Technology and Policy Options for a Low-Emission Energy System in Canada

Findings of an Expert Panel on Energy Use and Climate Change

Seminar Presented by

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Abstract

A synopsis is presented on the key findings of the Council of Canadian Academies' Expert Panel Report on energy use and climate change, which was released in late October of 2015. The evidence is clear: increased greenhouse gas emissions from human activity are causing pervasive changes to the Earth's climate, and significant and rapid efforts will be needed to reduce these emissions in the coming decades. The Panel's report is an up-to-date, accessible review of options for reducing greenhouse gas emissions and moving Canada toward a low-emission future. It provides an overview of Canada's energy system, an analysis of different energy sources and technologies, and an exploration of the public policies available to support a shift toward low-emission energy sources and technologies. Moreover, the investigation is guided by a systems thinking approach, recognizing the interconnectedness of society and the natural environment supporting it. Overall, the Panel acknowledged that the technologies needed for moving toward a low-emission energy system and the policies required for promoting the use of those technologies, already exist, are well-understood and are constantly improving. Optimal strategies and policies for advancing reductions in greenhouse gas emissions will need to be adaptive by evolving as necessary in response to emission trends, new technological developments, and other social, economic, and political changes. They will also benefit from system level principles of resilience, sustainability, fairness, and integration across jurisdictions and disciplines. The report constitutes an indispensable resource for private sector decision-makers, different levels of government, and the public as they seek to better understand energy use and the options available to combat climate change.

Acknowledgement

This seminar presentation is entirely based on the following Expert Panel Report, which was orchestrated and published by the Council of Canadian Academies (CCA) located in Ottawa, Ontario, Canada. The Expert Panel consisted of a multidisciplinary group of eight experts, for which K.W. Hipel and P.R. Portney were the Co-Chairs, as well as an Assessment Team from the CCA. Magna International Inc. kindly funded the project.

Expert Panel Report

Council of Canadian Academies (CCA), "*Technology and Policy Options for a Low-Emission Energy System in Canada*", Report of the Expert Panel on Energy Use and Climate Change, Report released on October 27, 2015, by the CCA, Ottawa, Ontario, Canada K2P 2K3, 2015.
(This report can be downloaded free of charge at http://www.scienceadvice.ca)

Speaker Biography

Keith W. Hipel is *University Professor* of Systems Design Engineering at the University of Waterloo where he is *Coordinator* of the Conflict Analysis Group. He is *Past President* of the Academy of Science within the Royal Society of Canada, *Senior Fellow* of the Centre for International Governance Innovation, *Fellow* of the Balsillie School of International Affairs, and *Past-Chair* of the Board of Governors of Renison University College. Dr. Hipel thoroughly enjoys mentoring students and is a recipient of the *Distinguished Teacher Award*, *Faculty of Engineering Teaching Excellence Award*, and the *Award of Excellence in Graduate Supervision* from the University of Waterloo, as well as the *2011 Outstanding Engineering Educator Award* from IEEE Canada. His major research interests are the development of conflict resolution, multiple criteria decision analysis, time series analysis and other decision-making methodologies for addressing complex interdisciplinary system of systems engineering problems lying at the confluence of society, technology and the environment, with applications in water resources management, hydrology, environmental engineering, energy, and sustainable development. Prof. Hipel is the author or co-author of 4 books, 12 edited books, more than 285 journal papers, as well as many conference and encyclopedia articles (over 10,160 citations; H-index = 49, i10-index = 211). Dr. Hipel is the recipient of the *Japan Society for the Promotion of Science (JSPS) Eminent Scientist Award*; *Joseph G. Wohl Outstanding Career Award* from the IEEE Systems, Man and Cybernetics (SMC) Society; IEEE SMC *Norbert Wiener Award*; *Docteur Honoris Causa* (France); *Doctor Honoris Causa* (Hungary); *Sir John William Dawson Medal* (Royal Society of Canada); and *Engineering Medal for Research and Development* from Professional Engineers Ontario.

“Technology and Policy Options for a Low-Emission Energy System in Canada”, Report of the Expert Panel on Energy Use and Climate Change：Overview*

The Expert Panel on Energy Use and Climate Change
Council of Canadian Academies (CCA)

A reliable energy system is essential for a functioning society, and improvements in humanity’s capacity to harness energy from a range of sources have helped raise living standards around the world. Canada, like many countries, relies on fossil fuels for most of its energy. Coal, oil, and natural gas together account for 72% of Canada’s energy supply, and they are the dominant sources of energy used for transportation, space heating, many industrial processes, and electricity generation in some provinces. The burning of these fuels is increasing the amount of carbon dioxide in our atmosphere and causing pervasive changes in the Earth’s climate. The resulting widespread and substantial risks to society and ecosystems justify significant, accelerated efforts to reduce greenhouse gas emissions from human activity over the coming decades. The Council of Canadian Academies (the Council) was tasked with synthesizing the evidence on select energy sources and technologies, as well as public policies, that would be involved in a transition to a low-emission energy system in Canada. This charge came in response to frustration among some business leaders that stemmed from a lack of clarity about key facts relating to energy technologies and climate change, and policy options to address this challenge. To address this charge, the Council convened a multidisciplinary, eight-member expert panel (the Panel) comprising people with expertise in economics, public policy, engineering, and energy systems and technologies. From its discussion and review of the evidence, the Panel identified three key findings.

* This paper is a part of the report “Technology and Policy Options for a Low-Emission Energy System in Canada”, Report of the Expert Panel on Energy Use and Climate Change” by the Expert Panel on Energy Use and Climate Change, Council of Canadian Academies (CCA). The report is available at http://www.scienceadvice.ca .

Finding 1: Canada could achieve major emission reductions with the adoption of commercially available technologies.

Over the course of the next several decades, a transition to a low-emission energy system would involve three main strategies: improvements in energy efficiency, a shift from high-emission to low-emission energy sources (i.e., energy substitution), and possibly the adoption of carbon capture and storage (CCS) technologies. Improvements in energy efficiency can result in early gains and provide a foundation for the cost-effective introduction of low-emission technologies, but deeper emission reductions will require energy substitution and potentially the application of CCS in conjunction xii Technology and Policy Options for a Low-Emission Energy System in Canada with continued fossil fuel use. Taking advantage of existing technologies in these areas and across the transportation, building, and industry sectors could result in emission reductions on a large scale. Promising options for reducing emissions include:

- Transportation: Ongoing efficiency gains for all vehicles, increasing reliance on low-emission electricity for passenger transportation, expanding use of biofuels in freight transportation, and long-term urban planning and investments in transportation infrastructure.
- Buildings: Ongoing efficiency gains in new buildings or in conjunction with building renovations, transitioning to electricity for space heating in highly energy-efficient buildings, and selective adoption of community heating systems that capture and use waste heat and/or rely on renewable energy sources.
- Industry: Ongoing efficiency gains in industrial processes, reduction of fugitive emissions, application of CCS in suitable industrial processes, and electrification and enhanced use of biomass in applicable industrial applications. However, given the higher cost of these technologies relative to conventional options, they are unlikely to be widely adopted unless stringent, compulsory policies are introduced. Further innovation and technological development is also essential for reducing the costs of low-emission energy technologies over time.

Finding 2: Low-emission electricity is the foundation for low-emission energy systems.

Switching to low-emission electricity eliminates carbon dioxide emissions from power generation and allows for further emission reductions as the transportation, building,

and industry sectors gradually increase their use of electricity as an energy source. Many Canadians live in jurisdictions that already benefit from lowemission electricity; however, future emission reductions will require a transition in provinces that still depend on emission-intensive electricity sources such as coal, as well as expanding low- and non-emitting generation in all provinces to meet growing demand. This expansion will require careful planning to integrate higher shares of electricity generation from intermittent renewable sources (such as solar, wind, and run-of-river hydro) with additional energy storage capacity and other dispatchable energy sources (such as hydropower, nuclear, geothermal, biomass, and coal or natural gas with CCS). Investments in electricity transmission lines, interconnections, and grid modernization can Executive Summary xiii also enhance flexibility and enable greater reliance on low-emission generation technologies. The costs of low-emission electricity generation technologies, while still generally higher than those for fossil fuel-fired power plants, have been falling rapidly. Given the relatively low electricity prices in Canada in most jurisdictions, the increased cost of electricity from low-emission energy sources is not likely to pose a major burden for most consumers and businesses.

Finding 3: A transition to a low-emission energy system is achievable with the right combination of stringent and flexible policies.

There is no one right policy for reducing energy-related emissions. However, experience to date has shown that voluntary measures alone are insufficient, and policies that focus exclusively on further technological progress offer no guarantee of emission reductions. Stringent, compulsory, economy-wide emission reduction policies are therefore essential if Canada is to successfully undertake an energy system transition. Carbon taxes, cap-and-trade systems, and other regulations are all possible approaches. Regardless of the instrument, certain design features can improve performance of such policies across a range of criteria. These include linking policies to binding and increasingly stringent emission limitations, or to binding and increasingly high carbon prices; including appropriate monitoring and penalty provisions; providing extensive compliance flexibility; treating new and existing firms fairly; harmonizing policies across Canada and establishing international linkages; compensating groups that are adversely impacted by policies (at least on a transitional basis); and involving the public in decision-making. In addition to compulsory policy, enabling policies are very important for supporting emission reductions. These include direct government investment, adjustment of subsidies, enabling infrastructure, innovation support, and

making regulatory processes more efficient. Support for energy innovation can accelerate the adoption of low-emission technologies by making them more affordable. With flexible economy-wide policies in place, individuals, businesses, and other decision-makers can choose the technology and energy responses that are right for their context and adjust these choices over time to adapt to further scientific progress, technological developments, and emission reduction trends. xiv Technology and Policy Options for a Low-Emission Energy System in Canada.

MOVING FORWARD

Addressing climate change will ultimately require globally coordinated action to protect a common resource — the Earth's atmosphere — and society must be willing to pay now for benefits that accrue largely to future generations. However, climate change as a technological and policy problem may not be as complex as is often assumed. Both the consequences of climate change and its potential solutions have been extensively studied and are now well understood. While energy system transitions typically require many decades due to the longlived nature of infrastructure and massive investments required, they can be accelerated with strategic policy support, and they are already under way in many jurisdictions across Canada. Due to the risk of getting locked in to new emission intensive capital and infrastructure, delaying mitigation increases the cost of meeting emission reduction goals over time. Ensuring that transitions are fully realized will require policies that are adaptive to changing economic, technological, and environmental conditions and persistent over time. With appropriately stringent and flexible policies in place, large emission reductions from Canada's energy system are achievable over the course of several decades. This transition will not be without cost for consumers, businesses, or the economy as a whole. It can, however, be achieved without jeopardizing Canada's long-term economic growth and competitiveness.