SETTING THE CONTEXT

Overview: Nova Scotia's Electricity System

In Nova Scotia, most electricity is supplied by the public utility, Nova Scotia Power Inc. (NSPI). Nova Scotia has a vertically integrated monopoly, meaning that NSPI generates, transmits, and distributes most of our electricity. The utility owns more than 95 per cent of the province's system for the creation and delivery of electricity. It serves about 500,000 residential, commercial, and industrial customers.

NSPI is a publically regulated private corporation. The amount of capital it can invest and the amount of profit it can earn is regulated by the Utility and Review Board (UARB). The UARB regulates the operating costs of the utility, and the province limits the amount of executive salary that can be recovered through power rates.

In addition to NSPI, there are six municipal electric utilities. These utilities buy electricity from NSPI and other sources, generate some of their own, and sell directly to their customers. The municipal utilities are also regulated by the UARB.

Independent power producers (IPP) generate electricity and sell it to NSPI. They supply a significant amount of the province's renewable energy, such as wind and biomass. More than 70 per cent of the large-scale wind turbines generating electricity in Nova Scotia are independently owned by companies other than NSPI.

What Nova Scotians pay for electricity is determined through several different regulated processes. At the beginning of every year, NSPI estimates the cost of providing electricity, and the projected revenue that will be recovered through their approved rates. If a shortfall in revenue is projected that isn't expected to be recovered through the Fuel Adjustment Mechanism[2] process, then NSPI will typically file a General Rate Application with the UARB asking for permission to adjust rates going forward.

This application takes into account the return on equity, fuel costs, management and labour, reliability programs, operating, maintenance, and generation costs. The UARB determines whether rates are adjusted, and by how much.

As a private company, Nova Scotia Power Inc. provides capital from lenders and its shareholders. This capital is generally used to invest in long-term assets such as major equipment and system upgrades or new generation. The lenders receive a competitive rate of return based on the assumption that there is only a moderate amount of risk that the debt will go into default. The shareholders receive a return

[2] The Fuel Adjustment Mechanism ensures that power rates reflect the actual cost of fuel—not just the forecasted cost. These are typically adjusted at the beginning of the calendar year, based on the true expense. This means that they could go up or down if the true cost of fuel was different than the projected cost.

based upon comparisons in the marketplace for similar kinds of investments and risk. Shareholders have a higher degree of risk—if there is a form of loss that is found to be imprudent, they bear that loss first. The current breakdown of capital invested in Nova Scotia Power Inc.'s assets is 37.5 per cent equity and 62.5 per cent debt.

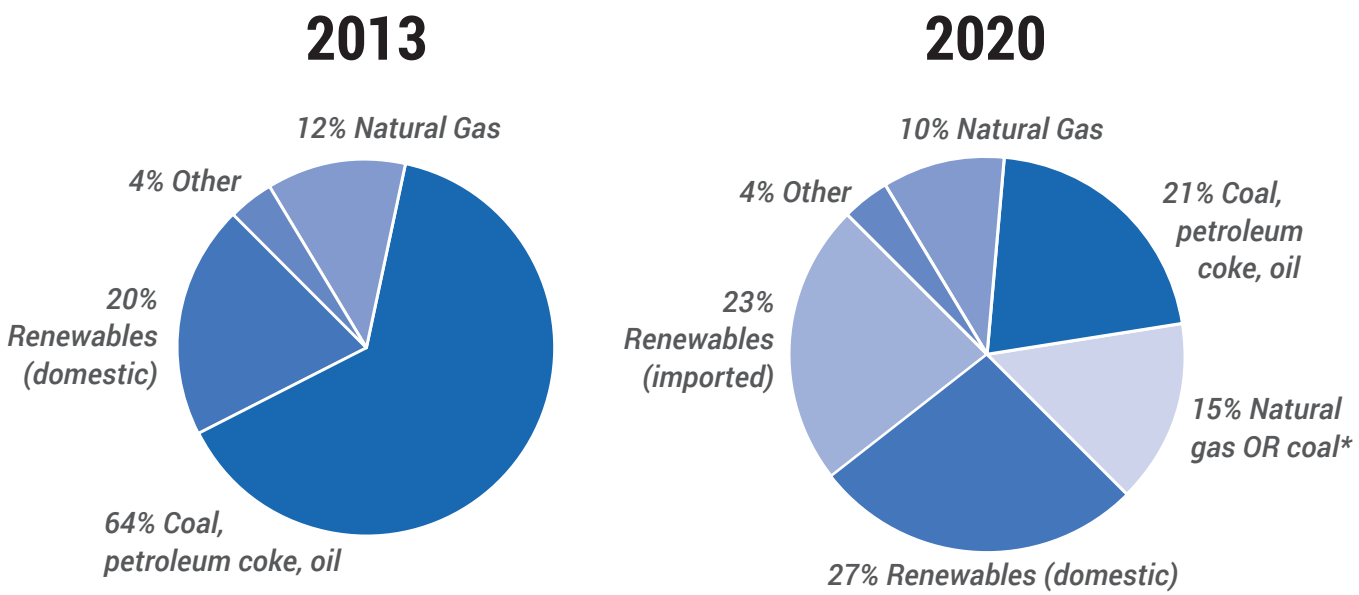
Evolution of Our System

Many of the first electricity customers in Nova Scotia were served by small hydroelectric facilities throughout the province. As demand grew, fossil fuels became the primary source of electricity. By the 1970s, oil was our primary source of electricity generation until the OPEC crisis caused prices to double, and then double again.

In the face of these global price shocks, the province decided to produce electricity from coal, as much of it was mined locally and prices were low. As recently as 2006, coal and related products met more than 80 per cent of the province's electricity needs.

Over the past decade, closure of local coal mines and changes to emissions regulations have meant that a significant amount of our coal is imported from the United States and Colombia. Reliance on imported coal leaves Nova Scotia vulnerable to the volatility of global coal prices. Prices have risen as much as 75 per cent at some points in recent years, but have retreated since recent spikes. Our experiences with fossil fuels have shown the risks of relying too heavily on one fuel source.

Fig.1 Nova Scotia energy sources in 2013 (actual) and 2020 (predicted)



** Dependent on factors such as cost and emissions requirements.*

Electricity is generated throughout the province at power plants using coal, petroleum coke, oil, and natural gas, and at plants using renewable sources of energy (wind, hydro, tidal, and biomass). NSPI also imports small quantities of electricity through a transmission line connecting Nova Scotia and New Brunswick, which typically provides 4–6 per cent of our total annual supply.

Together, local generation and imports make up our generation mix. This mix changes from year to year, depending on resource availability (wind), fuel prices (fossil fuels), and environmental regulations.

By 2020, Renewable Electricity Standards (RES) regulations require a minimum of 40 per cent of the province's electricity to come from renewable sources of energy. That legal requirement will be met through existing projects under contract and already committed new construction including the Maritime Link.

Diversifying our electricity sources is important for ensuring electricity security as well as stable and predictable prices. Having too much of our electricity come from one source has proven to be a bad strategy in the past. Moving from oil to 80 per cent dependence on coal and similar fuels seemed like a good idea when it provided economic benefits for Nova Scotia through the use of local coal. Then the mines closed and the world began to be concerned about the impacts on climate change from carbon-intensive fuels such as coal.

Clearly there are risks from becoming overly dependent on a single source. Diversity is a safer choice as it allows for more flexibility in sourcing our electricity (balancing imports, exports, and intermittent and firm sources). It lets us take advantage of low electricity prices for some fuel choices (imported electricity) and provides options to avoid large price increases for some fuels.

Understanding Our Needs

Nova Scotia uses about 11 gigawatt-hours (GWh)[3] of electricity every year. Long-term planning studies project that the province could need anywhere between 13 GWh and 8 GWh of electricity a year over the next 25 years.

About 44 per cent of Nova Scotia's electricity use is in the residential sector, 34 per cent in the commercial sector, and 24 per cent in the industrial sector.

Planning for our electricity future must take into account the fact that close to a quarter of our electricity sales are attributed to a handful of large industrial customers. The addition or loss of a large industrial customer could significantly change the overall amount of electricity required to meet demands.

The demand for electricity in the commercial sector is tied to the size of the province's economy as measured by the gross domestic product (GDP). It is currently projected

[3] 11 GWh represents the amount of electricity generated, not electricity sales. NSPI's electricity sales are approximately 7 per cent lower due to system losses during transmission and distribution.

to grow at about 1.2 per cent per year. The residential sector is expected to grow by about 0.2 per cent. However, much of this growth can be offset by energy efficiency programs and technologies. Depending on how much support these programs receive and how much growth in demand actually occurs, both the residential and commercial sectors could see a net decline in electricity use over the long term.

Another complicating factor in planning for Nova Scotia's electricity system is the large difference between our winter peak and shoulder seasons. Nova Scotia has a winter-peaking utility, meaning we use most of our electricity (2200 megawatts) during the cold winter months. However, long spring days when there is no air conditioning required we use significantly less (700 megawatts).

This creates a challenge in that we need an electricity system that has the capacity and flexibility to significantly scale up or down, as the season requires. Traditional fossil fuel plants can do that to some degree because they are controlled by the utility, but the availability of new renewable resources such as wind or solar are controlled by nature. They produce electricity when the resource is available—not necessarily when we need it. As a result, we often have more electricity than we need in the summer, so we need to store it, sell it elsewhere, or let it go to waste. Without storage technologies or good transmission connections with our neighbours, today some of it is wasted.

If it goes to waste—a practice referred to as curtailing wind generation or spilling of water at hydro generation sites—this lost opportunity cost is paid for by all customers. Current supply contracts with independent power producers ensure that they are paid for the electricity they produce whether the system can use it or not. If contracts were changed to allow utilities to refuse the power, the cost per unit would likely go up.

Connections With Our Neighbours

Many potential options for sourcing electricity from outside of the province are limited by our poor transmission connections with other systems. We currently have only one major connection to New Brunswick, which only allows for about 300 megawatts (MW) of non-firm capacity. However, the primary purpose of this connection (also referred to as an intertie) is to ensure reliability standards are met, and not necessarily to provide electricity on a daily basis. Nova Scotia's access to the intertie depends on New Brunswick's consumption, so during high demand periods there is effectively no capacity for Nova Scotia.

Firm capacity is electricity that can be guaranteed at any given time (most fossil fuels for example). Non-firm or intermittent capacity cannot be relied upon. They cannot be easily dispatched when they are needed (wind, tidal).

Starting in 2009, the four Atlantic provinces and the federal government began an extensive research initiative aimed at enhancing the co-operation of government and regional power utilities in Atlantic Canada for a cleaner energy future. The project, known as the Atlantic Energy Gateway (AEG), included eight modeling and research studies around power system planning, operations modeling, clean energy (industrial), and economic development. Two major implications for Nova Scotia emerged from this work.

Part of the AEG work was based on the assumption that a new electrical connection between Nova Scotia and Newfoundland known as the Maritime Link would be built. It was approved by the Nova Scotia Utility and Review Board in 2013 and is scheduled for completion in 2017.

Under the 35-year contract with Nalcor, NSPI will pay the cost of building the electrical connection, and in return will receive a fixed amount of electricity (153 MW). In addition to the long-term contract, up to 198 MW of non-firm capacity will be available for purchase if it is required and cost effective. This additional electricity is guaranteed to be at market price, which has generally been lower than current energy costs in Nova Scotia.

If market prices for additional hydro-electricity from the Maritime Link are cost effective, more than 50 per cent of Nova Scotia's electricity could come from renewable sources in the 2020s and 30s.

The Maritime Link also creates a new Atlantic energy loop that strengthens Nova Scotia's interconnection to the North American grid. Being part of a new energy loop will allow the province to import new supplies of clean energy such as from Quebec and New Brunswick, use renewable imports to balance our locally produced intermittent generation, and potentially export surplus renewable energy in the future. This connection also provides a strategic advantage for Nova Scotia by putting us first in line for access to energy from Muskrat Falls and also from Upper Churchill after it reverts back to Newfoundland in 2041.

The Atlantic Energy Gateway work also supports opportunities to enhance connections with other provinces by upgrading our existing intertie and share reliability responsibilities with New Brunswick. The creation of the Maritime Link is expected to encourage increased connections with New Brunswick and the broader northeast region, to enable other markets to access Maritime Link surplus electricity, and possibly surplus renewable electricity form Nova Scotia as well.

Environmental Considerations

How we source electricity now and in the future is also influenced by the province's commitment to improving environmental outcomes to benefit citizens. Nova Scotia has committed to reducing greenhouse gas (GHG) emissions by approximately 25 per cent in the electricity sector by 2020 to meet a provincially regulated cap of 7.5 million tonnes, and 55 percent by 2030 to meet a cap of 4.5 million tonnes.

Nova Scotia is committed to improving air quality and protecting the health of our citizens in a way that achieves good environmental outcomes while balancing economic impact to rate payers. Starting in January, new and amended legislative requirements will reduce pollution from our electricity system over the next 15 years. New air pollution requirements move from an annual to a multi year cap system that allows more freedom to make economic choices on fuel sources while still maintaining compliance and achieving the same environmental outcomes. For the first time ever, the requirements also include annual sulfur dioxide emissions limits in communities with generating stations. By 2030, sulfur dioxide from electricity generation will reduce by 86 per cent and mercury by 89 per cent from 2001 levels. Nitrogen oxides will be reduced by 69 per cent from 2000 levels.

These new requirements will help the province reach an agreement on national air pollution targets with the federal government. On a fleet level, they will bring us closer to other jurisdictions while allowing the utility to meet declining caps in whatever way the is most cost effective without requiring capital intensive and expensive pollution control equipment such as scrubbers. The federal government is committed to developing air pollution standards for the electricity sector (BLIERS), and while we don't know what the federal regulations will look like, our new 2030 targets put us in a better position to reach an agreement with the federal government similar to what was achieved on the GHG-side for coal-fired electrical plants.

Overall our air quality requirements are part of our strategy to transform the electricity sector to be cleaner burning and more renewables focused, with lower greenhouse gas emissions.

The Environmental Goals and Sustainable Prosperity Act was passed in 2007 and outlines 21 goals and 2 overarching objectives that recognize the importance of integrating environmental sustainability and economic prosperity.[4] The act was amended in 2012, following a mandated five-year review, and 4 more goals were added for a total of 25. The amended act sets two main objectives for the year 2020: (1) to demonstrate international leadership by having one of the cleanest and most

[4] *http://www.novascotia.ca/nse/egspa/docs/EGSPA.2012.Annual.Report.pdf*

sustainable environments in the world, and (2) to provide certainty to all sectors of the economy while improving the province's environmental performance to a level at or above the Canadian average. The 21 goals relate to improving performance around key environmental areas such as air quality, greenhouse gases, renewable energy, and energy efficiency buildings, among others.

In support of the initiative, the Department of Energy amended the Electricity Act and changed the Renewable Electricity Regulations. Under the regulations, the government outlined rules to meet the legislated minimum targets for renewable energy of 25 per cent by 2015, and 40 per cent by 2020. We are currently on track to exceed both of these regulatory requirements.

Using Less Electricity

A large part of Nova Scotia's electricity future relates to increasing energy efficiency. One of the best ways to manage future electricity supply costs is to use less electricity. In 2014, the Government of Nova Scotia restructured Efficiency Nova Scotia under the Electricity Efficiency and Conservation Restructuring (2014) Act.

This essentially requires Efficiency Nova Scotia (ENS) to compete directly with NSPI's cost of generation going forward. If efficiency measures provide the lowest cost, then NSPI will have the obligation to purchase all cost-effective energy efficiency. A set amount ($39 million) was approved for 2015 as a transition year, and for 2016 onwards, ENS and NSPI will have to negotiate three-year agreements for the appropriate amount of demand-side management programs.

Efficiency Nova Scotia's 2015 plan estimated that they will save ratepayers 121 million kilowatt-hours of electricity in 2015—enough to power 12,000 homes. These saved kilowatt-hours have an average cost of $0.025 compared to the conservatively estimated cost of electricity production of $0.04, resulting in around $180 million in electricity cost savings over the next 10 years.[5]

[5] *http://www.efficiencyns.ca/who-we-are/energy-and-efficiency-plan-for-2013-2015/*

KEY CHALLENGES AND OPPORTUNITIES

Reports and Studies

Throughout the review process, the Department of Energy has sought feedback from a variety of informed sources to help identify the key opportunities, challenges, and realities we can expect to face in planning for our electricity future. During the first phase of the review, the department contracted with ICF International to complete work related to technical components of the system and London Economics Inc. for a review of our electricity marketplace. A number of other sources and studies have also been reviewed, as outlined below.

Integrated Resource Assessment

In addition to ICF International's technical study on future electricity supply and demand in Nova Scotia, the review also takes into account a similar process by electricity system stakeholders and the Utility and Review Board called the Integrated Resource Planning process (IRP). Through the IRP, the UARB required NSPI to develop multiple scenarios for our electricity, considering current requirements. The IRP process included significant input from stakeholders.

Nova Scotia Power filed its final IRP report with the Utility and Review Board in October 2014. The UARB subsequently directed NSPI to file its preferred resource plan and avoided cost on December 10, 2014.

The 2014 IRP looked at system requirements out to 2040. Thus, the IRP looked at both supply and demand for the utility over a 25-year horizon. The information provided through the IRP was integrated into the first two review studies (emerging technologies and market trends in supply and demand).

Energy Management Working Group

As a result of the ICF studies, the department brought together a group of stakeholders to discuss issues around energy management systems. This working group developed a report[6] that discusses some of the key challenges facing the changing electricity environment, including the development of smarter community energy systems. Some of the key issues discussed include

- integration of renewables
- management of system peak demand

[6] *The Energy Management Working Group Report can be found online at http://energy.novascotia.ca/electricity/electricity-system-review/electricity-review-phase-i/energy-management-working-group*

- metering
- billing
- data
- competition and new business opportunities
- planning
- access to capital

Other Expertise

The review also takes into account expertise from a number of other studies and reports, including the following:

- technology reports by Natural Resources Canada (Clean Electricity and Renewables Portfolio – Portfolio Strategic Plan, August 2014 Draft for Consultation)
- the Tidal Value Chain Study funded by Atlantic Canada Opportunities Agency and Offshore Energy Research Association
- the Report of the Energy Management Systems Working Group
- information from the Carbon Capture and Storage Consortium of Nova Scotia
- the Ecology Action Centre report on Solar Photovoltaics in Nova Scotia: Report on Costs and Measured Electrical Productivity

This collection of work is currently being used to inform next steps from the Electricity System Review.

Key Findings

Our Electricity Demand (Now and in the Future)

Both the ICF study on supply and demand and the recent IRP found that we will be able to meet our most likely demand scenarios (slow growth of electricity use) with our existing and committed generation, and increases to electricity efficiency and demand-side management.

Some new generation may be required to replace existing sources near the 2030 time frame, but the capacity we have today may be all the capacity we need well into the end of the next decade. Significant new, large-scale generation before 2030 would

only be needed if we see a massive increase in demand, such as major developments in our offshore sector.

Growth in electricity demand depends on a number of factors. Energy efficiency improvements, increased focus on demand-side management, and uptake in technologies that better manage our home electricity use all help us use less electricity and mitigate electricity demand growth.

However, technologies such as electric air source heat pump systems (whole-house ducted systems and split systems) are growing in popularity and have the potential to increase electricity demand during peak times (cold winter days). Improvements to electric transportation technologies (electric vehicles) could also increase our electricity consumption.

Planning for our future electricity system needs to start now. Major electricity projects have long lead times. The studies suggest that we should use the next 5 to 15 years to plan for 2030 and beyond. At the same time, we should investigate potential energy solutions and manage demand growth through investments in grid modernization, energy efficiency, storage strategies, and other generation technologies.

Today's Energy Supply (now to 2020)

As mentioned in the previous section, Nova Scotia likely has enough existing and committed generation to meet our electricity needs toward 2030. In the short term, our key challenges are making the most of our existing renewables and improving our ability to integrate intermittent sources of electricity into our system.

To date, there are commitments for wind projects totaling approximately 550 MW. However, the growing use of wind presents a challenge, as the amount of electricity produced by a wind turbine is tied directly to wind speed. A wind turbine might produce at its full capacity, at a portion of its capacity, or not at all. The output can change very quickly depending on the availability of wind—from no production to full production with a gust. With experience and improvements in weather modeling, the ability to predict the hourly, day-ahead wind production output is increasing.

Still, there remains a need to back-up intermittent sources of electricity. This can be done through firm sources of electricity like fossil fuels and natural gas, through power from the Maritime Link, or through new technologies such as storage.

Once the Maritime Link is in-service, it will provide both a firm, reliable source of renewable electricity and additional competitively priced non-firm market energy. It should also provide incentives to improve our connections with surrounding markets.

In the short term, it will be important to gain a better understanding of the role that the Maritime Link can play in our electricity system and the future opportunities it may create.

Coal continues to play a big role in our energy mix. Through the equivalency agreement negotiated with the federal government, the federally prescribed timeline to shut down coal plants will not apply to Nova Scotia; instead, the electricity sector will continue to reduce coal to meet declining GHG emission caps laid out in provincial regulation from 2010 to 2030. Outside of coal plant closures to free up transmission for the Maritime Link, all other existing coal units will likely stay open well into the next decade and will be used when it is economic (within our emissions caps) or necessary to meet peak demands. There is the potential that some of the Tuft's Cove thermal units in Dartmouth may need to be replaced; however, it is not anticipated that a large number of coal plants will come off-line in the next decade. It is more likely that they will be used less frequently.

An additional issue facing our system planning is the role of distributed (locally produced) energy. There is a possibility to integrate more locally generated electricity as the costs of some technologies start to come down over the next few years. For example, the study completed by Natural Resources Canada looked at when a number of technologies can expect to reach grid parity (when the cost to produce the electricity matches the cost to residential retail consumers). The study found that solar photovoltaic (PV) may reach full retail cost grid parity somewhere around 2020 in some Canadian markets.

The implication is that by 2020 it may become economically viable for residential homeowners in some parts of Canada to get their electricity from a solar PV system installed on their roof through a net-metering arrangement with their electricity distribution company. There are, however, additional costs to the utility, as net metering is inherently subsidized by non-net metered utility customers. Residents who generate electricity are not required to pay fees associated with transmitting their electricity to other customers or fees for exiting the system. They have access to on-demand electricity when they need it, but are no longer paying some of the embedded costs of the larger rate base.

Our Future Supply (2020 and beyond)

As we near 2030, there will be opportunities to replace a significant amount of our electricity generation.

Many wind farms in the province operate under power purchase agreements (PPA), which are 15 to 20 year contracts for electricity. The first PPA for wind was signed

in 2006, with the majority of Community-Feed-In-Tariff wind projects awarded in 2012. This means that between 2026 and 2035, many of our current contracts for renewable electricity (550 MW) will expire.

The current GHG regulation includes emissions caps only to 2030. It is uncertain how the province and federal government will proceed, but it is likely that requirements to reduce greenhouse gas emissions will become more stringent and may require the retirement of some of our coal plants after 2030. Future climate change policies at home and globally may also result in financial penalties for carbon emissions.

There will likely be more opportunities to access new electricity markets with improved transmission connections for Nova Scotia.

In May 2012 the Province of Nova Scotia released the Marine Renewable Energy Strategy, which laid out a plan that would see the province take a phased and progressive approach to the development of Marine Renewable Energy. A longer-term goal of producing 300 MW of power from in-stream tidal energy projects was also established with the assumption that significant lessons will be learned from the initial arrays deployed in the next five years in Nova Scotia resulting in continued broad community support and lower costs.

The OERA Value Proposition Report (to be released later this spring) looks at economic impacts from development to meet our needs and exports. It assumes cost reductions will come from experience and innovation. This results in the provincial goal of 300 MW being achieved by 2028, serving incremental renewable electricity needs throughout the 2020s and beyond. It also recognizes that an accelerated development of our tidal resources improves our competitive position to export tidal goods and services into other jurisdictions, which represents a unique renewable energy economic development opportunity for Nova Scotia.

Beyond 2028, further tidal development at any significant scale in the province will require additional markets within Nova Scotia, access to export markets, or both.

Electricity Prices

A number of complex and constantly changing factors impact Nova Scotia's cost of electricity. Our historic dependence on one fuel source (first oil, then coal) made us susceptible to fluctuations in global market prices. We still get the majority of our energy from fossil fuels, including natural gas, so we are subjects to volatility in terms of price and availability. For example, there were days in the winter of 2014, where NSPI could not buy all of the fuel it needed due to increased demand in New England. As a result, the utility had to interrupt some of its industrial customers.

Over the past 10 years, the province has taken significant strides to diversify our fuel sources. Integrating more renewables, though more costly today, provides long-term price stability. The price we pay for wind today is the price we will pay in 20 years due to long-term, fixed-price contracts. For example, when the Pubnico Wind Farm was first built, costs for the electricity it generated were comparatively high. Over time, the price stayed stable while other fuel prices rose, making it on par today with some of our less expensive fuel choices.

Innovation and Technology

Renewable Energy Sources

ICF International completed a review of new and emerging technologies that might make sense for generating electricity in Nova Scotia in the near and longer term. They pointed out that the cost of many technologies would come down over time, but at different rates and times. To enable a comparison between each one, they levelized the costs.

A levelized cost takes into account the capital cost of the technology and projected long-term fuel costs, as well as availability of the fuel source and other resources within the province. For example, the cost of a generation technology may decrease significantly, but if the province doesn't have enough of the energy input when we need it—or a system that can store it in a cost-effective manner—then the overall cost of the electricity from that source will stay fairly high.

The emerging technology study found that given Nova Scotia's cost of electricity, many new technologies cannot be considered cost effective for large-scale integration today. However, a combination of more cost effective technologies and higher electricity rates in the future might support increased uptake over time.

It may be necessary to introduce some of these technologies on a smaller scale to understand how they will perform within our system. Pilot projects would allow us to study and redesign new technologies to suit our system, while only having a small impact on rates.

Technology could impact our future electricity system by changing the way we generate electricity, manage electricity, or both. New technologies can help us both store electricity from intermittent sources (solar, wind, and tidal) to use it when we need it, or shift out electricity demand so that we are using electricity as it is being produced.

Renewable energy technologies become more attractive when we can find cost-effective ways to store surplus electricity until the system needs it. A battery is a commonly thought of form of storage for electricity, but other technologies such

as thermal storage (including ice, chilled water, hot water, phase-change materials, ceramic bricks, earth energy storage), compressed air, flywheels, and hydrogen are also emerging as options.

These technologies can also help smooth some of our peak-load demand scenarios. For example, some heat pump technologies allow for electrical energy to be stored as thermal energy, which could be accessed when system demand is high. Instead of a heat pump system adding to our peak demand, the stored thermal energy could be drawn on during high demand times instead of electricity. This type of system could also allow us to maximize our renewable resources by storing energy when they are producing and could alleviate some of the peak demand pressure on the system.

Some Renewable technologies may be expensive today, but if storage costs can be significantly reduced, new lower-cost options will emerge. This is why we need to design a system of generation, transmission, and use of electricity that is flexible and can accommodate a range of new technology options.

The Natural Resources Canada and ICF International studies agree that the increased use of renewables will be constrained by the grid's ability to accept these variable sources of electricity. The studies note that an inability to manage variable generation will hold us back from taking full advantage of the current state-of-the-art capabilities of renewable energy generators. We will require more intelligent electricity infrastructure (distribution and automation) to fully take advantage of renewable technologies.

The following list of technologies was identified in the ICF International study as relevant to Nova Scotia:

Solar to generate electricity (photovoltaic or PV): Nova Scotia has a good solar regime, so solar use for hot water heating can be effective and make economic sense. However, timing is an issue when solar is used for generating electricity. ICF noted that the best days for generating solar energy in the province are unfortunately during periods when our electricity demand is the lowest. This presents a challenge in having any large-scale adoption of solar in Nova Scotia without the availability of affordable storage solutions. Solar must also be considered in the context of existing investments in other intermittent renewable energy resources. We have reached the limit at which we can integrate further sources of intermittent electricity cost effectively without new storage technology, and sources such as wind are currently more effective.

Biomass: Biomass is currently used in a number of projects in Nova Scotia. However, even at commercial scale, the cost is relatively high (13 to 17 cents per kWh). New fuel stocks and research may provide an opportunity for innovation within the province.

Geothermal for electricity: Specific geology and geography is needed for geothermal temperatures to be hot enough to create steam to drive a turbine. There is no such resource available in Nova Scotia, although there are a number of locations where the temperature differential is sufficient to drive heat pumps for space heating.

District energy systems: Community-scale district energy systems for combined heat and power represent a potential opportunity for the province, but they are based on site-specific efficiencies and economies of scale, such as taking advantage of multiple infrastructure replacement (water, sewer, and power lines).

Tidal: Development of hydrokinetic energy, particularly in the Bay of Fundy, offers great opportunity to Nova Scotia as a clean, renewable source of power with major economic benefits. Note that tidal is not included in the chart below because the expected cost-reduction time frame is only beginning to become clear.

Carbon capture and storage (being explored but unlikely): Based upon what was known at the time of their study, ICF suggested that there were no significant opportunities for carbon capture and storage within the province. However, research by the Carbon Capture and Storage Consortium is exploring whether there is enough capacity to store the CO2 output of a coal plant the size of Point Aconi in Cape Breton. Drilling results are expected early in 2015. If the results are positive for storage, then technology to capture CO2 could be considered for use when it becomes more cost effective. If the results are negative, then this technology could be ruled out as an option.

More information can be found in the ICF technical report[7] and the summary report posted on the Electricity System Review website.

Energy Management Technologies

The introduction of management systems that can shift, store, and release energy represents a significant opportunity for improvement. Today's electricity system functions through a series of reactive one-way relationships. For decades, the equation was simple: customers increase the amount of electricity they need and the utility increases the amount of electricity generated. However, as we add renewable intermittent sources of electricity, the equation is more complicated. Electricity is now generated independent of customer demand. Now the utility has to manage other generation sources as intermittent resources come online.

Advances in technology can allow a more dynamic relationship between electricity users (ratepayers), the utility (Nova Scotia Power Inc. or municipal utilities), and power producers (the utility or independent power producers) to maximize our existing resources.

[7] *The ICF International technical study and summary report can be found at http://energy.novascotia.ca/electricity/electricity-system-review*

Ideally, our future electricity system will be able to respond to an increase in demand from one sector by reducing demand in another with no noticeable impact to the consumer. It will respond to a drop in supply from one intermittent source of electricity by drawing power out of storage or making minor adjustments to demand. We will only be able to do this through increasingly complex control systems.

There are opportunities today to incorporate emerging technologies, and more in the next two decades as the province replaces older central station coal and natural gas plants.

Our Future Electricity Marketplace

London Economics Inc. completed a detailed assessment of our electricity system marketplace and governance structure. It considered ways to improve the system through increased competition, accountability, and changes in the regulatory framework.

Increasing Competition

Liberalization of our electricity system means more competition for the generation of electricity, and potentially more choice in who will supply electricity. Liberalization does not mean the elimination of regulations; it means reshaping the way we regulate utilities.

There are advantages to the current model. For example, accountabilities are clear. Nova Scotia Power Inc. (or a municipal electric utility) can be held directly responsible for service issues and safety. They are also obligated to serve any customer who requests service.

A fully liberalized system that depends on market decisions spreads responsibility for these matters among the many players. Experience has shown that in a completely liberalized system, an Integrated System Operator (ISO) or a TransCO (transmission company) is needed to ensure the coordination of services required to meet a reliable supply of electricity. However, ISOs and TransCOs do not own, operate, or build any generation assets.

It is also important to note that neither a fully liberalized system nor increased competition will guarantee lower power rates. Over the long term, competition has the potential to increase efficiency and cost effectiveness, which can mitigate increases. However, experience in a number of jurisdictions has shown that full liberalization can also lead to sharp increases in the beginning since new players have new costs while existing players still have costs from the previous system. It is also likely that electricity costs will always be linked to some degree with inflation.