

VISION 2050

THE FUTURE OF CANADA'S ELECTRICITY SYSTEM



Canadian
Electricity
Association

Association
canadienne
de l'électricité



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About CEA

Canadian Electricity Association members generate, transmit and distribute electrical energy to industrial, commercial, residential and institutional customers across Canada every day. From vertically integrated electric utilities, independent power producers, transmission and distribution companies, to power marketers, to the manufacturers and suppliers of materials, technology and services that keep the industry running smoothly — all are represented by this national industry association.

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INTRODUCTION: TIME FOR A VISION

**THIS IS ONE OF
THOSE MOMENTS
OF CHANGE
IN CANADA'S
ELECTRICITY
SYSTEM**

CHANGE IN THE ELECTRICITY INDUSTRY TENDS TO COME IN WAVES. THE INDUSTRY IS DESIGNED TO BE CONSERVATIVE AND CONTROLLED, SO IT CAN ENSURE RELIABILITY. PLANNING HORIZONS ARE MEASURED IN DECADES, IF NOT GENERATIONS, WITH LONG PERIODS OF SILENCE BROKEN BY MOMENTS OF CHANGE.

This is one of those moments of change in Canada's – and indeed North America's – electricity system. There are several reasons why:

- Many electricity assets are approaching their end of life and must be replaced;
- Developments in information technology (IT) and automation raise exciting possibilities for a reconfigured electrical grid;
- Extreme weather reminds us of our reliance on critical electrical infrastructure;
- Many stakeholders are advocating greater forms of regional integration in North America.

It's time to modernize our electricity system for the next generation.

As we consider options for the future, we need to remember the journey that created the system we have today. When the electricity industry started in the late 19th century, it was made up of a number of independent operations, city by city; what we might now call micro-grids.

It became apparent early on that both cost and reliability could be improved when these municipal systems were linked through major investments in larger generating stations and transmission lines. The price of electricity tended to drop with economies

of scale. Reliability improved with transmission that enabled large movement of electricity from one place to another. Together these factors drove the development of the industry as we know it.

In the mid-20th century, consideration of environmental impacts began to grow in importance. By the 21st century, environmental sustainability of the electricity system evolved to a social imperative. This gave rise to the growth of new renewable technologies such as solar, wind, biomass and tidal. These “new” renewables complement the long-established renewable hydroelectricity Canada has been relying on for over a hundred years.

Today, the electricity industry has a commitment to limit its carbon footprint and operate in an environmentally-responsible way. More than three-quarters of Canada's electricity generation comes from non-emitting sources, largely from hydro, which is still the most efficient renewable technology. Across the country, more non-hydro renewables are being added to the grid and the industry continues to find new ways to reduce the environmental impact of gas and coal. The industry is also working throughout the country to create a culture of energy conservation.

Over the years, the role of the customer has evolved as well. Early on, the customer received what others thought best. However, the paradigm has shifted and, by the end of the 20th century, deregulation of industries accelerated, leading to increasing competition, which in turn created opportunities for lower prices and ultimately gave “customer choice” a foothold in the electricity industry.

More recently, changing technologies have shifted the role of the customer, increasing the impact of consumers in shaping the electricity system. Fortunately, the same technologies that give the customer a more central role also create opportunities to better manage the new complexities as the system evolves. Customization to meet consumer need will become a key attribute of our electricity system, allowing for efficiencies from production to end-use.

The journey to present-day reflects a balance among three pillars that have shaped the industry over the last hundred years:

- Affordability;
- Reliability;
- Sustainability.

It is not an exact science – the three attributes cannot be specifically measured and put into an equation. In fact, the dynamics are often different in each region of the country. Finding the right balance is largely done through a process that involves legislation, regulation and often, politics of the day.

The electricity industry is more than simply individual companies that produce and deliver power – it comprises the largest interconnected machine in North America, an incredible network of equipment, people and possibilities. Today, electricity

companies are updating their complex energy systems that employ hundreds of experts, thousands of kilometres of wires and millions of ideas that have led to state-of-the-art technology and infrastructure.

The industry is adapting to the major technological changes of our time including the greater use of information technology, smart grid applications, renewable technology integration, electrification of transportation and the development of more decentralized forms of generation. This means the industry will modernize the grid and make it more responsive to customers, meeting two important objectives – the system will become more efficient and people will have more control over their energy use and costs.

The electricity industry has an obligation to leave a functioning and reliable system to our children. It is nothing short of its legacy to them. It is also accountable to the public and governments of today to operate in the public interest and has an obligation to provide real value for the money people pay for their power. That means working to earn the public trust beyond producing power reliably. The industry must increase efficiency, eliminate waste and provide transparency about decisions it makes.

Given these dynamics, the Canadian electricity industry has taken a forward view and developed a vision for the future.

In this spirit and within this context, this document has three purposes.

First, it aims to inform its readers about the long lead times in electricity infrastructure projects and the importance of planning several decades ahead in support of desired outcomes in the shape and composition of the electricity system.

Second, it aims to clarify the policy variables and decisions that must be made over the next five to 10 years on the path to ensuring the reliability and sustainability of a modernized Canadian electricity system in 2050.

And third, it advances a vision for the future of electricity in Canada, and offers ideas for how to achieve this vision.

THE ELECTRICITY INDUSTRY HAS AN OBLIGATION TO LEAVE A FUNCTIONING AND RELIABLE SYSTEM TO OUR CHILDREN



Photo: courtesy of Capital Power Corporation

Vision 2050 is primarily intended for policymakers and stakeholders in the energy sector in Canada; it may also be of relevance to many Canadians with an interest in energy, the economy or the

environment. Increasingly, as electricity moves to the center of many policy debates, there is a welcome broadening of the definition of 'electricity stakeholder'.



Part 1 discusses the fundamental characteristics of the electricity system that ought to be taken into account in any strategic planning or visioning exercise.



Part 2 discusses the most likely scenario for the mix of power generation and includes data for future energy supply and demand scenarios.



Part 3 identifies the key variables that will impact the future of the system including the size, composition, management and economic variables that highlight the important choices that must be made over the next decade in Canada.



Part 4 makes the case for the urgency of action.



Taking into account these earlier discussions, **Part 5** offers a vision for Canada's electricity future, its objectives and proposed recommendations.



Vision 2050 creates an opportunity to continue delivering the three pillars of a strong electricity system – reliability, affordability and sustainability. The Canadian Electricity Association (CEA) welcomes your views on Vision 2050.

1 FUNDAMENTAL CHARACTERISTICS OF THE ELECTRICITY SYSTEM

WHILE IT MAY
SEEM LIKE WE
HAVE YEARS
TO DECIDE ON
THE SYSTEM
WE WANT, 2050
IS AN ELECTRIC
HEARTBEAT AWAY



THE ELECTRICITY SYSTEM HAS THREE FUNDAMENTAL CHARACTERISTICS THAT COMBINE TO DETERMINE ITS EVOLUTION AND THE CONSTRAINTS UNDER WHICH IT OPERATES: ITS INFRASTRUCTURE IS REPLACED ONLY VERY SLOWLY, ITS PRINCIPAL ACTORS ARE INTERDEPENDENT ACROSS BORDERS, AND IT MANAGES AND DELIVERS A PUBLIC GOOD.

Slow Turnover

The electricity industry has a much slower capital stock turnover than most other industries. Most North Americans replace their personal computer every three to four years and their family car every decade or so. In contrast, coal plants operate for 50 years or more and nuclear plants for 40 years or more. Hydroelectric plants can operate for more than a century – as is the case with DeCew Falls Generating Station No. 1 in Ontario, in service in 1898, and Pointe du Bois in Manitoba, in service in 1911 – both are still operating safely today.¹ Transmission and distribution lines also have a long provenance: Quebec’s transmission system is organized around 735 kilovolt (kV) power lines, the first of which was commissioned in November 1965.

Electricity assets are also slow to turn over because innovations tend to occur at a slower pace than in many other industries, and truly disruptive innovations – innovations that redefine

the entire industry – occur only rarely. As Canadian energy expert Vaclav Smil comments: “Wishful thinking, pioneering enthusiasm, and belief in the efficacy of seemingly superior solutions are not enough to change the fundamentally gradual nature of energy transitions ... [They] nearly always require major infrastructural developments ... moreover, they inevitably confront environmental, legal, or organizational complications and are hindered by irrational perceptions of risk.”²

The slow pace of turnover in electricity has a clear implication: while it may seem that we have years to decide on the system we want, 2050 is an electric heartbeat away. What we decide to build today will form the foundation for the system our children and grandchildren count on. Once infrastructure is in place there are significant economic costs to failing to maximize it for the duration of its very long useful life. In other words, it will be with us for decades, so we had better choose wisely.

1 Canadian Hydropower Association, “Hydropower in Canada: Past, Present, and Future,” *Renewable Energy World.Com*, October 1, 2009, accessed February 10, 2014, <http://www.renewableenergyworld.com/rea/news/article/2009/10/hydropower-in-canada-past-present-and-future>.

2 Vaclav Smil, “The True (Slow) Pace of Energy Transitions,” *AEIdeas*, September 8, 2010, accessed February 10, 2014, <http://www.aei-ideas.org/2010/09/the-true-slow-pace-of-energy-transitions/>.



Photo: courtesy of Hydro-Québec

Energy Interdependence

Energy resources are interdependent to a significant extent, especially in terms of the electricity grid and international energy prices. In the North American context, when overgrown trees downed power lines in Ohio in 2003 and cascading blackouts occurred as far away as James Bay in Canada, Canadians were given a dramatic reminder of how our power systems tie together. Altogether more than 508 generating units at 265 power plants across Canada and the United States shutdown during the outage.³

There are many ways that our energy systems are already interconnected in North America. The Canadian electricity community works alongside its U.S. counterparts to develop and maintain reliability, quality, safety and environmental standards, as well as exchange ideas and support on shared practices and trends of common interest. When Hurricane Sandy hit New York City especially hard in October 2012, the Canadian Electricity Association and its member utilities worked side-by-side with U.S. colleagues to restore power.

With the exception of Nova Scotia, P.E.I. and Newfoundland, all Canadian provinces are connected to neighbouring U.S. states via more

ENERGY RESOURCES ARE INTERDEPENDENT TO A SIGNIFICANT EXTENT, ESPECIALLY IN TERMS OF THE ELECTRICITY GRID AND INTERNATIONAL ENERGY PRICES

than 30 major transmission interties.⁴ Canada is a net exporter of electricity to the United States: in 2012 Canada imported 10.9 terawatt hours (TWh), and exported 57.9 TWh, for a net export total of 47.0 TWh.⁵

Energy markets, including electricity markets, are also connected through price. In the summer just before the 2007 earthquake that shut down the Kashiwazaki-Kariwa nuclear plant outside Tokyo, an LNG tanker was headed from the Middle East towards the United States. Once the earthquake

3 U.S.-Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations," *US Department of Energy*, <http://energy.gov/oe/downloads/blackout-2003-august-14-2003-blackout-one-year-later-actions-taken-united-states-and>.

4 "Electricity," *Government of Canada*, accessed February 10, 2014, <http://www.can-am.gc.ca/rerelations/electricity-electricite.aspx?lang=eng>.

5 "Electricity Exports and Imports Statistics," *National Energy Board*, accessed February 10, 2014, <http://www.neb-one.gc.ca/clf-nsi/rnrgynfmrtn/sttstc/lctrcyxprtmprt/lctrcyxprtmprt-eng.html#s2012>.

Major Canada-U.S. Transmission Interconnections

*Construction scheduled for completion in Summer 2013.

Source: National Energy Board.



occurred, the tanker changed course for Japan, as the energy-deprived country was prepared to pay more for its LNG.⁶

Even in situations where energy fuels are never exported, and instead simply consumed at home, the domestic price is influenced by the global market. The price of uranium mined in Saskatchewan can be influenced by Australian uranium mining prices, while the price for gas in Canada is integrated with

U.S. prices.⁷ Climate change too raises the prospect of global – or at least internationally linked – markets for carbon trading or other forms of carbon regulation. Canadian provinces have been participants in U.S. regional climate initiatives, including the Regional Greenhouse Gas Initiative and the Western Climate Initiative. In short, energy and especially electricity decisions in Canada may affect the U.S. and international context, and vice-versa.

6 The story about the LNG tanker changing course is from an IHS CERA briefing note. Also see Howard V. Rogers, "LNG Trade-flows in the Atlantic Basin: Trends and Discontinuities," *Oxford Institute for Energy Studies*, p. 29: <http://www.oxfordenergy.org/wp-content/uploads/2010/11/NG41-LNGTradeFlowsInTheAtlanticBasinTrendsandDiscontinuities-HowardRogers-2010.pdf>.

7 "The Canadian and U.S. natural gas markets operate as one large integrated market. This means that events in any region such as changes in transportation costs, infrastructure constraints or weather will have effects on the other regions;" from "Natural Gas: Natural Gas – How Canadian Markets Work," *National Energy Board*: <http://www.neb-one.gc.ca/clf-nsi/rmgynfmrtn/prcng/ntrlgs/cndnmrk-eng.html>.

THE INDUSTRY IS A STEWARD OF THE PUBLIC TRUST CONFERRING SIGNIFICANT BENEFITS ON SOCIETY AS A WHOLE

Electricity System as a Public Good

Although electricity companies look to advance their own interests, as all businesses do, the industry is also a steward of the public trust: its effective functioning confers significant benefits on society as a whole. When the electricity system functions well, it has a meta-role in supporting the stability and growth of other industries and other parts of the economy. In developing economies electricity has been shown to be a driver of or at least strongly correlated with human development,⁸ and is equally critical for the sustainability of developed economies.

The reverse can be just as important. Market failures in electricity often translate into wider crises. As the California electricity crisis of 2000–2001 reminded us, competition in electricity markets cannot be understood through the standard analysis that is applied to most other industries. In a typical industry, a participant can only abuse its position if it has a dominant market share.⁹ In electricity markets, however, physics requires that electrons flow continuously, and transmission constraints limit new entrants. Given these characteristics, in a poorly designed electricity market a supplier with even a tiny market share – or a trader acting on its behalf – can exercise or even abuse market power unilaterally as the last available resource in a



given location.¹⁰ The California crisis cost the state an estimated \$40 to \$45 billion, and reminded policymakers of the importance of good market design to encourage competition and guard against gaming behavior by traders and suppliers.¹¹

On the household level, the absence of electricity can be life-threatening to elderly and other vulnerable citizens and ratepayers during our cold winters and hot summers.¹² Electricity also requires environmental, health and safety regulation – of transmission lines, of air emissions from coal plants (e.g., mercury, sulfur oxides, nitrogen oxides), of the ecosystem impact and safety dangers of flooding from hydroelectric plants, as well as the need to safely dispose of long-lived radioactive waste from nuclear plants. A recent study in China found that pollution in northern China – mostly caused by coal-fired power

8 See Alan D. Pasternak, "Global Energy Futures and Human Development: A Framework for Analysis," *U.S. Department of Energy*, October 2000, <https://e-reports-ext.llnl.gov/pdf/239193.pdf>, or e.g., Amie Gaye, "Access to Energy and Human Development," *Human Development Report*, <http://hdr.undp.org/en/content/access-energy-and-human-development>.

9 Hence the term "abuse of dominant position" in competition law, and the use of the Herfindahl-Hirschman Index to measure market concentration as a means of evaluating whether the market is competitive or not. See e.g., "Glossary of terms used in EU competition policy: Antitrust and control of concentrations," *Directorate-General for Competition*, Brussels, July 2002, http://ec.europa.eu/competition/publications/glossary_en.pdf.

10 For a detailed explanation of how a supplier with a very small market share can abuse market power through physical or economic withholding, see e.g., Frank Wolak, "Lessons from International Experience with Electricity Market Monitoring," July 11, 2005, http://www.stanford.edu/group/fwolak/cgi-bin/sites/default/files/files/wolak_market_monitoring_jul05.pdf.

11 Christopher Weare, "The California Electricity Crisis: Causes and Policy Options," *San Francisco: Public Policy Institute of California*, 2003, p. 4, http://www.ppic.org/content/pubs/report/R_103CWR.pdf.

12 See e.g., Sean Campbell, "2003 European heat wave," February 23, 2009 presentation, <http://www.atmos.washington.edu/2009Q1/111/ATMS111%20Presentations/Folder%201/CampbellS.pdf>.



Photo: courtesy of Saskatoon Light & Power

IN THINKING ABOUT THE FUTURE OF ELECTRICITY, WE MUST BE MINDFUL OF ITS BENEFITS AND RESPONSIBILITIES TO SOCIETY AS A WHOLE, AND ACROSS GENERATIONS

plants that have fewer air emission controls – causes “people in northern China to live an average of 5.5 years shorter than their southern counterparts.”¹³

For all these reasons, electricity markets require effective regulation.

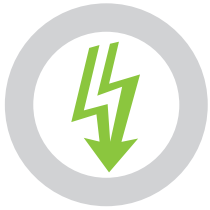
In short, whether electricity utilities are publicly owned or are private corporations, they also inescapably serve the public interest – and ultimately must answer to the general public.

Electricity has a direct impact on the life of every Canadian. In thinking about the future of electricity, therefore, we must be mindful of its benefits and responsibilities to society as a whole, and across generations. Our overriding objective must be to provide to our children a system that is thoroughly reliable and sustainable and that can support their standard of living and sustained economic growth, just as the current system has for our generation.

13 Jonathan Kaiman, “China’s reliance on coal reduces life expectancy by 5.5 years, says study,” *The Guardian*, July 9, 2013, accessed February 10, 2014, <http://www.guardian.co.uk/environment/2013/jul/08/northern-china-air-pollution-life-expectancy>. Also see: Yuyu Chen et al, “Evidence on the impact of sustained exposure to air pollution on life expectancy from China’s Huai River policy,” *Proceedings of the National Academy of Sciences*, May 28, 2013, <http://www.pnas.org/content/early/2013/07/03/1300018110>.

2 ELECTRICITY MIX SCENARIO FOR 2050

**SCENARIOS
AND MODELS
CAN HELP
DEFINE WHAT IS
POSSIBLE AND
WHAT IS NOT
WHEN THINKING
ABOUT OUR
ELECTRICITY
FUTURE**



LOOKING TO THE FUTURE, ELECTRICITY SCENARIOS COMBINE DEMAND AND SUPPLY INPUTS INTO POSSIBLE PICTURES OF THE COMING YEARS.

On the demand side they take into account factors such as population, gross domestic product (GDP), and technology to form a load forecast. On the supply side, they consider such variables as the cost of fuels, regulatory constraints, site availability, transmission and distribution potential, and the odds of social acceptance.

Modelling work on electricity scenarios in North America, Canada and at provincial levels has already been undertaken by a number of organizations. While varying scenarios to 2050 exist, such as the Trottier Energy Futures Project (TEFP) Low-Carbon Energy Futures: A Review of National Scenarios¹⁴, the National Renewable Energy Laboratory's (NREL) Renewable Electricity Futures Study (RE Futures)¹⁵, the International Energy Agency's World Energy Outlook 2013¹⁶, and the World Energy Council's World Energy

Scenarios: Composing energy futures to 2050¹⁷, we cannot predict with certainty what will shape the path to a low carbon future in electricity.

We do know there will be a role for hydroelectricity, some continuing role for natural gas, and the use of coal will be dependent upon carbon capture and storage (CCS). Energy demand will be a function of population growth, continuing improvement in energy intensity, and growth of electricity in transportation and some other parts of the economy. The composition of the system (i.e., the amount of coal/CCS, natural gas, nuclear, wind, solar, biomass and tidal) will be dependent upon changes in the economics of those technologies along with technological advancements in energy storage. In other words, various scenarios and models can help define what is possible and what is not when thinking about our electricity future.

14 "Low-Carbon Energy Futures: A Review of National Scenarios," *Trottier Energy Futures Project*, January 2013, <http://www.trottierenergyfutures.ca/wp-content/uploads/2013/01/Low-Carbon-Energy-Futures.pdf>.

15 "Renewable Electricity Futures Study (RE Futures)," *National Renewable Energy Laboratory (NREL)*, 2012, http://www.nrel.gov/analysis/re_futures/.

16 "World Energy Outlook 2013," *International Energy Agency*, November 2013, <http://www.worldenergyoutlook.org/publications/weo-2013/>.

17 "World Energy Scenarios: Composing energy futures to 2050," *World Energy Council*, October 2013, http://www.worldenergy.org/wp-content/uploads/2013/09/World-Energy-Scenarios_Composing-energy-futures-to-2050_Full-report.pdf.



Photo: courtesy of Columbia Power Corporation

For all of their value, however, a caveat is also in order: scenarios often omit important intervening factors that can dramatically change the longer-term picture. Leading energy forecasters such as the International Energy Agency, Cambridge Energy Research Associates (CERA), and the U.S. Energy Information Administration have all on occasion failed to anticipate significant demand and supply inputs and their effects on the energy system:

The 2008 financial crisis, the Fukushima nuclear accident and the shale gas discovery have all had major implications for demand-supply scenarios in different parts of the world, but none was anticipated in earlier scenario modelling efforts;

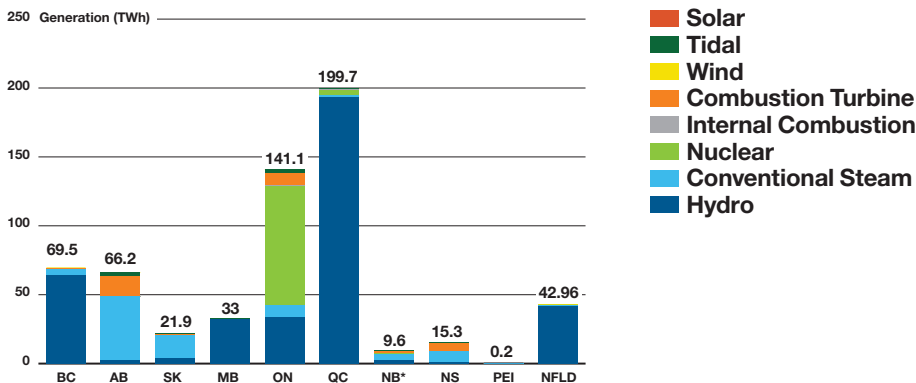
China replaced the United States as the world's number one greenhouse gas emitter much faster than almost anyone had anticipated.

The longer the forecast, the more likely it is to overlook some significant trend.¹⁸

The Most Likely Scenario

Despite the uncertainty inherent in long forecasts, if we start with the baseline of Canada's current electricity system, certain key themes emerge:

- Overall, Canada is a hydroelectric power, with some 63 per cent of our electricity generated by large and small renewable hydro resources;



Electricity Generation in Canada by Province and Fuel Type, 2012

Total Electricity Demand in Canada, 2012=599.5 TWh

Source: Statistics Canada, Survey 2151, 2012. Retrieved May 5, 2013

*With Point Lepreau nuclear generating station resuming power production on November 23, 2012, nuclear has been re-established as a major source (about 30%) of electricity in New Brunswick.

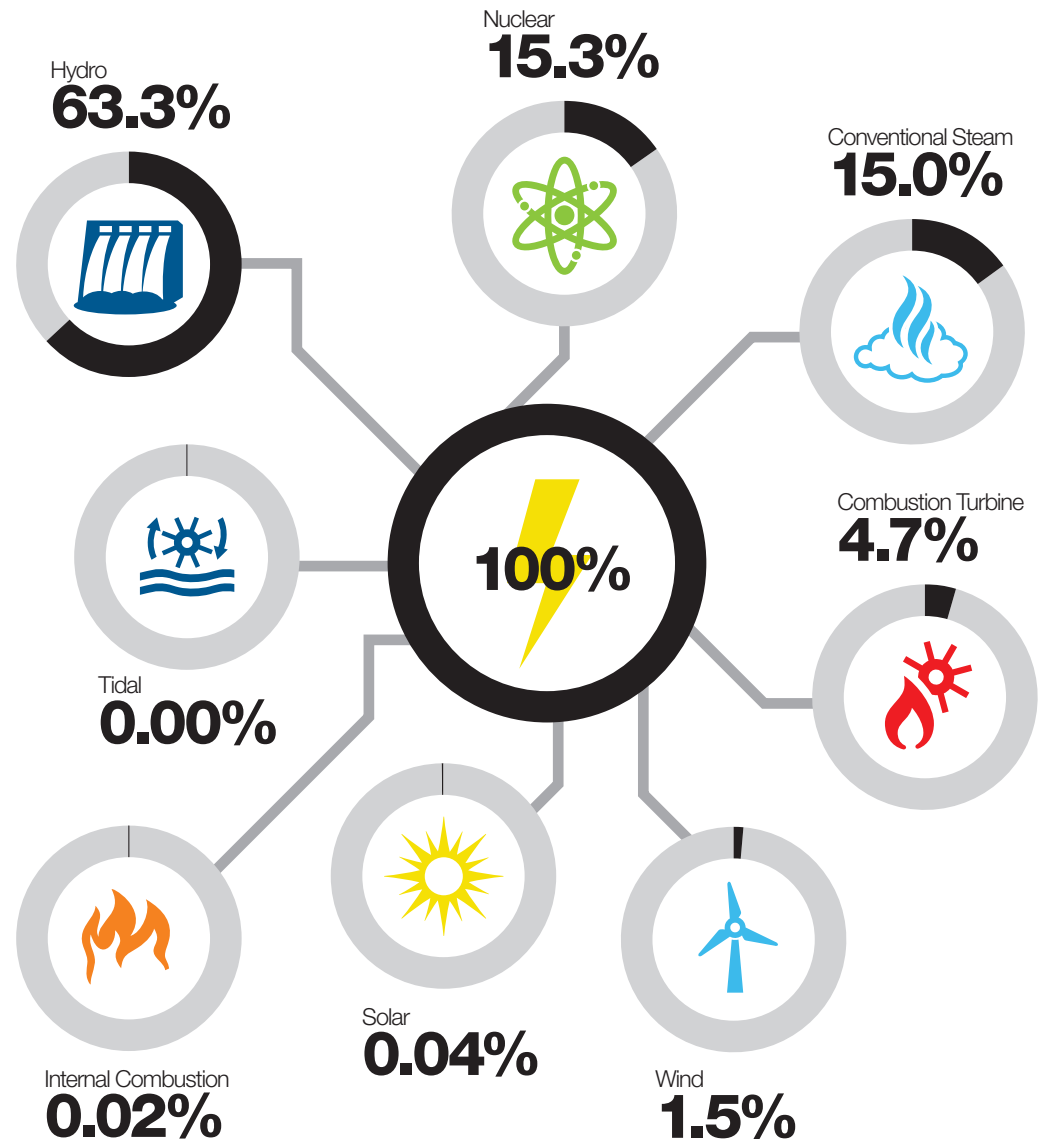
18 As Nassim Nicholas Taleb argues, history is defined by unpredictable disruptive events, and the accuracy of a forecast “degrades rapidly as you extend it through time;” Nassim Nicholas Taleb, “The Black Swan: The Impact of the Highly Improbable”, (New York: Random House, 2007), p. 209.

Electricity Generation in Canada by Fuel Type, 2012

Total Electricity Generated in Canada, 2012 = 594.9 TWh

Source: Statistics Canada, Survey 2151, 2012. Retrieved April 22, 2013.

*Numbers may not sum to 100 percent due to rounding.



- Canada's electricity system is already relatively clean and low carbon, with only 15 per cent generated from conventional steam (coal and natural gas), and a roughly equivalent amount generated from nuclear;
- Yet very little of Canada's current electricity production is generated from sources of renewable energy other than hydro. In 2012, wind contributed some 1.5 per cent of energy production, solar 0.04 per cent, and tidal power is so negligible as

to appear as 0 per cent when rounded down alongside other sources of generation, as in the chart above.

In addition, Canada's electricity system is characterized by significant regional and provincial variation in the mix of assets:

- Nuclear generation is a significant resource only in Ontario and New Brunswick (Quebec's sole nuclear generating station, Gentilly, was shut down in 2012);

CANADA'S ELECTRICITY SYSTEM IS ALREADY RELATIVELY CLEAN AND LOW CARBON

- British Columbia, Manitoba, Newfoundland and Quebec are heavily reliant (almost exclusively so) on hydroelectric power;
- Lastly, Alberta, Saskatchewan and Nova Scotia generate some 85 per cent, 74 per cent and 90 per cent of their power respectively from coal and gas resources.

How much could this current electricity picture change between now and 2050?

We can already establish at least three conclusions regarding the boundaries of 2050 scenarios and the 'possible worlds' we may encounter:

1. Under virtually all scenarios, hydroelectric power will continue to be the dominant electricity resource in Canada in 2050;
2. Nuclear may remain part of the mix in those provinces where it now plays a significant role, such as New Brunswick and Ontario. Apart from the possibility of Saskatchewan, it is unlikely to expand outside those provinces where it is already part of the generation mix;¹⁹
3. Renewable energy resources that currently have a relatively small market share – like wind, solar, biomass and tidal – are likely to grow their collective share of the overall generation mix.

For the purposes of this paper, the National Energy Board (NEB) report *Canada's Energy Future: Energy Supply and Demand Projections to 2035*,

provides a concrete point of departure for highlighting some relevant issues and variables that could shape or alter the electricity sector's path to 2050.

The NEB report assumes an average of real GDP growth of 2.3 per cent for its reference case, with the possibility of lower growth of 1.8 per cent, or higher growth of 3.2 per cent.²⁰

Population is another important factor, and the NEB projects growth for Canada's population of less than 1 per cent a year from 2010 to 2035. Its 'reference case' also sees total end-use energy demand (including energy used in the residential, commercial, industrial and transportation sectors)²¹ growing at 1.3 per cent a year over the projection period, slowing slightly from 1.4 per cent a year as occurred in its historical reference period of 1990 and 2008.²²

Assuming 2.3 per cent GDP growth a year and an increase in population of less than 1 per cent a year and end-use energy demand growth of 1.3 per cent, the NEB model sees power generation growing by about 1 per cent a year.²³ Drawing these inputs together, the report provides an interesting 'reference case' snapshot for how Canada's electricity system could evolve between 2010 and 2035.

The NEB envisions some interesting changes in the electricity mix in this reference case:

- Hydro, wave and tidal (grouped together here as water-based generation resources) decline by a few percentage points as a share of the overall mix from 59 per cent to 56 per cent; nuclear also declines, dropping from 14 per cent to 11 per cent;
- Natural gas grows from 9 per cent to 15 per cent, while coal drops from 14 per cent to 6 per cent and half of the remaining coal includes carbon capture and storage (CCS);
- Other renewables – biomass, solar, geothermal and wind – grow from a collective share of 3 per cent in 2010 to 12 per cent by 2035;

19 Saskatchewan is the only other province that is now entertaining nuclear as a long-term option; see e.g., "Nuclear power? Not yet, says Saskatchewan," *World Nuclear News*, December 18, 2009, accessed February 10, 2014, http://www.world-nuclear-news.org/np-nuclear_power_not_yet_says_saskatchewan-1812097.html. Other provinces are not expected to join the list.

20 "Canada's Energy Future: Energy Supply and Demand Projections to 2035," *National Energy Board*, November, 2011, p. viii, <http://www.neb-one.gc.ca/clf-nsi/nrgymfmr/nrgyrprt/nrgyfttr/2011/nrgspldmdndprjctn2035-eng.html>.

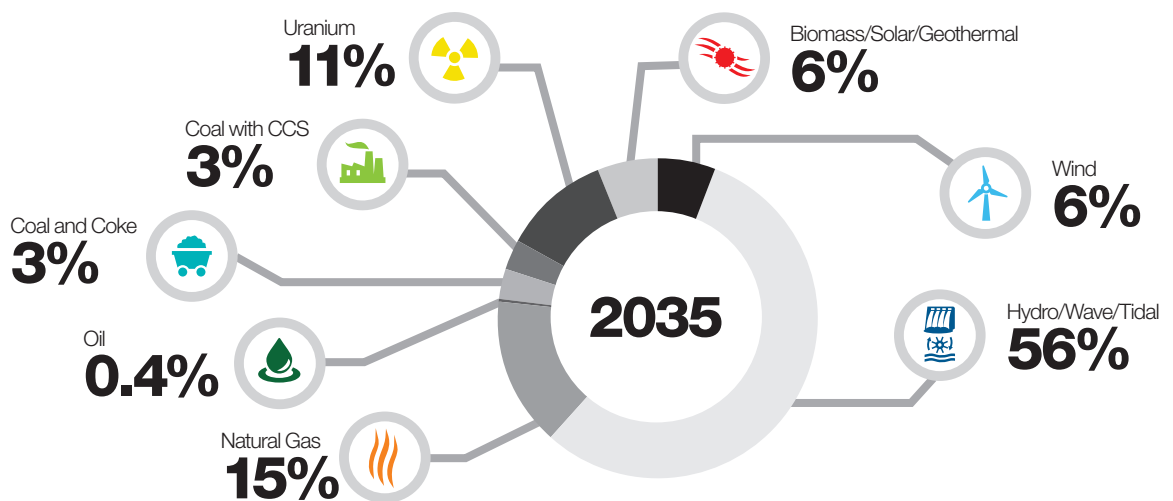
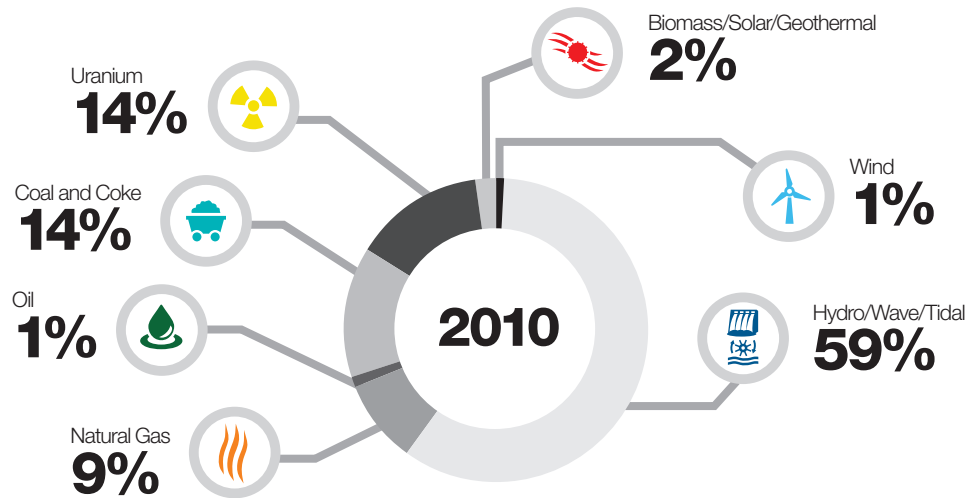
21 See "Canada's Energy Future," p. 7.

22 As the report concludes: "Slower population and economic growth, higher energy prices, and enhanced efficiency and conservation programs all contribute to slowing demand in the residential, commercial and transportation sectors. In the industrial sector, strong oil and gas production, as well as robust economic growth in a number of energy intensive industries, result in faster demand growth than the historical pace;" "Canada's Energy Future", p. 51.

23 "Canada's Energy Future", p. 42.

National Energy Board Electricity Generation Projection, 2010–2035

Source: Canada's Energy Future: Energy Supply and Demand Projections to 2035, National Energy Board, November 2011.



- To meet this supply-demand reference scenario, the model projects an increase by 27 percent of total generation capacity over the period, “with natural gas-fired and renewable-based capacity showing the largest increases.”²⁴ In this scenario, total installed capacity would grow from 133 GW in 2010 to 170 GW by 2035, including new gross capacity of 55 GW, “of which 19 GW are for replacement and 36 GW are to service incremental demand and export markets.”²⁵

The NEB also explores variations on the reference scenario, which it deems its “most likely” case,²⁶ by developing sensitivities into four alternative cases, ones centered on higher and lower energy prices, and faster and slower economic growth. While it is beyond the scope of this paper to consider these alternative scenarios, let alone how such scenarios could evolve over another 15 years to 2050, it is important to highlight some of the key variables that will make a difference in the overall composition, size, management and financial levers of the electricity mix through to 2050.

24 As the report explains, “This capacity increase is driven by two key factors. First, as existing power facilities age, they will need to be replaced for reliability, economic and/or environmental reasons. Second, sufficient capacity will need to be constructed to meet growing demand while maintaining sufficient reserve margins,” “Canada’s Energy Future”, p. 41.

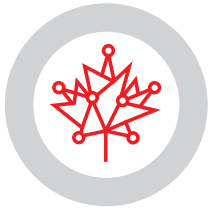
25 “Canada’s Energy Future”, p. 41.

26 The quotation adjusts for a typographical error; to be precise, the NEB calls its reference scenario “the ‘mostly likely’ (sic) outcome for Canada’s future;” see “Canada’s Energy Future”, p. viii.

3

KEY VARIABLES AFFECTING THE FUTURE OF CANADA'S ELECTRICITY SYSTEM

**CANADIANS WILL
NEED TO MAKE
SOME IMPORTANT
DECISIONS IN THE
NEAR FUTURE**



THERE IS A KEY SET OF VARIABLES THAT WILL AFFECT THE FUTURE OF CANADA'S ELECTRICITY SYSTEM – WHAT WILL BE BUILT AND HOW IT WILL BE MANAGED – INCLUDING:

- The future size of the system;
- The future composition of the system;
- Changes in the management of the system;
- Key economic and fiscal levers.

Models can generate a range of scenarios by altering inputs and assumptions. The difficulty is that energy and infrastructure planning today must occur in the absence of full certainty, with developments in technology or unforeseen events threatening to upend the most rational assumptions about the future.

Some of the variables affecting a 2050 vision for electricity are external factors that cannot be predicted clearly today and depend on a combination of technology advances, policy support and consumer response to price signals. These variables affect how our future electricity system will be managed and designed. Fundamental change in each might well impact significantly on the system as a whole. Nevertheless, there are prudent steps policy makers can take because other variables are more controllable and present real dilemmas and choices.

Between the variables that are within the scope and control of the electricity sector, Canadians will need to make some important decisions in the near future.

For other variables, important choices will need to be distinguished from less important choices – at least from the standpoint of a visioning effort for electricity in Canada and what needs to be decided or resolved over the next five to 10 years.

Key Variables in the Size of the System

Some of the key variables that could alter the total size of electricity supply and demand in Canada are as follows:

- **Population and GDP.** If the population and economy were to grow much slower or faster than expected, energy demand would be altered accordingly.
- **Energy efficiency and demand management.** More aggressive energy efficiency and demand management programs (e.g., with wider price elasticity to drive customer behavior) could slow growth in total electricity demand, or in theory even reduce total electricity demand relative to current levels.
- **Electric vehicles.** The NEB assumes a relatively slow development for electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs). They forecast that by 2035, EVs and PHEVs will meet only 0.5 per cent of total passenger transportation

demand, roughly equivalent to 700,000 EVs and PHEVs on the road.²⁷ If the NEB forecast turns out to be conservative, however, and electric vehicles provide as much as 10 per cent of passenger transportation demand by 2035, then electricity demand would see a significant corresponding increase across the country.

- **Electricity for export.** The electricity industry could decide to reduce or expand total generation capacity in response to U.S. demand. In 2012, Canada exported (on a net basis) 47 TWh of some 595 TWh in total generation or roughly 7.8 per cent of its total electricity generation.²⁸ The integrated North American grid allows both countries to take advantage of the diversity of supply. On both sides of the border, sustainable Canadian electricity is poised to remain an appealing option for governments seeking to transition towards a low-carbon economy.

Key Variables in the Composition of the System

The Canadian electricity system is in need of massive infrastructure renewal. The Conference Board of Canada estimates that by 2030, close to \$350 billion in new investment will be required just to maintain existing electricity capacity, with most of Canada's non-hydro assets needing renewal or replacement by 2050.²⁹

Public understanding, support and input will be required for such an enormous scale of investment to move forward. Also, utilities will need to consult with and engage Aboriginal communities as integral partners in the development and execution of many electricity projects across Canada, including Aboriginal communities in remote and Northern locations.

And as we have seen from the slow pace of replacement of electricity assets, new infrastructure introduced in the next several years will be with us in 2050. This underlines the need for forward planning and making wise choices. The assets we build must be highly reliable, safe, secure (including from cyber

Working with Canada's Aboriginal Peoples and Communities

As Canada's electricity industry looks to the future, it is fully aware of the need to respect the rights of Aboriginal Peoples and communities. Canada's energy future will, in part, be defined by our ability to incorporate the economic, environmental, social and cultural interests of Aboriginal Peoples in the development of our renewable and non-renewable energy resources. Beyond the legal responsibility to respect Aboriginal rights and title, the electricity sector is committed to exploring mechanisms for resource revenue sharing; increasing employment, contracting and procurement opportunities; supporting education and training; and developing formal partnerships with Aboriginal Peoples on electrification.

threats), and resilient in the face of growing risks from a changing climate and intensifying storm patterns.

There are three types of electricity generation that could significantly alter the total composition of the electricity mix – nuclear, fossil fuels and renewables. Understanding the contribution of these three will provide perspective on the parameters and boundaries for Canada's electricity system and how it may evolve.

Nuclear

The provinces of Ontario and New Brunswick will either renew nuclear generation when the current assets reach their end of life, or replace them with other forms of generation. Nuclear power provides more than 50 per cent of the power in Ontario,³⁰ and about 30 per cent of the power in New Brunswick,³¹ so the impact

27 "Canada's Energy Future", p. 14.

28 "Electricity Exports and Imports," *National Energy Board*, accessed February 10, 2014, <http://www.neb-one.gc.ca/cf-nsi/rnrgynfmtn/sttstc/lctrcyxpmtprt/lctrcyxpmtprt-eng.html#s2012>.

29 More precisely, "[i]nvestment in electricity infrastructure in Canada from 2011 to 2030 will total an estimated \$347.5 billion, in current dollars," see "Shedding Light on the Economic Impact of Investing in Electricity Infrastructure," *Conference Board of Canada*, 2012. p. 1, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=4673>.

30 In 2012, nuclear generation provided 56.4% of the electricity output in Ontario. See "Supply Overview (2012)," *IESO*, accessed February 10, 2014, <http://www.ieso.ca/Pages/Power-Data/Supply.aspx>.

31 See "New Brunswick Power Nuclear Corporation," *CANDU Owners Group Inc.*, accessed February 10, 2014, <http://www.candu.org/nbpower.html>.



Photo: courtesy of Ontario Power Generation Inc.

of renewal or replacement is significant. Aside from Ontario and New Brunswick, Saskatchewan is the only province that may add a nuclear power plant to their generation fleet at some point after 2020.

The nuclear debate typically centers on four issues: safety, waste, economics, and carbon. Of these, economics and carbon are likely to sway policy decisions more than safety and waste in the next five to 10 years.

- **Safety.** After the Fukushima Daiichi nuclear crisis, public trust in nuclear power plants and related institutions declined significantly – not just in Japan, but also in other parts of the world.³² But some of the strongest proponents of nuclear in Canada are located in communities close to the plants. Such proponents point out that Canada’s circumstances are completely different from those that led to the catastrophe in Japan. Given that existing host communities for nuclear remain supportive, it is unclear whether Fukushima will have any more of a long-term impact on the policy debate in Canada than did Three Mile Island and Chernobyl.
- **Waste.** With regard to high-level radioactive waste storage, Canada has developed a policy

framework for resolving the issue, but has yet to select a location for a permanent repository. However, in the context of choices in the next decade, the waste issue is of lesser importance. The sum of all accumulated high-level nuclear waste in Canada would still only fill the equivalent of six hockey rinks to the height of the boards.³³ In the meantime, the waste can be safely stored in pools in existing facilities, and the Nuclear Waste Management Organization will slowly advance the permanent repository discussion and site selection through its own process, with the possibility of permanent storage starting in 2035 or so.³⁴ The waste issue is not likely to determine whether additional nuclear generation will be built between now and 2050.

- **Economics.** The central economic question facing Canada’s existing nuclear plants – whether to refurbish or replace a plant – can quickly become a highly technical exercise. In the simplest terms, however, the stakes are clear: will refurbishment and/or new build be costlier or cheaper than replacing those assets with other forms of electricity generation, both in capital costs and in operating costs? In New Brunswick, the Energy and Utilities Board has

32 See e.g., “2012 Edelman Trust Barometer: Executive Summary,” *Edelman*, 2013, p. 5, <http://www.edelman.com/insights/intellectual-property/2012-edelman-trust-barometer/about-trust/executive-summary/>.

33 John Spears, “Nuclear waste seeks a home,” *The Star*, September 1, 2012, accessed February 10, 2014, http://www.thestar.com/business/2012/09/01/nuclear_waste_seeks_a_home.html.

34 “... [T]he [Nuclear Waste Management Organization] hopes to have narrowed the field to one or two communities by 2015, then spend until about 2020 deciding on a specific site ... After that, it will take three to five years to do an extensive environmental assessment of the site. The proponents will also have to satisfy the Canadian Nuclear Safety Commission ... and obtain a license to construct and operate the facility. Then, it will take six to 10 years to build. The NWMO doesn’t expect the first bundles to be stored until 2035;” John Spears, “Nuclear waste seeks a home,” *The Star*, September 1, 2012, accessed February 10, 2014, http://www.thestar.com/business/2012/09/01/nuclear_waste_seeks_a_home.html.

THERE ARE THREE TYPES OF ELECTRICITY GENERATION THAT COULD SIGNIFICANTLY ALTER THE TOTAL COMPOSITION OF THE ELECTRICITY MIX – NUCLEAR, FOSSIL FUELS AND RENEWABLES

already approved NB Power's plan for the newly refurbished Point Lepreau Nuclear Plant to operate for another 27 years, although not without some controversy about the viability of the plan.³⁵ In Ontario, meanwhile, the Pickering, Bruce and Darlington nuclear facilities all have reactors coming offline in the next decade, with various plans for potential refurbishment; however, the province recently abandoned proposed plans to build two new nuclear reactors in the near future. The province of Ontario's Long Term Energy Plan has indicated that nuclear will continue to form the bulk of electricity generation going forward. It has deferred any construction of new facilities but has approved refurbishment of units at Bruce and Darlington, beginning with one unit each. Further refurbishment will depend on the ability to control costs and respect timelines. The province has also said it is considering an earlier shutdown of Pickering than is currently planned. Also, as mentioned earlier, the province of Saskatchewan is considering nuclear as an option for the future. Finally, a new factor playing into the economic debate is whether small modular reactors – several units of several hundred MW each – will be able to achieve the required economy of scale and reduce the nuclear capital cost.³⁶

- **Carbon.** The economic debate for nuclear is tied to the carbon debate. If Canada decides to regulate carbon through taxation or a cap-and-trade scheme, emitting gas and coal resources will become comparatively more expensive, and

the nuclear option will appear correspondingly more favorable at least on this axis of comparison. It could also entail export opportunities to the U.S.; the U.S. nuclear fleet will start ramping down in the 2030s if it is not replaced. From another perspective, provinces that make plans to remove nuclear from their mix over time will need to show Canadians the carbon impact of their decisions. For Ontario, nuclear provides 50 per cent of electricity (and is forecast to drop only slightly to 47 per cent), so the loss of this resource would easily run the risk of increased carbon emissions.

While safety and waste issues are enduring features of the nuclear debate, the economic and carbon aspects of nuclear policy decisions may have more immediate importance in planning the future. In practical terms: New Brunswick and Ontario will need to show how refurbishing, building or retiring nuclear will variously impact on costs in their electricity system, the stability of the grid, emissions in each province, and trading opportunities through the interties.

Fossil Fuels

Fossil fuels will continue to make up a portion of our electricity mix – even in lower-carbon scenarios for 2050. It is important that we consider some of the significant factors affecting their use.

Natural Gas

Fluctuations in gas price could also lead to boom cycles, with rapid expansion in gas infrastructure, followed by bust cycles, in which some of these new plants shut down as the price drops again.³⁷ Averaged over time, however, it is a reasonable assumption that gas will increase as a share of overall supply to replace some coal and in response to the shale gas boom. The degree to which gas gains market share, however, will partly depend on the extent to which government looks to champion its production ahead of other resources.

The first question for gas is: what role should it play in any future energy mix? Since gas emits roughly

35 See e.g., "Refurbished Point Lepreau operating at 35% capacity," *CBC News*, March 18, 2013, accessed February 10, 2014, <http://www.cbc.ca/news/canada/new-brunswick/story/2013/03/18/nb-lepreau-refuel-capacity.html>.

36 See e.g., "AECL Nuclear Review: Special Issue on Small Reactors," *AECL*, Volume 1, No. 2, December 2012: http://www.aecl.ca/site/media/Parent/ANR_1-2_ENG.pdf.

37 For a related discussion see Andrew N. Liveris, "Wanted: A Balanced Approach to Shale Gas Exports," *The Wall Street Journal*, February 24, 2013, accessed February 10, 2014, <http://online.wsj.com/article/SB10001424127887323495104578312612226007382.html>.

half the greenhouse gases of coal, gas industry advocates – particularly in the U.S. context – call for the use of gas as a bridging resource away from coal and towards renewables at some theoretical point in the more distant future. In the Canadian context, the Conference Board of Canada forecasts that gas could “contribute a cumulative \$940 billion [in 2012 dollars] to the country’s economy between 2012 and 2035.”³⁸

Yet critics caution that once additional gas infrastructure is built, it will be difficult to walk away from this infrastructure.³⁹ One way to focus this conversation is to ask: if gas is a bridge, for how many years, and what is on the other side?

The shale gas discovery in North America has added a new wrinkle to this debate. As energy expert Daniel Yergin argues: “Owing to the scale and impact of shale gas and tight oil, it is appropriate to describe their development as the most important energy innovation so far of the 21st century.”⁴⁰ Canada will need to make several choices around shale gas, and the central question reflects the broader ‘bridge’ debate: will Canada be supportive of the industry’s development, as is largely the case in the United States, or more resistant to site development and extraction, as in many parts of Europe?

As with specialized efforts to promote renewables, Canadian policy makers need to be clear about why they may choose to develop shale gas. For instance, if shale gas could replace a significant amount of coal in Canada, this shift in the electricity system could be beneficial from a carbon and emissions perspective. But if shale gas is likely only to replace coal at the margins, then what is the argument for working hard and allocating scarce dollars to develop the resource ahead of other options? Every dollar spent is also an opportunity cost.

A key uncertainty around natural gas, moreover, including shale gas, is the question of price. While shale seems inexpensive today, it is unclear whether

potential water shortages present a constraint on future output as the current technology uses very large amounts of water. Concerns have also been advanced about the productivity of fracked wells over time.⁴¹ Conversely, government policies towards shale gas production, both in Canada and the United States, will also impact on gas supply and prices in Canada. Observers tend to extrapolate forward from the current gas price, but gas prices have always proven volatile, and the gas industry has seen a number of boom and bust cycles.

Coal

Under most scenarios, coal plants will reduce their share of the overall generation mix in the decades to come, either to be replaced with gas plants or other forms of generation such as renewables. The future of coal in Canada is being shaped above all by environmental considerations.

Ontario has said it will accelerate the shutdown of all coal plants in 2014 and has introduced legislation to prohibit any future start up. For remaining coal plants, notably in Alberta and Saskatchewan, a key question is whether they will be fitted with carbon capture and storage (CCS) in response to policy measures and economic incentives.



Photo: courtesy of SaskPower

38 “The Role of Natural Gas in Powering Canada’s Economy,” *Conference Board of Canada*, December, 2012, p. iii, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=5251>.

39 As the (former) National Roundtable on the Environment and the Economy argues, for instance: “the existence of natural gas infrastructure paves the way for continued use of natural gas for space and water heating, despite the option to replace this equipment with new zero-emission technology prior to the end of a building shell’s lifespan;” see “Framing the Future: Embracing the Low Carbon Economy,” *National Roundtable on the Environment and the Economy*, 2012, p. 64: <http://collectionsCanada.gc.ca/webarchives2/20130322140948/http://nrtee-trnee.ca/>.

40 In his testimony before the House Energy and Commerce Committee, Yergin goes on to qualify his comment: “That is said with recognition of the major technological advances in wind and solar since 2000; but, as is described in [my book] *The Quest*, those advances are part of the ‘rebirth of renewables.’ As actual innovations, solar and wind emerged in the 1970s and 1980s;” *Dr. Daniel Yergin, Subcommittee on Energy and Power of the House Energy and Commerce Committee, Testimony submitted for Hearings on ‘America’s Energy Security and Innovation,’* p.2., February 5, 2013: <http://democrats.energycommerce.house.gov/sites/default/files/documents/Testimony-Yergin-EP-Energy-Security-2013-2-5.pdf>.

41 See e.g., Bill Chameides, “Shale Gas and Tight Oil: Boom? Bust? Or Just a Petering Out?” *Huffington Post*, February 27, 2013, accessed February 10, 2014, http://www.huffingtonpost.com/bill-chameides/shale-gas-and-tight-oil_b_2773893.html.



Photo: courtesy of Nova Scotia Power Inc.

In 2012, the federal government of Canada promulgated a new regulation for coal that sets a “stringent performance standard” for CO₂ emissions for new coal plants and those at their end of life.⁴² Beginning in 2015, the standard will require that 50-year old coal plants only be allowed to continue – and new plants only be permitted to go ahead – if they emit no more than 420 tonnes of carbon dioxide per gigawatt hour (CO₂/GWh)⁴³ – a rate that is achievable by new baseload natural gas combined cycle technologies available today.⁴⁴ The stated objective of the regulation is to “implement a permanent shift to lower- or non-emitting types of generation, such as high-efficiency natural gas, renewable energy, or fossil fuel-fired power with carbon capture and storage (CCS).”⁴⁵ In response to the regulation, utilities in Alberta, Saskatchewan and Nova Scotia will need to decide whether to: shut down some coal plants; replace coal plants with other technologies; or install CCS technologies. The Boundary Dam 3 coal plant in Saskatchewan will be an important test for

the viability of commercially operating CCS plants in Canada. The project is expected in commercial service in 2014, “and will feature the world’s first commercial-scale, fully-integrated carbon capture and storage system.”⁴⁶ It could set the stage for others to follow.

While the drivers are environmental, Canadian provinces need to consider economic and operational issues as well. The coal debate ought to focus on the feasibility of efficiency improvements, replacement generation and/or CCS within the projected lifespan of each asset. Some reductions in coal emissions will prove to be more easily achievable than others.

Renewables

While renewable generation is set to continue to grow, it is unclear whether its pace of growth will accelerate – as could occur with breakthroughs in energy storage – or remain relatively modest. Groups like World Wildlife Fund International, the Trottier Energy Futures Project, and Clean Energy Canada at Tides Canada envision potential for Canada’s electricity system to be, as Tides Canada puts it, “overwhelmingly” powered in 2050 by “clean and renewable sources—wind, solar, water, biomass, and geothermal resources—instead of fossil fuels.”⁴⁷ Yet these scenarios typically require significant reductions in overall demand in order for the system to achieve this outcome. For example, a recent discussion paper by the Trottier Energy Futures Project projects potential for final energy demand at a level “55 percent below the reference or ‘business-as-usual’ case, due to energy efficiency improvements across all end uses and sectors.”⁴⁸ Renewable sources of energy – not only hydro but also wind, solar, biomass, etc. – hold intuitive appeal for many Canadians, and have become a major driver of change in the industry.

42 See “Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations (SOR/2012-167),” *Environment Canada*: <http://ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=209>.

43 *Ibid.*

44 See P.J. Partington, Matt Horne and Tim Weis, “Pembina Institute Comments on Canada’s Proposed Reduction of Carbon Dioxide from Coal-fired Generation of Electricity Regulations,” *Pembina Institute*, October, 2011, <http://pubs.pembina.org/reports/coal-reg-submission-comments.pdf>. An earlier proposed version of the regulation may have called for a slightly more stringent emissions standard of 375 tonnes/GWh; see *Shedding Light*, p. 2, footnote 2.

45 *Ibid.*

46 “The Integrated Electric Grid: Maximizing Benefits in an Evolving Energy Landscape,” *Canadian Electricity Association*, p. 14: http://www.electricity.ca/media/pdfs/CanadaUS/CEA_US%20Policy%20Paper_EN.pdf.

47 “A New Energy Vision for Canada,” *Tides Canada*, 2012, p. 19: <http://tidescanada.org/energy/newenergy/>.

48 See “Low Carbon Energy Futures: A Review of National Scenarios,” *Trottier Energy Futures Project*, January 2013, p. 16, <http://www.trottierenergyfutures.ca/wp-content/uploads/2013/01/Low-Carbon-Energy-Futures.pdf>. Or as the WWF projects: “In 2050, energy demand is 15 per cent lower than in 2005. Although population, industrial output, passenger travel and freight transport continue to rise as predicted, ambitious energy-saving measures allow us to do more with less;” see “The Energy Report: 100% Renewable Energy by 2050,” WWF, Report 2011 p. 24, http://www.wwf.ca/conservation/global_warming/energy_report.cfm.

As indicated earlier, recent analyses by the Trottier Energy Futures Project and other organizations envision scenarios for Canada in which “renewable electricity technologies dominate electricity supply by 2050.”⁴⁹

But renewables also raise their own challenging set of policy questions. For starters: should Canada decide to champion the development of renewable energy? If so, then what is the policy rationale for doing so? While carbon mitigation is often provided as a key reason, the development of renewable energy is not always the most economic or sustainable way of attempting to reduce carbon in an electricity system. Germany, one of the world’s leading jurisdictions in promoting renewable energy, has recently brought new coal units into service, with more being built, and now needs to import some coal-based electricity from the Netherlands.⁵⁰ The circumstances behind Germany’s situation are complex, but we should not assume that support for renewable energy will always translate into the most economic carbon reductions.⁵¹

Second, if the goal is to accelerate dramatically the diffusion and development of the sector, are we willing to spend large sums of money to do so, and if so, to what extent over the incremental investments required? Accelerated renewable energy development will require substantial investment. In some jurisdictions, for example Spain, aggressive feed-in-tariffs have had to be rolled back because of their impacts on electricity rates.⁵² The question to ask Canadian ratepayers is not whether they are in favour of wind or solar energy per se; the more difficult but pertinent question to ask is how much additional money they are willing to spend each month on their electricity bill (or through some other financing vehicle like taxation) in support of faster wind or solar development than would otherwise occur. That question has become increasingly politicized as provincial utilities seek

rate increases that are, in part, being raised to pay for new investments in the renewable energy sector. Consumer and industrial user pressure have combined to increase the “political risk” of approving rate increases to pay for wind and solar expansion.

Third, many forms of renewable energy are diffuse and decentralized.⁵³ Are we ready to permit new hydro and wind sites in our own backyards, among others, or will we support renewable energy in principle but not so much in practice? Many people in cities would prefer that wind farms be set up in the countryside, while farmers often look on wind equipment as an industrial piece of machinery. Siting decisions and revenue sharing among neighbours have become quite controversial in some areas of Ontario. Just as importantly, renewable energy often encounters bottlenecks with transmission. Are we ready to allow (and pay for) additional forms of enabling transmission to access new sources of renewable energy, and to carry them across long distances to population centers?

MAJOR TECHNOLOGICAL ADVANCES AMONG THE MANY FORMS OF ELECTRICITY STORAGE NOW BEING DEVELOPED WOULD SIGNIFICANTLY STRENGTHEN THE ROLE OF RENEWABLES IN CONTRIBUTING TO A RELIABLE ELECTRICITY SYSTEM

49 Trottier, p. viii. Also see “A New Energy Vision for Canada,” *Tides Canada*, 2012, <http://tidescanada.org/energy/newenergy/>.

50 See e.g., Stefan Nicola, “Germany to Add Most Coal-Fired Plants in Two Decades, IWR Says,” *Bloomberg*, February 27, 2013, accessed February 10, 2014, <http://www.bloomberg.com/news/2013-02-27/germany-to-add-most-coal-fired-plants-in-two-decades-iwr-says.html>.

51 For an extended argument on the importance of the distinction between reducing emissions and promoting renewable energy, see Mark Jaccard, “Sustainable Fossil Fuels: The Unusual Suspect on the Quest for Clean and Enduring Energy” (Cambridge University Press, 2005).

52 “The cost del sol: Sustainable energy meets unsustainable costs,” *The Economist*, July 20, 2013, accessed February 10, 2014, <http://www.economist.com/news/business/21582018-sustainable-energy-meets-unsustainable-costs-cost-del-sol>.

53 Renewable energy is often perceived as having a much larger footprint than traditional sources of energy, but Amory Lovins offers an interesting refutation of this view – see Amory Lovins, “Renewable energy’s footprint myth,” preprint of an article for *The Electricity Journal*, April 6, 2011: http://www.rmi.org/Knowledge-Center/Library/2011-07_RenewableEnergysFootprintMyth.

THE QUESTION TO ASK CANADIAN RATEPAYERS IS NOT WHETHER THEY ARE IN FAVOUR OF WIND OR SOLAR ENERGY PER SE; THE MORE DIFFICULT BUT PERTINENT QUESTION TO ASK IS HOW MUCH ADDITIONAL MONEY THEY ARE WILLING TO SPEND EACH MONTH

Finally, there is the important and exciting question of innovation in electricity storage. Already in Canada large storage hydroelectric plays an important role in balancing supply and demand. Major technological advances among the many forms of electricity storage now being developed would significantly strengthen the role of renewables in contributing to a reliable electricity system.⁵⁴

Prudent planning would suggest that policy makers monitor these generation variables carefully and adjust the base-case scenario iteratively. Generation variables represent a risk of significant change in the overall generation mix, with follow-on consequences for major decisions on investments in new assets or those slated for refurbishment.

Key Variables Affecting the Management of the System

The following variables affect how our future electricity system will be managed and designed:

- Energy efficiency and demand management;
- Electric vehicles (EVs);
- Consumer management of energy;

- Grid modernization (Smart Grid);
- Human resources.

Fundamental change in each might well impact significantly on the system as a whole.

Energy Efficiency and Demand Management

Effective energy efficiency and demand management programs can result in avoided generation – so-called ‘negawatts’ to replace ‘megawatts,’ – to coin a memorable phrase from futurist Amory Lovins.⁵⁵

Perhaps one important lesson from collective global experience is that programs that only seek to share information and raise awareness among customers have a negligible impact. When various forecasts model significant potential for energy efficiency and reduction in demand peaks, Canadians will need to ask whether the policy measures intended to enable these gains are likely to achieve their predicted effects. Jurisdictions that are overly optimistic on reductions that fail to materialize may find themselves scrambling to build power plants (often gas plants) ad hoc to fill the supply gap.

To achieve major gains in efficiency, electricity customers must be motivated through the carrot and stick of pricing incentives and disincentives. There is some evidence that Japan's efficiency measures after the 1970s oil crisis, and again after Fukushima, have resulted in significant efficiency savings. In the United States, California and Vermont have both claimed some success through their energy efficiency and demand management programs.

In Canada, meanwhile, there are significant energy efficiency opportunities “despite years of efforts,” particularly in the building sector.⁵⁶ Changes to building codes and standards for appliances represent an easy way to achieve significant gains in efficiency and demand management when multiplied by buildings and customers across the country.

54 For a useful discussion of electricity storage technologies, see: http://www.electricitystorage.org/technology/tech_archive/technology_comparisons. Also see: <http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/in-eastern-ontario-a-battery-five-times-the-size-of-niagara-falls/article8820070/>. (All accessed February 10, 2014)

55 See e.g., Amory Lovins, “The Negawatt Revolution: Solving the CO₂ Problem,” *Keynote Address, Green Energy Conference, Montreal*, 1989, accessed February 10, 2014, <http://www.ccnr.org/amory.html>.

56 As participants at one National Round Table on the Environment and the Economy pointed out, “[l]ess than 1% of new commercial buildings are LEED or BOMA Best certified; [t]he National Energy Code of Canada for Buildings requires a maximum energy usage of 38 kWh/ft²/year, while participants suggested Canada could easily achieve 20 kWh/ft²/year; [g]round-source heat pump (GSHP) technology is highly underused; and [p]hantom load was estimated as representing between 12 and 15% of electricity costs;” “Framing the Future,” p. 121.

Electric Vehicles (EVs)

The internal combustion engine has an energy conversion efficiency of around 30 per cent (from the chemical energy in gasoline to the kinetic energy of driving), while electric motors have a conversion efficiency of around 80 to 85 per cent.⁵⁷ So why have electric vehicles, along with other “new energy” vehicles, not already become the norm?

Part of the answer is that electric vehicles have failed to meet all customer expectations regarding cost, battery power (range anxiety), and ease of infrastructure (recharging stations). In addition, a variety of power trains are still in contention, so customers are uncertain about which one to adopt. In 2009, on the foundation of billions of dollars in subsidies and attractive purchasing incentives, China set a target of 500,000 “new-energy” vehicles (EVs, hybrids and others) by 2011 – but only achieved a volume of 15,000, including 10,000 EVs.⁵⁸ As Gordon Orr of the consultancy McKinsey comments, “to date in China, as elsewhere in the world, customers have largely rejected EVs.”⁵⁹ Even Israel, often seen as a model jurisdiction for electric vehicles – it is a small land mass allowing for easier infrastructure, and does not want to rely on gasoline imports – has seen significant setbacks, including the bankruptcy of its most prominent private sector electric battery proponent, Project Better Place.⁶⁰

Yet these setbacks may all appear as growing pains a decade from now, as the case for EVs remains strong – and is growing stronger. First, electric vehicles can already provide savings for customers relative to internal combustion engines on a lifecycle basis.⁶¹ Second, even using technologies available today – the current generation of



Photo: courtesy of Toronto Hydro Corporation

electric car technology and coal plants operating today – an electric car powered by coal may still have a lower emission ratio (CO₂ per km) than a standard combustion engine (cleaner sources of electricity yield bigger advantages).⁶² Third, emerging economies like China still have a “pressing” need for electric vehicles to help alleviate acute air pollution, and we may see a “second wave” for EVs in these economies in another several years.⁶³ If China alone continues to make major efforts to scale electric vehicles, their costs globally will likely decline. As technology improves for electric cars, batteries improve, and operating costs decline, more customers are likely to migrate to electric vehicles, driving costs down further again. So the medium term trend is promising.

- 57 See e.g., U.S. government’s fuel economy discussion at: <http://www.fueleconomy.gov/feg/atv.shtml>; also see Tesla Motors discussion, “Using Energy Efficiently,” <http://www.teslamotors.com/goelectric/efficiency>; also see Amy Raskin and Saurin Shah, “The Emergence of Hybrid Vehicles: Ending Oil’s Stranglehold on Transportation and the Economy,” *Alliance Bernstein*, June 2006, <http://www.calcars.org/alliance-bernstein-hybrids-june06.pdf>, p. 14. (All accessed February 10, 2014).
- 58 “Although China has not made quite the leap I predicted in electric cars, its commitment to developing the world’s leading electric-vehicle (EV) industry has been substantial. That commitment includes billions of dollars in subsidies and huge incentives for potential buyers, as well as directives to government purchasers to buy electric. ... There will be a second wave for EVs in China, but probably not on a major scale until after 2017,” see Gordon Orr, “Forecasting China,” *McKinsey Quarterly*, July 2013, http://www.mckinsey.com/insights/asia-pacific/forecasting_china?cid=china-eml-alt-mip-mck-oth-1307.
- 59 Orr, *ibid*.
- 60 Isabel Kershner, “Israeli Venture Meant to Serve Electric Cars Is Ending Its Run,” *New York Times*, May 26, 2013, accessed February 10, 2014, http://www.nytimes.com/2013/05/27/business/global/israeli-electric-car-company-files-for-liquidation.html?_r=0.
- 61 “Update of Life Cycle Costs for Hybrid and Plug-In Hybrid Electric Vehicles,” *Electric Power Research Institute*, December 2005, <http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000001010202>.
- 62 In one recent study, for example, emissions for an electric vehicle in coal-heavy China average 258g CO₂e/km, while “the average American gasoline vehicle” had emissions averaging 300g CO₂e/km;” see Lindsay Wilson, “Debunking the ‘Electric Cars Aren’t Green’ Myth,” *The Energy Collective*, June 7, 2013, accessed February 10, 2014, <http://theenergycollective.com/lindsay-wilson/234736/electric-cars-aren-t-green-myth-debunked>.
- 63 As Gordon Orr comments: “Although China has not made quite the leap I predicted in electric cars, its commitment to developing the world’s leading electric-vehicle (EV) industry has been substantial. That commitment includes billions of dollars in subsidies and huge incentives for potential buyers, as well as directives to government purchasers to buy electric. ... There will be a second wave for EVs in China, but probably not on a major scale until after 2017;” “Forecasting China,” *McKinsey Quarterly*, July 2013, http://www.mckinsey.com/insights/asia-pacific/forecasting_china?cid=china-eml-alt-mip-mck-oth-1307.



Photo: courtesy of Newfoundland Power Inc.

SETBACKS MAY ALL APPEAR AS GROWING PAINS A DECADE FROM NOW, AS THE CASE FOR ELECTRIC VEHICLES REMAINS STRONG – AND IS GROWING STRONGER

Even so, Canada faces three key questions around electric cars. First, Canada has low population density. With vast spaces separating major cities, and if even a country as small as Israel has had challenges, getting the infrastructure right will be critical. So what questions can be learned around infrastructure from the Canadian experience to date, and from emerging efforts in other jurisdictions? Cooperation with the United States would likely help EV prospects in Canada, as a seamless

North American approach to electric vehicle infrastructure would make EVs more attractive to Canadians, and likely bring economies of scale as well.⁶⁴

Second, will incumbent service providers (e.g., existing gasoline sellers) put up a fight if electric cars threaten to scale too quickly or too much? Third, what kind of potential impact will electric cars have – at various levels of market penetration and use – on the total electricity demand/supply mix? If Canada would like to see more than 700,000 EVs on the road by 2035, it will need to address these issues.

Consumer Management of Energy

Customers are increasingly looking for ways to manage their own energy:

- To choose the type of energy from which they obtain electricity.
- To act as both suppliers and customers (i.e., two-way flow of electrons).
- To customize how they use energy.

⁶⁴ For an interesting discussion of policy options to support EV infrastructure in the European context, see "Market Models for the Roll-Out of Electric Vehicle Public Charging Infrastructure," *Eurelectric (Concept Paper)*, September 2010, http://www.eurelectric.org/media/45284/2010-09-21_market_model_final_for_membernet-2010-030-0808-01-e.pdf.

Though the trend is at an early stage, there are a number of telling illustrations from different jurisdictions:

- The city of Boulder, Colorado, voted in 2011 to disconnect from Xcel Energy and form its own municipal utility out of dissatisfaction with the slow pace at which Xcel was introducing renewables and reducing greenhouse gas emissions.⁶⁵
- In 1996, the politicians of Växjö, Sweden passed a unanimous vote “to free the city from fossil fuels” and to draw power from a biomass district heating network instead.⁶⁶
- The city of Delft in the Netherlands uses a heating network from waste heat, “instead of letting it go to waste,” with plans to expand the network from geothermal energy. As the deputy mayor explains, “we generate more and more of our own energy locally.”⁶⁷
- In Eastern Canada, PowerShift Atlantic, a collaborative research project involving NB Power and several other utilities, several governments, and the New Brunswick System Operator, uses electric thermal storage units for home heating to create a virtual power plant to accommodate variability in wind generation.⁶⁸
- The trend is likely to gain in strength with each subsequent generation. Baby Boomers had to learn how to program their microwave ovens as their world evolved from analog to digital. In contrast, an eighteen year old today has never known life without the Internet and her social life constantly involves leveraging software to interact with virtual people and systems. She readily associates technology with multiple forms of interaction and choice – but she also expects it to be intuitive and seamless. While it may have been premature to imagine Baby Boomers embracing complex forms of electricity demand

CUSTOMERS WANT TO HAVE MORE OF A ROLE NOT ONLY IN CONTROLLING THEIR DEMAND, BUT ALSO IN CONTRIBUTING THEIR OWN SUPPLY TO THE GRID

management through differentiated prices and electricity storage options, some forms of customization of energy use fall much more easily within the worldview and expectations of 20-somethings today.⁶⁹ If energy efficiency options can be easily managed through intuitive apps, and they involve real cost savings, there is no barrier in principle to young people exercising those options.

Lastly, increasing consumer management of energy will reinforce distributed (or localized or micro) generation, and vice-versa. On one hand, customers want to have more of a role not only in controlling their demand, but also in contributing their own supply to the grid. On the other hand, redoubled efforts to understand “local resources and energy flows” (e.g., waste heat, water resources, geothermal, etc.) may in turn encourage more customization and democratization efforts as micro-generators develop supplies outside traditional utility models. Some perspective, however: even if a shift to localized generation gains momentum, and the two-way flow of electrons increases, the electricity system will predominantly remain powered by large centralized power stations in 2050.

65 Dan Frosch, “Colorado: Boulder Votes to Remove Power Company,” *The New York Times*, November 2, 2011, accessed February 10, 2014, http://www.nytimes.com/2011/11/03/us/colorado-boulder-votes-to-remove-power-company.html?_r=0.

66 “An energy transition for our citizens,” *Energy Cities*, April 25, 2013, accessed February 10, 2014, http://www.energy-cities.eu/IMG/pdf/CALL_VAXJO_EN-2.pdf.

67 *Ibid.*

68 “The project will run until 2014, piloting technology that shifts energy supply to specific appliances in homes and commercial buildings to optimize wind generation with minimal or no disruption to participating electric utility customers:” see “PowerShift Atlantic and NB Power win national wind energy award,” *NB Power* (News release, Government of New Brunswick website), October 17, 2012, accessed February 10, 2014, http://www2.gnb.ca/content/gnb/en/news/news_release.2012.10.0967.html.

69 For an interesting report focused on how banks can appeal to this young and “tech savvy” demographic, see David Levi, “The Art of Capturing Young, Tech-Savvy Customers,” *Accenture*, 2012: <http://www.accenture.com/SiteCollectionDocuments/cn-zh/Research%20and%20Insights/accenture-young-tech-savvy-final.pdf>.



Photo: courtesy of Brookfield Renewable Energy Group

GRID MODERNIZATION IS NOT AN END IN ITSELF, RATHER, IT IS AN ENABLER OF OTHER INNOVATIONS AND ADVANCES

Nonetheless, the customization driver is disruptive and radical in that it redefines the most fundamental precepts of the current electricity system – the large local utility, the grid, and the customer – by blurring traditional distinctions among all three.

Grid Modernization (Smart Grid)

The notion of a redefined and reconfigured grid connects to another variable, the so-called ‘smart grid.’ The term has received a lot of buzz, some of it confusing, and has been associated with many concepts and applications, so the Canadian Electricity Association prefers and encourages use of the term ‘grid modernization’.

CEA defines grid modernization as “the addition of two-way communications, control and automation capabilities to the existing power grid to make it more reliable, flexible, efficient, clean, safe and customer-friendly.”⁷⁰

A modernized grid has five capabilities:

- Demand response;
- Facilitation of distributed generation;
- Facilitation of electric vehicles;
- Optimization of asset use;
- Problem detection and mitigation.⁷¹

The crucial point to understand from these applications is that grid modernization is not an end in itself. Rather, it is an enabler of other innovations and advances. Its value and potential arise from how it is used to support other electricity-related goals and how it shifts the management of the overall electricity system.

In the context of a vision for the future, grid modernization can support all of these other variables affecting our future system:

- Renewables integration and storage;
- Electric vehicles;
- Energy efficiency and demand response;
- Customization and democratization of energy.

With appropriate investment and planning, many of these variables will be able to interact seamlessly with one another. For example, an ordinary Canadian family could plug in their electric car to the grid to charge overnight (a time of reduced overall demand), and then during the day, deliver solar power back to the grid (customization). The utility company could even potentially access the power available in their idle electric car (if the customer grants this option in advance) to meet peak demand under certain conditions, so that the vehicle also acts as a form of electricity storage. Together these represent a completely different way to think about electricity flows.

Grid modernization is already underway in Canada in interesting ways, as with the PowerShift Atlantic example mentioned earlier, smart meters in British Columbia and Ontario, and other initiatives.

70 “Smart Grid,” *Canadian Electricity Association*, <http://www.electricity.ca/resources/smart-grid.php>.

71 “The Smart Grid: A Pragmatic Approach,” *Canadian Electricity Association*, 2011, <http://www.electricity.ca/media/SmartGrid/SmartGridpaperEN.pdf>.

MILLIONS OF CANADIAN HOMES COULD BE LOAD CENTERS, PEAK SHAVERS AND MICRO-GENERATION UTILITIES

As the grid modernizes further, millions of Canadian homes could be load centers, peak shavers and micro-generation utilities – one, two or all three according to their particular preferences and arrangements. With greater integration of renewables and forms of storage, the electricity system should become less of a peaking system over time, though there will still be need for price signals to reflect fluctuations in resource availability.

Centralized generation and transmission across large distances will remain the anchor of the system for some decades at least, but ratepayers will become much more active, intelligent, customized, localized participants in the system as well.

Human Resources

The final variable involves finding the right people – the pressures associated with attracting and retaining a sufficiently large and expert work force to manage the electricity system.

Over the past decade, Canadian electric utilities have put in place programs, partnerships and strategies to plan for pending demographic challenges. While it has been estimated that 40 per cent of the work force or 45,000 employees are set to retire between 2011 and 2016, Conference Board of Canada research indicates that the Baby Boom-cohort retirement is now (2014) just beginning. In addition, the Conference Board has estimated that there will be a need for 156,000 workers per year over the next 20 years to carry

out the renewal of Canada's electricity infrastructure⁷². Infrastructure renewal and modernization will also require employees with new and advanced technology and analytical skill sets. Getting to 2050 will depend on the ability of the sector to attract workers, assembling a sufficient workforce with the appropriate skills, and flexible management practices.

Overall growth in Canadian employment will slow to well under 1 percent a year and to just 0.6 percent annually by 2025. Employers will have to reduce their pace of hiring and possibly alter their business models to address talent shortages. From 67.0 per cent in 2010, the overall participation rate is projected to decline through to 2031 to a range between 59.7 per cent and 62.6 per cent⁷³. That would represent the lowest overall number of people either employed or actively seeking work since the late 1970s.

Further, competition with other resource sectors which continue to draw from the same labour pool as the electricity sector will impact the sector's ability to recruit the required talent from this receding pool of labour. Attraction and retention competition between the resources and energy sectors creates challenges for regulated utilities within the energy sector. For example, Alberta's current wage premium is approximately \$12,000 per year higher than in other regions of Canada. Utilities are also constrained on the variable pay front. For example, in 2014 variable pay (i.e., non-salary compensation such as profit sharing, bonuses, cash incentives, other perks) in the oil and gas sector is estimated to be 16 per cent of base salary while in the utilities sector it is predicted to be 5.2 per cent⁷⁴.

An area of future opportunity lies with greater collaboration with Canada's Aboriginal Peoples in increasing employment, contracting and procurement opportunities while supporting education and training programs for skilled trades. Jobs and entrepreneurial opportunities will exist in both renewable and non-renewable electricity and Aboriginal Peoples have a shared interest in expanded electrification, particularly in Northern communities.

72 "Shedding Light on the Economic Impact of Investing in Electricity Infrastructure," *Conference Board of Canada*, February 2012, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=4673>.

73 "Section 3: Feature article: Projected trends to 2031 for the Canadian labour force," *Statistics Canada* (Canadian Economic Observer, August 2011, vol. 24 no. 8).

74 Nicole Stewart & Elyse Lamontagne, "Compensation Planning Outlook 2014," *The Conference Board of Canada*, October, 2013.

ELECTRICITY INVESTMENTS IN CANADA – IN THE AGGREGATE, AND INDIVIDUALLY – WILL UNAVOIDABLY ENTAIL SIGNIFICANT COSTS TO RATEPAYERS AND TAXPAYERS IN THE COMING DECADES

As a result of these challenges, the electricity sector and its unions will need to be more flexible and creative in their approaches to talent recruitment and retention, and the use of non-monetary retention incentives. Use of external talent pools would increase flexibility and opportunities to redeploy key in-house talent as needed and virtual work models such as home-based call center agents may need to become increasingly mainstream. Individualized talent management strategies will also be needed to support a more flexible workforce.

Key Financial and Economic Levers Affecting the System

Electricity investments in Canada – in the aggregate, and individually – will unavoidably entail significant costs to ratepayers and taxpayers in the coming decades. Electricity rates are likely to increase in every province. Social license for those price increases (and their de-politicization) will likely depend on ratepayers focusing on and accepting the value proposition of electricity. That is why it is important to consider these costs in their proper context: they must be weighed not only against the benefits of the investments but also in light of the alternatives. Clearly, some approaches will yield higher returns on investment than others. The weighing of costs and benefits to maximize returns is a calculus that ought to be considered at multiple levels: for households, for the electricity sector, for electricity in conjunction with transportation, and lastly, for the economy as a whole.

If it is understood that electricity investment is necessary, and it will have a cost impact, investment as part of an overall vision may yield a more prudent 'electricity portfolio,' with benefits to society as a whole, than a piecemeal approach. A set of financial and economic variables will need to be considered over the next 35 years to facilitate the necessary changes to a more diverse and responsive electricity system. They include a number of financial instruments to support a low carbon energy mix:

- Operating subsidies;
- Capital subsidies;
- Carbon pricing.

Operating Subsidies

Government policy through various forms of subsidy and/or regulation has always played a significant role in the evolution of the system. Below is a brief overview of leading subsidy programs. Note that the discussion below excludes standards. While standards too may impose a cost on customers – for example the Corporate Average Fuel Economy (CAFE) regulations for U.S. vehicles – they are not normally considered financial instruments. Operating subsidies subsidize the operational cost of a facility.

Taxpayer Funded Subsidies

Taxpayer-funded operating subsidies can be in the form of tax credits or direct subsidies. For example, in the U.S., the Production Tax Credit (PTC) is a tax credit for operators of wind farms, which makes their operation financially viable in many market places. In Ontario, the Clean Energy Benefit, a rebate paid to customers for the energy component of electricity bills, is an example of taxpayers subsidizing electricity customers to offset some of the cost impact of the *Green Energy Act*.

Customer Funded Subsidies

Customer-funded approaches to offsetting operational costs tend to vary in form and effect. For example, in one variation, the operator is paid 'above market' prices for its output – in order to help make the investment profitable – and the costs are socialized over the customer base with customers paying in proportion to the amount of electricity they use. Ontario has a number of contract arrangements that fall into this category,



Photo: courtesy of Columbia Power Corporation

including the Feed-In-Tariff (FIT) program that is in place to encourage the development of renewable generation.

Governments can make choices about the way these kinds of programs are implemented to adapt to jurisdictional realities. In Germany for example, with its FIT program, it goes one step beyond having all customers pay in proportion to usage – as is the case in Ontario – and instead shelters certain trade-exposed industries from the higher prices. The effect is a transfer of the costs of the FIT program to residential customers. In another example, Quebec has adopted customer-funded tactics that incent industrial development in remote regions. Likewise, Ontario provides price cushioning to heavy industrial users in Northern Ontario through its Northern Industrial Electricity Rate Program which has been extended to 2017.

Net Metering

In some jurisdictions net metering is an option whereby the customer installs some form of generation (typically solar). While generating, the meter runs 'backwards' to reflect the customer supplying the grid with electricity above what they consume themselves. The surplus supplied to the grid is then credited against the amount purchased from the grid over the period of time being mea-

sured, and the consumer is only charged the net amount consumed from the grid. It differs from some FIT programs which have two meters, one for consumption, the other for production, and each is handled as a separate account. If the net metering rate is the full retail rate (i.e., generation plus all wires charges) then it is a subsidy as the net metering customer is not paying for all the wires services the customer still requires. Furthermore, with high penetration (i.e., with a large volume of generation feeding 'backwards' onto the grid), the burden of wires costs is shifted to those customers who do not have their own generation, effectively a wealth transfer. In the U.S. Southwest, net metering at the full retail rate is common. When combined with the current federal Investment Tax Credit of 30 per cent for solar systems on residential and commercial properties, solar can appear to be competitive at 15 cents/kWh.

Capital Subsidies

Capital subsidies help reduce original capital cost to improve the financial return of an investment.

Loan Guarantees

In this case, a government with a very good credit rating (e.g., Canada) 'guarantees' an amount of debt for a project proponent, thus reducing project

A CARBON PRICE THAT IS IMPLEMENTED WIDELY ACROSS THE ECONOMY WILL BE MORE EFFICIENT AND COST-EFFECTIVE THAN ONE THAT ONLY TARGETS A NARROWER SUBSET OF EMITTING OPERATIONS

financing costs. The lower cost is passed on to the customer, and it does not require any cash from the government, although theoretically the federal taxpayer in the case of a federal loan guarantee has an increased long-term liability. In the case of the Maritime Link/Muskrat Falls Loan Guarantee, the federal government's rationale was twofold: two provinces working together, and reduction of greenhouse gas emissions.

Energy Efficiency Programs

Typically these include a rebate mechanism to help offset the increased initial capital cost of equipment for operators or customers (e.g., appliances, lighting, industrial equipment). These programs can be taxpayer-funded (e.g., a federal rebate on the purchase of an electric vehicle) or customer-funded through electricity rates (e.g., Ontario's saveONenergy program).

RD&D Taxpayer Support

In Canada, programs via tax credits or investments by Sustainable Development Technology Canada (SDTC) reduce the risk of research, development and deployment (RD&D) of new and innovative technologies, reducing the financial risk of technology developers and investors. This form of taxpayer support is distinct from the United States' electricity Production Tax Credit (PTC) and other programs as the money does not go to operators; it is seed money to promote innovation.

Federally, Canada also has a Scientific Research and Experimental Development tax credit program.

Carbon Pricing

A vision for a diverse and responsive electricity system should be reinforced by sound and well-coordinated economic policies. Perhaps the most fundamental policy is to encourage transparent electricity pricing so market signals can work effectively and Canadians can make informed choices.

In addition, a number of financial instruments have been implemented in OECD countries (i.e., members of the Organisation for Economic Co-operation and Development) to encourage the adoption of lower carbon emitting and/or renewable energy technologies into the energy mix (both electricity and transportation fuels).

The fundamental challenge for new technologies in general terms is the lack of financial attractiveness in early stages of adoption: for the investor or project owner, there is no clear financial return in most market settings; for the customer, there are perceived and real risks in being an early adopter. However, without early adoption, operating experience, and reduction in costs as scale is achieved, there will be lots of new technology in theory, but not practice.

The introduction of an economy-wide carbon price (via a tax or trading system) increases the cost of carbon-emitting operations. This increased cost may result in earlier turnover of emitting capital stock, in addition to providing incentives for operators to support energy efficiency and to develop new, lower emitting technologies into the energy system.

In designing carbon pricing mechanisms, consideration must be given to avoiding 'leakage,' which is the situation in which a business relocates from an area with carbon pricing to another which has none. Another form of leakage can occur if only a few economic sectors are targeted (e.g., if electricity has carbon pricing and transportation fuel does not, then the opportunity for low carbon electricity to displace high carbon fuel is reduced). As a general rule, a carbon price that is implemented widely across the economy will be more efficient and cost-effective than one that only targets a narrower subset of emitting operations.



Photo: courtesy of Manitoba Hydro

Introducing a carbon price may, however, create an issue for families and individuals living at or beneath the poverty line, and potentially for renters who pay the increased energy price but have no control over the efficiency of appliances and heating/ventilation/air conditioning (HVAC) equipment. Therefore other policy adjustments with respect to social assistance should be introduced.

Lastly, the impact on industry (export and import dynamics) will depend on whether the carbon price is common to all major trading partners; otherwise, border adjustments may be required. For example, in both Quebec and California, electricity imports are charged a tax in proportion to the average emission factor from the supplying market.

Given the complexity of all these variables – those involving the size and composition of the system, management of it by industry and consumers, the pace and scope of grid modernization, the resolution of human resource challenges and the financial

and economic levers brought to bear – the task seems a bit daunting. There is the natural instinct to delay decision making until many of them clarify somewhat more. However, there is a strong case to be made for the urgency of getting on with updating Canada's electricity system and infrastructure.

**THERE IS A STRONG
CASE TO BE MADE
FOR THE URGENCY
OF GETTING ON WITH
UPDATING CANADA'S
ELECTRICITY SYSTEM
AND INFRASTRUCTURE**

4

THE CASE FOR ACTION NOW



**ELECTRICITY
INFRASTRUCTURE
MUST BE
MAINTAINED AND
RENEWED. THIS
WILL REQUIRE
SUBSTANTIAL
NEW CAPITAL
INVESTMENT**



THE CONFERENCE BOARD OF CANADA ESTIMATES THAT, OVER THE NEXT 20 YEARS, SOME \$350 BILLION MUST BE INVESTED JUST TO MAINTAIN THE RELIABILITY OF THE SYSTEM WE HAVE TODAY.⁷⁵

The 1970s and 80s saw dramatic investments in electricity infrastructure – in 2011 dollars, about \$10.5 billion per year. Then in the 1990s, things started to slip: the rate slowed to \$9.2 billion. In the first decade of this century, it rose back to \$10.8 billion.⁷⁶

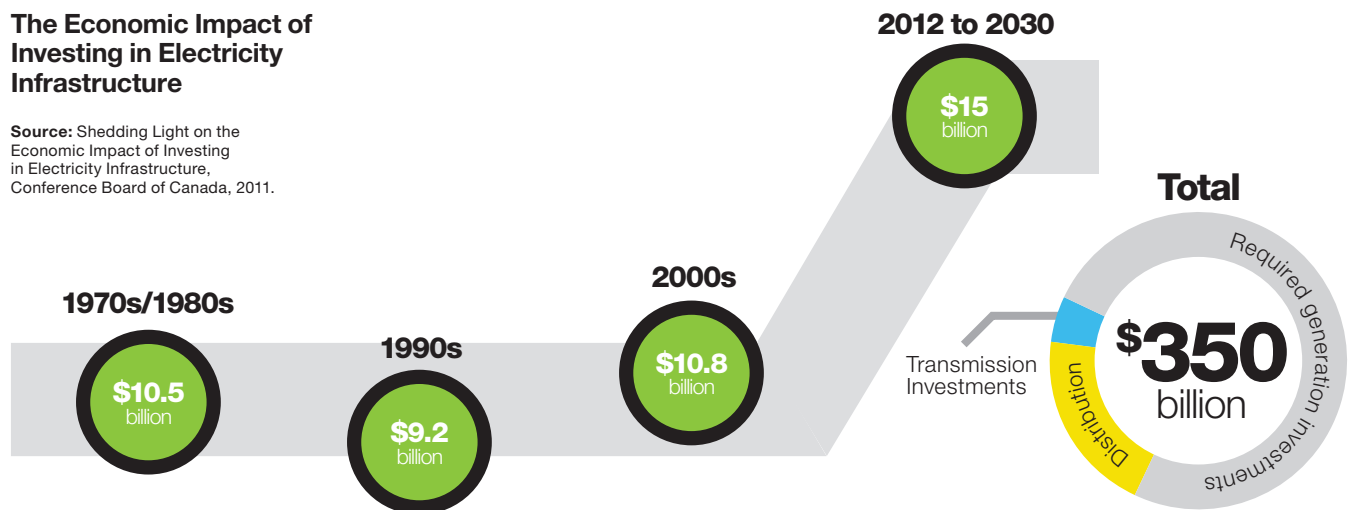
So over the past four decades, investments have averaged above \$9 billion and below \$11 billion in today’s dollars. To keep the system running will

require, on average, \$15 billion per year. We’ll need to keep that up for the next two decades. And that’s just to maintain the reliability of what we have today.⁷⁷

Approximately two-thirds of that investment will be for required generation investments, another 20 per cent for distribution, and the balance for transmission investments.⁷⁸

The Economic Impact of Investing in Electricity Infrastructure

Source: Shedding Light on the Economic Impact of Investing in Electricity Infrastructure, Conference Board of Canada, 2011.



75 "Shedding Light on the Economic Impact of Investing in Electricity Infrastructure," *Conference Board of Canada*, 2012, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=4673>.
 76 "Canada's Electricity Infrastructure: Building a Case for Investment," *Conference Board of Canada*, 2011, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=4132>.
 77 *Ibid.*
 78 "Shedding Light on the Economic Impact of Investing in Electricity Infrastructure," *Conference Board of Canada*, 2012, <http://www.conferenceboard.ca/e-library/abstract.aspx?did=4673>.

THE PRACTICAL REALITY IS THAT CITIZENS IN AN ADVANCED ECONOMY EXPECT NOTHING LESS THAN RELIABLE ELECTRICITY TODAY AND INTO THE FUTURE

While there is a theoretical possibility that Canada could try to save money by not renewing infrastructure along these lines, in reality this theoretical option is a non-starter. For one thing, less-than-reliable electricity would entail its own costs – through economic losses and opportunity costs, to say nothing of the potential price of brownouts and blackouts. In addition, the practical reality is that citizens in an advanced economy like Canada expect nothing less than reliable electricity.

And time is fleeting. Long lead times for planning and construction for refurbishment and new construction suggest that we do not have the luxury of many years of assessment before making decisions. Most of our current electricity assets will have reached the end of useful life by 2050.

Electricity public policy is politically charged – other than taxation, it is probably the largest area in which public policy impacts directly on consumer spending and disposal income. Virtually all stakeholders are consumers as well, including some of the most influential groups like heavy industrial users, companies of all sizes and business associations. Electricity is a significant business input cost and is a large factor in business investment decisions. The blending of energy and environmental policy has significantly complicated the political dynamics.

The net result is a broad coalition of interests that is predisposed to withhold social license and to resist significant price increases, including those that result from capital investment. In times of fiscal constraint and difficult political choices, governments have tended to limit their direct investment and have tried to manage the rate of price increase, with a resultant shortfall in renewal of infrastructure, particularly by public utilities.

There is a clear need for significant engagement by governments and the industry to broaden the discussion of price to the larger questions of value for money and the future requirement for a reliable, sustainable electricity system. The lead times for planning and construction preclude quick responses to a crisis in supply. For example, it can take many years to secure approvals for large transmission infrastructure and up to 10 or 15 years to build large hydroelectric or nuclear facilities. Depoliticizing the discussion in order to reduce political risk and shore up social license will take time and disciplined effort.

The industry is experimenting with innovative technologies to increase efficiency and control as well as to reduce its carbon footprint. However, much remains to be done to advance technologies like storage, CCS and electricity IT. Barring the advent of unexpected transformative technologies, nurturing and incenting experimentation and innovation is a slow, incremental process. Front-end investments tend to take years to provide a return and a reduction in the end price of a given technology.

Finally, there is an argument that there will be significant first-mover advantages for countries with a low carbon economy. The international pressure for carbon reduction is likely to gather more momentum and affect international trading patterns and prices. Canada is in a position to gain significant advantage from reducing carbon input costs to business, particularly those generated by electricity production.

Principles for Prudent Electricity Investments

As we consider scenarios for future electricity investments as well as their costs and benefits, the overall objective is to ensure that Canadians continue to have the safe, secure, reliable electricity system they have enjoyed for many decades. Now, as the electricity industry maps out a vision for the electricity system for the next generation, it is important to remind ourselves of key principles to inform prudent investment decisions:

A modern electricity system not only dispatches electrons, but also confers reliability benefits in the face of fluctuating supply and demand conditions. This reliability is an intangible good that is often taken for granted in our day-to-day life, but it forms part of any cost-benefit analysis around infrastructure renewal.

RELIABILITY



Electricity must remain accessible to the population. As electricity prices increase, governments will need to protect lower income citizens and ratepayers from 'energy poverty' through social policies and support.

EQUITY



Careful attention paid to how incremental and intermittent forms of generation will be integrated into the overall electricity mix may provide greater grid stability and dispatch flexibility.

INTEGRATION



A forward-looking approach to electricity may generate additional revenues through the sale of electricity exports.

GROWTH



Innovative new technologies and applications may deliver significant environmental, social and economic benefits.

INNOVATION



Grid modernization will entail further opportunities for energy efficiency, and households may enjoy returns on efficiency investments through reduced electricity consumption and customization of use (e.g., consumption during non-peak periods).

EFFICIENCY SAVINGS



Energy efficiency is an issue in transportation as much as in electricity. While electrification of transportation will entail some infrastructure switching costs, it will also generate a more efficient mode of transportation, resulting in savings to customers over time. In addition, the business case for electrification is further strengthened when energy security and environmental benefits are taken into account (both of which entail hidden costs to the economy).

TRANSPORTATION BENEFITS



For the economy as a whole, just as gaps in electricity reliability may generate electricity losses, so conversely, can resilient infrastructure generate confidence and stimulate other forms of growth and innovation in the economy. Electricity is the lifeblood of all other aspects of the economy.

RESILIENCE BOOSTS CONFIDENCE



5 VISION 2050

**PRECISELY BECAUSE
THE ELECTRICITY
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ELECTRICITY SYSTEMS NORMALLY CHANGE SLOWLY. GIVEN THIS GRADUALISM, IT IS NOT DIFFICULT TO IMAGINE AN ELECTRICITY SYSTEM IN 2050 THAT IS SUBSTANTIALLY SIMILAR TO THE ONE WE HAVE TODAY.

However, it is a fallacy to conclude that because electricity systems are slow to change, there is no point advocating for change.

In fact, this is why there is a need for transformation.

Precisely because the electricity system does not move quickly, the electricity industry calls for a vision of electricity today if it is to be achievable by 2050. In addition, this vision must be pursued proactively, including practical steps over a sustained period by multiple stakeholders, if it is to have a chance of success.

Vision 2050 centers on a commitment to renew the electricity system through the optimal evolution of electricity supply and demand, so as to deliver maximum value to customers and citizens, and to contribute to a lower carbon economy.

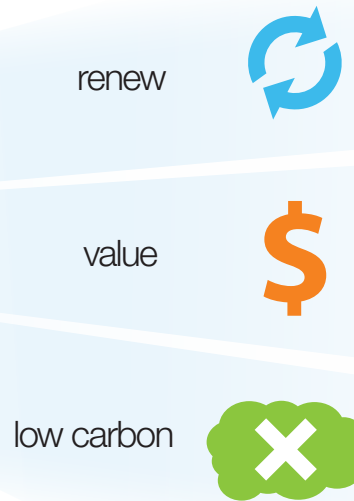
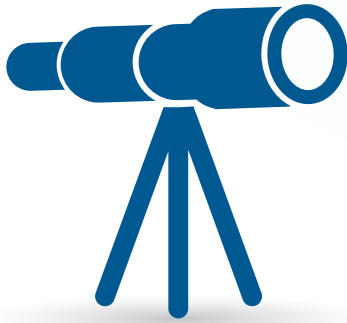
In general terms, there are three broad objectives and streams of action required to implement the Vision 2050:

- Renewing the electricity system;
- Delivering maximum value;
- Contributing to a low carbon economy.

Coming to terms with all that is required will be a lengthy and complex process. Some of it is in the hands of government and consumers, much of it in the hands of the industry and market forces. Over time there will be hundreds of initiatives, big and small, on the way to accomplishing Vision 2050. At the moment, however, four recommendations stand out as the ones likely to produce the greatest transformations.

Below, Vision 2050 identifies key recommendations and strategies for action that ought to be undertaken by the provincial and federal governments, regulators, electricity companies, and ordinary Canadians in support of the vision. Each would contribute significantly to one or more of the Vision 2050 objectives of renewing the system, delivering maximum value and contributing to a low carbon economy.

VISION 2050: The Future of Canada's Electricity System



Recommendation One: Accelerate Innovation and Customer Management of Energy

Electricity regulations were developed in a different era. To accelerate innovation and customization, Vision 2050 recommends both the **federal and provincial governments** review policies, laws and regulations to ensure they do not serve as obstacles to – but rather facilitate and enable – two-way electricity flows, micro-generation, emerging forms of generation like solar and biomass, and flexible demand response.

Innovation can also be framed as a response to challenges, including, for instance, efforts to further enhance cybersecurity and the need for improved adaptation and resilience in the face of more intense weather events. Hydroelectric power in particular will need to take account of changes in water availability by season and location as the result of climate change, and it may face growing competition in North America from competing water uses. These challenges will likely be manageable, but they will need to be taken into account by **system planners** and **utilities**.

The **federal government** is already exercising leadership through Sustainable Development Technology Canada (SDTC), a research, development and demonstration fund which aims to help accelerate breakthroughs, learning through pilots, and cost reductions in electricity innovation (e.g., low carbon generation, improved efficiencies in transmission and distribution, extended storage, and electrification of transportation).⁷⁹ Vision 2050 recommends that SDTC maintain its role as a seed-funding institution to promote innovation.

Provincial governments, too, can help solve a traditional obstacle to investment in energy-saving technologies, low carbon generation, and electric vehicles, even those investments that will pay for themselves within a few years – the obstacle of “upfront costs.”⁸⁰ As the (former) National Roundtable on Energy and Environment observes, “several of these programs are in existence in North America, but in Canada, the coverage of these programs is incomplete, and the strength of existing programs can be increased.”⁸¹

As for **utilities**, they should update infrastructure to enable grid modernization. In doing so, however,

79 See Dimitri Zenghelis, “A strategy for restoring confidence and economic growth through green investment and innovation,” *Policy Brief*, April 2012: <http://www.lse.ac.uk/GranthamInstitute/publications/Policy/docs/PB-Zenghelis-economic-growth-green-investment-innovation.pdf>.

80 See e.g., Zenghelis, *ibid.*; also see Merrian C. Fuller, Stephen Compagni Portis, and Daniel M. Kammen, “Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power,” *Environment Magazine*, January-February 2009; and NRTEE, “Framing the Future”. As the NRTEE paper comments: “High up-front costs can be a major barrier to customer purchases of renewable micro-generation, electric vehicles, or low-carbon buildings, despite net savings over the lifetime of these technologies. Reducing up-front costs ... would encourage purchasing decisions with carbon impacts in mind;” “Framing the Future”, p. 91.

81 See “Framing the Future”, p. 91.



Photo: courtesy of Nalcor Energy

they should be careful to weigh the costs and benefits of specific grid modernization programs (e.g., two-way metering, smart metering, dynamic demand response, and large scale storage) before committing extensive resources. The most hyped aspects of grid modernization are not necessarily those that will bring the greatest value. A phased approach to customization programs will allow for lessons learned along the way – and greater sympathy, perhaps, from economic regulators. Utilities should also identify, design and communicate opportunities for customers to offset price increases and save money through their own customized reductions in consumption.

There are many different types of innovation models worldwide. One model that holds considerable

promise for Canada is for **utilities** to form industry consortia focused on innovation that can pool customer funding from across jurisdictions and enable valuable collaboration and knowledge sharing.

Innovation requires experimentation and some risk of failure. If the regulator will disallow all innovation experiments as imprudent, the utility will remain commensurately risk averse. Thus **regulators** will need to update policies to encourage utility pilot programs of electricity customization and some limited instances of ‘learning by doing.’ At the same time, **regulators** should provide crucial oversight and establish governance criteria that include rigorous evaluation of customer benefits from innovative investments. They will need to strike a balance.

Recommendation Two: Implement Financial Instruments for Carbon Reduction

Vision 2050 offers the following recommendations regarding the selection of financial instruments:

North American carbon price. If the ultimate objective is to reduce the carbon intensity of the economy, then subsidy programs should be evaluated on a \$/tonne of reduction basis. Typically production tax credits and feed-in-tariffs have very high carbon reduction costs.

By contrast, if a North American carbon price were applied economy wide, the greatest reductions could be achieved at lowest cost. Also, given the current starting point of the Canadian electricity system (close to 80 per cent non-emitting), and the opportunity to add even more non-emitting generation (hydro, nuclear, CCS, wind), Vision 2050 sees a North American carbon price as holding potential for very significant carbon reductions at lower cost than alternatives. Realistically, however, there is very little political prospect of introducing a North American

economy-wide carbon price in the next five years. The absence of such a powerful price instrument will mean a significant missed opportunity.

Even so, with or without an economy-wide carbon price, the **federal and provincial governments** ought to identify and assess all low carbon electrical power opportunities in the economy. Low carbon electricity can replace carbon intensive fossil fuels not only in the transportation sector, but also in other sectors as well, such as hydropower in place of diesel in oil and gas extraction, and for various applications in the residential and commercial sectors.⁸² Also, **provincial governments** should develop (or maintain) loading order policies for new transmission to give priority to low carbon generation resources ahead of other incremental resources.

Electrical **utilities** could also help identify and assess all low carbon electrical opportunities as well as part of the cost-benefit analysis of various investment decisions, such as proposals to expand generating capacity for consumption at home and abroad. **Regulators**, meanwhile, could incorporate carbon reduction plans into their cost reviews and assessment of prudent versus imprudent investments.

Vision 2050 does not endorse **operator subsidy programs**. While operating subsidy programs have minimal impact on the market when penetration is extremely small, the problem is soon magnified, as these programs encourage the large growth of subsidized operations.

A capital subsidy used to offset high capital costs for early adopters is different, provided there is an eventual ramp down of the program as capital costs come down with scale and as customer demand grows (as we have seen in early adoption of hybrid vehicles).

Loan guarantees can be supported for unique circumstances (e.g., interprovincial electricity projects) as they do not draw on taxpayer cash, and the benefit goes to the customer.

Energy efficiency programs should not be financed through tax dollars and should be limited to very early adoption of new technologies.



Photo: courtesy of Horizon Utilities Corporation

Recommendation Three: Enable Electric Vehicles

Electric vehicles may grow to very high levels of market penetration, with corresponding environmental benefits and opportunities for electricity providers, or they may fall far short of their full potential.

To improve the odds that electric vehicles achieve widespread adoption on economic terms, all stakeholders should study carefully lessons and policy options from other jurisdictions as well as the experience to date in Canada.

The **federal government** could cooperate with the United States so EV infrastructure is seamless across the Canada-U.S. border, and benefits from economies of scale. **Federal and provincial governments** will need to develop plans for charging points and define a framework for their regulation from economic and safety perspectives.⁸³

Governments at all levels can also play a supporting role and send an important market signal in the form of ‘crowding-in’ investments, for example, by phasing in electric vehicles within public sector fleets.

As electricity experts, **utilities** are well positioned to advise governments on technical requirements for the supporting infrastructure for electric vehicles. They should also implement customer-friendly IT systems to measure what is being taken from the grid so customers can understand and control their own use patterns.

And of course, **utilities** will need to ensure reliable, low-cost clean generation to power the vehicles themselves, so their strategic plans should account for both faster and lower growth scenarios for adoption of EVs in Canada.

FOUR RECOMMENDATIONS STAND OUT AS THE ONES LIKELY TO PRODUCE THE GREATEST TRANSFORMATIONS

Recommendation Four: Expand Collaboration Across Borders

The electricity grid is already very much a shared resource between Canada and the United States, yet additional opportunities for integration and collaboration abound. Among the key priorities, the **federal government** could collaborate with the United States on promising pre-commercial/R&D areas of mutual benefit, such as carbon capture and storage, tidal power, and electricity storage. Such collaboration would allow for lesson sharing as well as economies of scale for research and larger scale demonstration projects. The **provincial government** and **utilities** have important roles in advising the federal government on the priority areas for such cross-border collaboration.

Lastly, electricity demand in the United States is set to continue growing in the coming decades and **utilities** should be more proactive in identifying, developing and providing additional clean electricity and storage for export to U.S. markets. **Provinces** and **utilities** will also need to work with one another and their U.S. counterparts on planning and building additional transmission lines and interties to support increased electricity capacity from Canada. For example, Quebec and Labrador have the potential to work together in providing additional energy storage and electricity to southern customers. In addition, some Canadian utilities may continue to invest in U.S. assets and vice-versa.

⁸³ For one view of how to develop public charging points, see the report “Public Charging Infrastructure in Canada,” *Electric Mobility Canada*, 2013, p. 24-25, http://www.emc-mec.ca/eng/pdf/EMC_EVSELocations_NRCan_R2.pdf.

VISION 2050 – A SUMMARY OF RECOMMENDATIONS AND STRATEGIES FOR ACTION

Recommendation	Federal Government	Provincial Governments	Regulators and System Operators	Utilities
Accelerate Innovation and Customer Management of Energy	Maintain national research, development and deployment (RD&D) funding via Sustainable Development Technology Canada (SDTC)	Support knowledge sharing, collaboration, and customer-funded innovations related to energy efficiency, low carbon electricity, energy storage and electric vehicles	Support integration of pilots in electricity customization Provide oversight and criteria for evaluation of customer benefits from innovative investments	Assess cost-benefits of grid modernization programs; start with pilots Introduce customized cost-saving options for customers through reduced electricity use Form industry consortia focused on innovation that can pool customer funding from across jurisdictions and enable collaboration
	Revise policies, laws and regulations to facilitate two-way electricity flows, micro-generation, emerging forms of generation and flexible demand response	Revise policies, laws and regulations to facilitate two-way electron flows, micro-generation, emerging forms of generation and flexible demand response	Advise governments on regulatory changes needed to facilitate two-way electron flows, micro-generation, emerging forms of generation and flexible demand response	Facilitate two-way electron flows, micro-generation, emerging forms of generation and flexible demand response
Implement Financial Instruments for Carbon Reduction	Phase out operating subsidies Continue providing R&D and early-adopter capital subsidies Provide loan guarantees for beneficial interprovincial projects	Phase out operating subsidies Continue providing R&D and early-adopter capital subsidies Develop (or maintain) loading order policies for new transmission to give priority to low carbon generation resources	Support technical issues arising from implementation of carbon policies	For generators, develop corporate plans for ongoing carbon reductions in fleets
Enable Electric Vehicles (EVs)	Develop enabling policies and regulations (e.g., for recharge points)	Develop enabling policies and regulations (e.g., for recharge points)	Advise governments on technical requirements for electric vehicles	Advise governments on technical requirements and commercial models for electric vehicles
	Early adoption of electric vehicles in public sector fleet	Early adoption of electric vehicles in public sector fleet	Not applicable	Implement customer-friendly information technology (IT) systems to measure what is being taken from the grid
Expand Collaboration Across Borders	Form an agreement with U.S. on RD&D collaboration areas	Advise federal government on key areas for RD&D collaboration with U.S.	Advise provinces on technical obstacles and enablers for expanded collaboration	Advise provinces on key areas for RD&D collaboration with U.S.
	Collaborate with U.S. on new transmission lines	Collaborate with U.S. on new transmission lines	Support new transmission lines for export	Expand clean electricity for export to U.S.

6 CONCLUSION: A CHOICE TO MAKE

**THE DECISIONS
THAT CANADA
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NEXT FIVE TO
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IN 2050**



VISION 2050 IS AN OPPORTUNITY.

As we have seen throughout history with the slow turnover of electricity infrastructure, the decisions that Canada makes today, and over the next five to 10 years, will have a huge impact on what our system will look like in 2050.

If we fail to make needed changes in infrastructure, we will face the challenge of maintaining an increasingly aging system, with reduced reliability and major operational challenges. Conversely, if the electricity industry's vision is implemented, and infrastructure is replaced at a sustainable level, along with a commitment to accelerate and integrate innovation with appropriate enabling policies, we will be well on our way to an even better electricity system and economy.

The far-reaching vision offered in this paper represents a new, more ambitious role for electricity in Canada. It calls for a new level of leadership, as well as supporting actions from governments, regulators, and utilities. Public understanding and support will be essential,

and elements of the vision will undoubtedly benefit and evolve from many conversations with citizens and stakeholders.

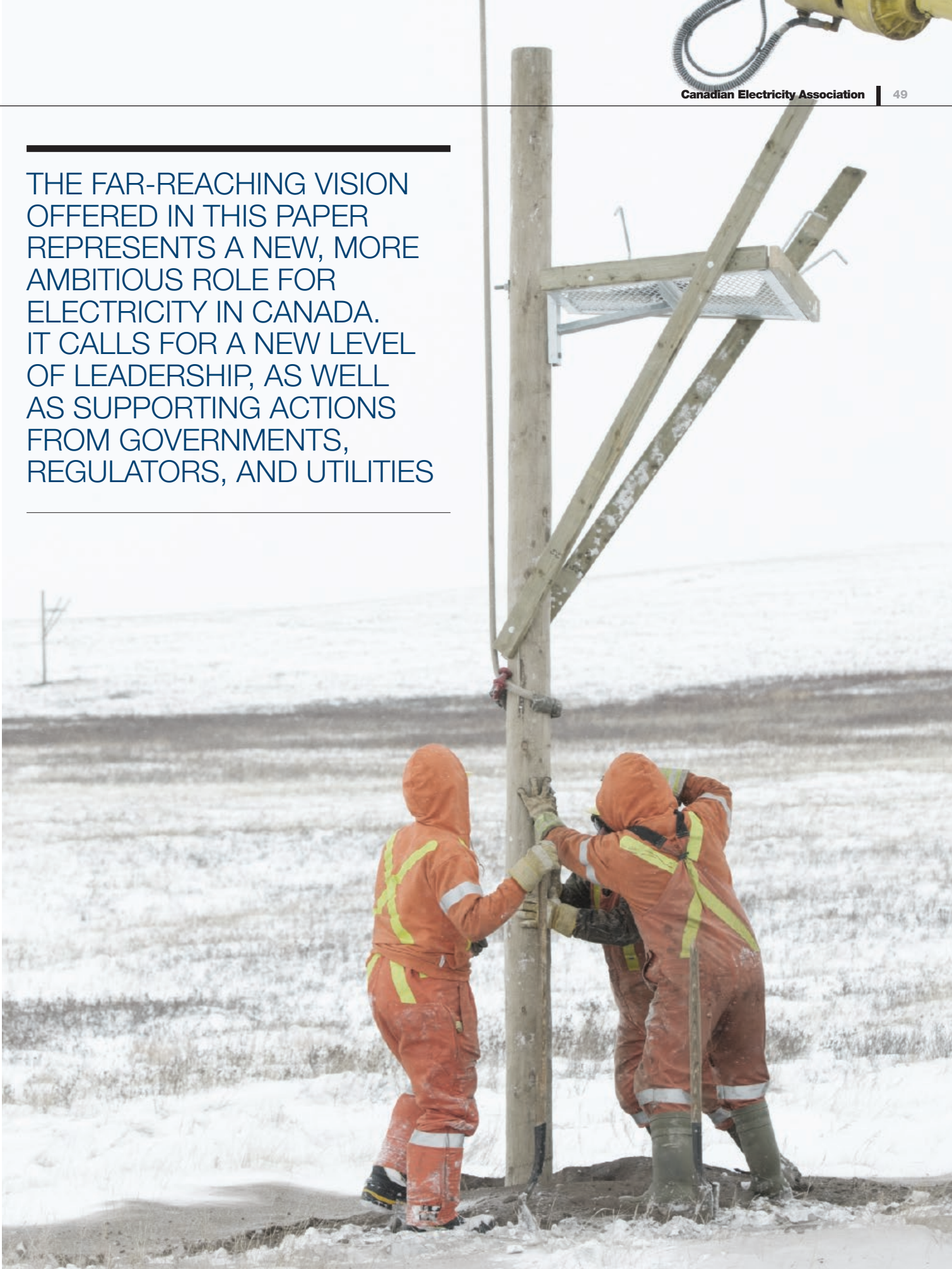
It responds to growing customer expectations for a more responsive and innovative electricity system. It is a chance to strengthen environmental outcomes and to generate additional revenues in the process: Canadian electricity, on average, is cleaner than available energy alternatives in North America. It is an opportunity to continue delivering the three pillars of a strong electricity system – reliability, affordability and sustainability.

This vision represents a real choice – a choice to pursue a proactive and coordinated approach to shaping our electricity future over a passive and fragmented approach.

As with so many choices, it will not be available forever.

It's time to decide.

THE FAR-REACHING VISION OFFERED IN THIS PAPER REPRESENTS A NEW, MORE AMBITIOUS ROLE FOR ELECTRICITY IN CANADA. IT CALLS FOR A NEW LEVEL OF LEADERSHIP, AS WELL AS SUPPORTING ACTIONS FROM GOVERNMENTS, REGULATORS, AND UTILITIES





Canadian
Electricity
Association

Association
canadienne
de l'électricité