Word%20Pro%20-%20Fall%20newsletter%2006.pdf. Accessed 1 March 2007.

Hagerman, G. 2005. *Nova Scotia Tidal In-Stream Energy Conversion (TISEC): Survey and Characterization of Potential Project Sites.* Electric Power Research Institute. TP-003 NS Rev 1, December 2005.

Hargreaves, S. 2007. "Calming ethanol-crazed corn prices." *CNNMoney.com*, January 30. http://money.cnn.com/2007/01/30/news/economy/corn_ethanol/index.htm. Accessed 25 April 2007.

Heinberg, R. 2006. *Energy Geopolitics 2006.* http://www.energybulletin.net/16393.html. Accessed 11 February 2007.

Hughes, L. 2002. *An Examination of Nova Scotia Power's Green Power Rider: submission to Nova Scotia UARB*. http://lh.ece.dal.ca/enen/UARBgp.pdf. Accessed 19 February 2007.

Hughes, L. 2005a. "Which climate change policy might that be?" *Chronicle-Herald*, February 25.

Hughes, L. 2005b. *Securing our future? A review of Nova Scotia's energy sector in 2004.* Halifax NS: Canadian Centre for Policy Alternatives, July 26.

Hughes, L. 2006. *Our winters of discontent: Addressing the problem of rising home heating costs.* Halifax NS : Canadian Centre for Policy Alternatives, March 20.

Hughes, L. et al. 2006. "A Study of Wind Energy Use for Space Heating in Prince Edward Island." In *Second International Green Energy Conference.* Oshawa ON: the University of Ontario Institute of Technology. June.

Hughes, L., 2007a. *Review, reduce, and replace: The three 'R's of energy security.* Research Report ERG 2007/01. Halifax NS: Energy Research Group, February. http://dclh.electricalandcomputerengineering.dal.ca/enen/2007/ERG200701.pdf. Accessed 2 March 2007.

Hughes, L., and Wood, T. 2007b. *Solar energy and multi-storey residential buildings.* Research Report ERG 2007/02. Halifax NS: Energy Research Group, February. http://dclh.electricalandcomputerengineering.dal.ca/enen/2007/ERG200702.pdf. Accessed 26 April 2007.

Hydrocarbons-Technology 2006. *Hamaca-Ameriven Syncrude Project, Orinoco, Venezuela.* http://www.hydrocarbons-technology.com/projects/hamaca/. Accessed 24 November 2006.

IEA 2001a. International Energy Agency. *Toward a sustainable energy future.* Paris: OECD.

IEA 2001b. International Energy Agency. *Oil Supply Security — The Emergency Response Potential of IEA Countries in 2000.* Paris: OECD.

IRAC 2005. *Frequently Asked Questions Petroleum Pricing.* Prince Edward Island: Island Regulatory and Appeals Commission, October. http://www.irac.pe.ca/document.aspx?content=faq/documents/petrol-pricing-faq.asp. Accessed 14 December 2006.

Indeco 2004. *Low income energy conservation and assistance.* Toronto ON: Indeco Strategic Consulting, April.

Industry Canada 2006. *International Market Research Reports — Nova Scotia Gas Delivery System.* http://strategis.ic.gc.ca/epic/site/imr-ri.nsf/en/gr116611e.html. Accessed 7 February 2007.

Joseph, A. nd. *Tidal Power Generation: A Sustainable Energy Source?* Truro NS: Nova Scotia Agricultural College.

MacDonald, N. 2006. Sable royalties. Personal communication. Nova Scotia Department of Finance, November 9.

Mahendrappa, T. 2005. "The dangers of whole-tree harvesting." *Atlantic Forestry Review,* May.

McKenna, B. 2005. "Cheney joins the oil sands pilgrimage." *Alexander's Gas and Oil Connections* 1016, August 31. http://www.gasandoil.com/GOC/news/ntn53528.htm. Accessed 12 January 2007.

MosNews 2006a. "Russia to create giant company to control oil and gas production at sea shelf — paper." *MosNews*, December 11. http://www.mosnews.com/money/2006/12/11/megashelf.shtml. Accessed 12 December 2006.

MosNews 2006b. "Gazprom says Shell made new proposal for Sakhalin-2 asset swap." *MosNews*, December 11. http://www.mosnews.com/money/2006/12/11/gazpromshell.shtml. Accessed 12 December 2006.

Mulick, C. 2006. "Challenges emerge for wind power." *Tri-city Herald, Kennewick, Washington*, July 12. http://www.tri-cityherald.com/tch/local/story/7956605p-7850113c.html. Accessed 15 July 2006.

Myrden, J. 2004. "Offshore outlook turns sour." *Chronicle-Herald*, September 10.

NAFTA 2002a. *Chapter Six: Energy and Basic Petrochemicals.* North American Free Trade Agreement. Ottawa: Department of Foreign Affairs and International Trade. http://www.dfait-maeci.gc.ca/nafta-alena/chap06-en.asp. Accessed 3 March 2007.

NAFTA 2002b. *Part Eight. Other Provisions. Chapter Twenty-One: Exceptions.* North American Free Trade Agreement. Ottawa: Department of Foreign Affairs and International Trade. http://www.dfait-maeci.gc.ca/nafta-alena/chap21-en.asp. Accessed 3 March 2007.

NEB 2005. *Outlook for Electricity Markets 2005–2006.* National Energy Board of Canada, June. www.neb-one.gc.ca/energy/EnergyReports/EMAElectricityMarkets2005_2006_e.pdf. Accessed 14 December 2006.

NEB 2006. *Short term Canadian Natural Gas Deliverability 2006–2008.* National Energy Board of Canada. No. NE2-1/2006E.

NRCan 2006. *Canada's Energy Outlook: The Reference Case 2006.* Ottawa: Natural Resources Canada. No. M144-126/2006E-PDF.

NS Energy 1999. Offshore Petroleum Royalty Regulations made under Section 23 of the *Offshore Petroleum Royalty Act* S.N.S. 1987, c. 9 O.I.C. 1999-337, N.S. Reg. 71/99. 17 June.

NS Energy 2006a. Schedule "A," Regulations Respecting Renewable Energy Standards made under *Electricity Act* N.S. Reg.35/2007.

NS Energy 2006b. Province to defend Nova Scotia interests. *Nova Scotia Department of Energy. News Release,* November 6. http://www.gov.ns.ca/news/details.asp?id=20061106004. Accessed 1 March 2007.

NS Environment 2005. Air Quality Regulations made under Section 112 of the *Environment Act.* N.S. Reg. 28/2005

NS Finance 2005. *Debt Reduction Plan 2005 — Debt Reduction and Offshore Offset Agreement.* Halifax NS: Nova Scotia Department of Finance, April.

NS Finance 2006. *Nova Scotia Budget — Assumptions and Schedules for the Fiscal Year 2006–2007.* Halifax NS: Nova Scotia Department of Finance. http://www.gov.ns.ca/finance/budget06/assumptions_and_schedules.pdf. Accessed 28 February 2007.

NS Finance 2007. *Province Facing Difficult 2007–08 Budget Process.* Halifax NS: Nova Scotia Department of Finance. February 7. http://www.gov.ns.ca/finance/news/release.asp?id=20070207014. Accessed 28 February 2007.

NS Petroleum Directorate 2001. *Seizing the Opportunity.* December.

NSPI 2005. *Flue Gas Desulphurization (FDG) Lingan Units 3 and 4, Work Order Submission CI 20089.* Work order submitted to NSUARB, November.

NSPI 2006a. *Notice of application and direct evidence.* Submission to NSUARB 2007 Rate Hearing. Halifax NS: Nova Scotia Power Incorporated, October.

NSPI 2006b. *NSPI's response to NS Energy "Renewable Energy Standards Regulations Wholesale Market Rules Regulations,"* November.

NSPI 2006c. "The best location to develop tidal power in North America." *Nova Scotia Power in the News,* May 16. http://www.nspower.ca/about_nspi/in_the_news/2006/05162006.shtml. Accessed 1 March 2007.

NSPI 2006d. *Domestic Service Time-Of-Day Tariff (Optional) Rate Code 06.* Nova Scotia Power Incorporated: Tariffs, March.

NSUARB 2006. In the Matter Of The Public Utilities Act and in The Matter of an Application by Nova Scotia Power Incorporated for approval of certain Revisions to its Rates, Charges and Regulations. Halifax NS: Nova Scotia Utility and Review Board. Decision.NSUARB-NSPI-P-882, 2006 NSUARB 23, March 10.

NSUARB 2007. In the Matter Of The Public Utilities Act and in The Matter of an Application by Nova Scotia Power Incorporated for approval of certain Revisions to its Rates, Charges and Regulations. Halifax NS: Nova Scotia Utility and Review Board. Decision. NSUARB-NSPI-P-886, 2007 NSUARB 8, February 5.

New Scientist 2007. "International climate angst is growing." *New Scientist*, No. 2592, February 24.

Nijjar, J. 2005. *Design of a district energy system.* MASc thesis. Halifax NS: Dalhousie University, Department of Electrical and Computer Engineering, August.

Nova Scotia Power Privatization Act, S.N.S.1992, c.8, as am. 1994, c.9; 1994, c.39; 1997, c.3; 1998, c.18; 1998, c.19; 2002, c.5; 2003, c.4.

OEE 2005. Office of Energy Efficiency. *R-2000: Energy Efficiency.* http://oee.nrcan.gc.ca/residential/personal/new-homes/r-2000/energy-efficiency.cfm?attr=4. Accessed 28 February 2007.

OEE 2007. Office of Energy Efficiency. *Comprehensive Energy Use Database Tables — Residential Sector — Nova Scotia.* http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_res_ns.cfm. Accessed 20 January 2007.

O'Reilly, G.A. 2005. *Naturally occurring radionuclides in Nova Scotia's rocks, water and air.* Nova Scotia Department of Natural Resources http://www.gov.ns.ca/natr/meb/pdf/05re02/05re02_Abstract18.pdf. Accessed 18 December 2006.

PCO 2001. Privy Council Office. *Closure of the Prince Mine,* May. http://www.pco-bcp.gc.ca/default.sp?Language=E&Page=archivechretien&Sub=FactSheets&Doc=princemine_20010516_e.htm. Accessed 14 December 2006.

PO 2006. Premier's Office. "New Energy Developments in Offshore Nova Scotia." *NS Premier's Office News release,* June 30.

Pacala, S. and R. Socolow 2004. "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies." *Science* 305, August 13.

Pearce, F. 2006. "Fuels gold: Big risks of the biofuel revolution." *New Scientist,* No. 2570, September 25.

Pelletier, A. 2004. *TransCanada and Petro-Canada to jointly pursue LNG facility in Gros Cacouna, Quebec.* http://www.bas-saint-laurent.org/texte.asp?id=438. Accessed 19 December 2006.

Poten and Partners 2004. *A Tanker Shortage Contributes to Rising Oil Costs,* October 21. http://www.poten.com/?URL=show_articles.asp?id=395&table=tMentions. Accessed 7 February 2007.

Proctor, S. 2006. "Scaled-back offshore project ready for government review — Deep Panuke will cost $700m." *Chronicle-Herald*, November 11.

REN21 2006. Renewable Energy Policy Network for the 21st Century. *Renewables — Global Status Report — 2006 Update.* http://www.ren21.net/globalstatusreport/download/RE_GSR_2006_Update.pdf. Accessed 19 February 2007.

Reuters 2006. *Petro-Canada says production resumed at Terra Nova.* November 14. http://yahoo.reuters.com/news/articlehybrid.aspx?storyID=urn:newsml:reuters.com:20061114:MTFH62639_2006-11-14_20-04-56_N14303533&type=comktNews&rpc=44. Accessed 14 December 2006.

Reynolds, N. 2007. "Light bulbs aren't going to do Kyoto trick." *Globe and Mail*, 20 April 2007.

Sauser, B. 2007. "Ethanol demand threatens food prices." *MIT Technology Review*, February 13. http://www.technologyreview.com/Energy/18173/. Accessed 24 April 2007.

Schmoker, J.W. 2000, *Reserve growth effects on estimates of oil and natural gas resources*. U.S. Geological Survey Fact Sheet FS-119-00. http://pubs.usgs.gov/fs/fs119-00/. Accessed 11 May 2007.

Shapouri, H. et al. 2004. *The 2001 Net Energy Balance of Corn-Ethanol.* U.S. Department of Agriculture. http://www.ncga.com/ethanol/pdfs/ShapouriEnergyBalance2004.pdf. Accessed 11 February 2007.

Shell 2004. *Shell Canada Q4 earnings down on one-time costs, weak refining margins.* http://www.sharewatch.com/story.php?storynumber=61911. Accessed 3 January 2006.

Sims, R. 2002. *The Brilliance of Bioenergy*. London, James & James.

Stats Can 2001. *2001 Census of Agriculture, data by province*. 2001 Census of Agriculture, Census Agricultural Region (CAR) and Census Division (CD) Land use, 2001.

Stats Can 2007a. *Consumer price index (CPI), 2001 basket content, annual, Nova Scotia.* Statistics Canada. Table 326-0002.

Stats Can 2007b. *Supply and demand of primary and secondary energy in terajoules, annual, Nova Scotia.* Statistics Canada. Table 128-0009.

Stats Can 2007c. *Coal and coke statistics.* Statistics Canada. Table 303-0016.

Steffes 2006. *Comfort Plus Hydronic Brochure*. http://www.steffes.com/downloads/pdf/hydronic_brochure.pdf. Accessed 17 February 2006.

Stigset, M. 2006. *Ethanol Drives Up Food Commodity Prices, Datagro Says.* November 22. www.bloomberg.com/apps/news?pid=20601086&sid=ayonmpI2Y1dA&refer=news. Accessed 27 November 2006.

Taber, J. 2006. "PM brands Canada an 'energy superpower'." *Globe and Mail*, June 15.

U.S. Congress. Senate. 2007. Biofuels Security Act of 2007. 110th Cong., 1st sess. Congressional Record. vol. 153, no. 1 (4 January) S62.

WLRI 2004. *A Study of Biomass Inventory, Costing, Processing Logistics and Equipment for the Production of Fuel Ethanol and Co-Products in Nova Scotia.* Halifax NS: Whale Lake Research Institute. Report prepared for Nova Scotia Departments of Energy, Agriculture and Fisheries, Economic Development, and Bio Vision Technology Inc., July.

Williams, E.D. 2003. "Assessing the potential of telecommuting as an energy savings technology in Japan." IEEE *International Symposium on Electronics and the Environment,* May. DOI 10.1109/ISEE.2003.1208064.

Wisenberg, D. 2006. "Coal-based liquid fuel gaining interest." *Wall Street Journal*, May 30. http://www.thefeedstock.com/2006/05/coalbased_liquid_fuel_gaining.php. Accessed 14 December 2006.

Wood, T. 2006. *Solar gain analysis for Halifax.* Halifax NS: Dalhousie University. Energy Research Group. Internal report, December.

World Bank 2005. *Energy Security Issues.* Moscow-Washington: World Bank, December.

Zerbe, J. 1991. "Liquid fuels from wood — ethanol, methanol, diesel." *World Resource Review* 3, 4. http://www.fpl.fs.fed.us/documnts/pdf1991/zerbe91a.pdf. Accessed 14 December 2006.

Notes

1 The most recent data from Environment Canada for Nova Scotian greenhouse gas emissions is for 2004.

2 Refined petroleum products (RPP) are the products of refining crude oil, and include propane, butane, petrochemical feedstocks, naphtha, gasoline (motor and aviation), aviation fuels, kerosene, diesel fuel, light and heavy fuel oil (including Bunker C), asphalt, coke (including petroleum coke), and lubricating oils (EIA 2007).

3 A petajoule (PJ) is a unit of energy, representing 10^{15} joules. One petajoule is the amount of energy found in about 29 million litres of gasoline.

4 Prior to 2006, Statistics Canada totaled the sales of home heating fuel in the Residential sector as part of residential energy consumption. Starting in 2006 (with 2004 data), home heating fuel is included in either the Commercial-Institutional sector or the Residential sector, depending upon the vendor. If the vendor is directly associated with a refinery, the volume sold is included in the Residential sector; however, if the vendor is not associated with a refinery, but purchases fuel oil from the refinery for subsequent sales to the Residential sector, the volume purchased by the vendor is included in the Commercial-Institutional sector. The total volume of fuel sold remains unchanged; however, it becomes a challenge to determine how much is actually consumed by the Residential sector.

5 Primary electricity as defined by Statistics Canada includes renewables (almost entirely hydroelectricity), nuclear, and fuel purchases. In Nova Scotia, primary sources are almost exclusively hydroelectric (falling water and tidal).

6 Conserve Nova Scotia is a Special Operating Agency of the government of Nova Scotia rather than a crown corporation, meaning that it functions under the authority of the minister of energy and can be restructured or cancelled at the discretion of the premier. Had it been established as a crown corporation, it would have a board of governors, would develop formal business plans, could give public policy advice to any minister, and could issue bonds for retrofit loans and other energy-related activities.

7 Nova Scotia's natural gas distribution network is not considered because of its limited size. This does not include the M&NE pipeline, as this infrastructure is intended to export almost all of Nova Scotia's natural gas to New England.

8 This program was originally run by the Department of Energy; it has subsequently been taken over by Conserve Nova Scotia.

9 The rebate program is intended for all Nova Scotian households and the average household rebate is estimated to be $200 per household. The provincial government has presented this as a progressive move, helping all Nova Scotians, overlooking the fact that in 2004–05, the Keep the Heat program paid needy Nova Scotian families $250 to offset heating costs. Since the program does not restrict the number of fuels that can be rebated, a single household could claim for wood, electricity, fuel oil, and propane. Since the rebate program is not based on income, all Nova Scotians will "benefit" from it.

10 Shell Canada considers the Glenelg project a "write-off" (Shell 2004).

11 Royalties do not include offshore license forfeitures which amounted to $61 million in 2004–05 and were forecast to be $42.2 million in 2005–06 (Budget 2006).

12 Regasification is the process of taking the super-cooled liquefied natural gas and allowing it to return to the gaseous state.

13 A second Petroplus company, Maple, is also involved with the Nova Scotia LNG project.

14 Keltic originally wanted to build a petrochemical plant using Nova Scotia's offshore natural gas as its feedstock. Only when offshore natural gas failed to meet expectations did Keltic turn to LNG (Foran 2006).

15 One metric tonne is equivalent to 1.4 m^3 of solid wood (BEDB 2006).

16 A photovoltaic panel or more commonly "solar cell" is a device that takes solar energy in the form light and converts it into electricity. A solar thermal panel is a device that takes solar energy and coverts it into heat.

17 The values listed are what would be obtained through a standard double pane window and do not represent the energy absorbed by a room, typically 80 percent of what is transmitted (Wood 2006).

18 Spinning reserve is production maintained by the energy supplier to handle situations when the one or more generation units go off-line unexpectedly; it is essentially an insurance policy. Traditionally, the spinning reserve has been about 20 percent of the supplier's production; in recent years, this number has been in decline as technology has improved and many utilities turn to natural gas turbines that can be brought on-line at a moment's notice.

19 Although the Energy Strategy and various provincial ministers of energy talked about "renewables," the underlying assumption was that "renewables equal wind." Wind energy subsequently caught the public's imagination, with the result that almost all "renewable energy" projects in the province deal with wind.

20 NRCan has included the Public Administration sector with the Commercial-Institutional.

21 It is important to note that the thermal storage of electricity can be used with any source of electricity. Wind is an ideal candidate for this as the cost per kWh is declining and thermal storage offers a means to overcome the problem of intermittency. Note that any intermittent source, such as wave or solar-PV could be used to generate electricity for thermal storage, although the cost per kWh may not be as attractive.

22 A district heating system is a means of distributing heat, usually in the form of hot water, through insulated pipes, to a group of buildings within an area of a city or town. The heating source can vary, from a central boiler supplying heat, as done in Charlottetown, to a combined heat and power station, supplying both heat and electricity to large parts of a community, as is done in Copenhagen and other Scandinavian cities. Combined heat and power district heating systems are typically 60 to 70 percent efficient, meaning that the fuel is used more efficiently than in conventional thermal generating facilities (Nijjar 2005).

23 This assumes that the biomass has an average low heating value of 15 GJ per tonne and that the biomass is combusted in furnaces with 90 percent efficiency.

24 Those using wood, electricity or natural gas for heating qualified for $100 from Keep the Heat.

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