

Report in Focus

TECHNOLOGY AND POLICY OPTIONS FOR A LOW-EMISSION ENERGY SYSTEM IN CANADA

Evidence clearly supports that the earth's climate is changing and that these changes are driven by greenhouse gas (such as carbon dioxide) emissions resulting from human activity.¹ Climate change is a daunting and complex problem with potentially disastrous consequences, which justifies significant and rapid efforts to reduce greenhouse gas emissions in the coming decades. This is no small challenge, and it will require major changes to how we produce and use energy.

Facing the climate change challenge, however, does not necessarily require fundamental changes to our society or our standard of living. We know the steps we can take if Canada wishes to do its part in reducing emissions and preventing catastrophic climate change. The technologies to move to a low-emission energy system, and policies that promote the use of those technologies, already exist, are well-understood, and are constantly improving. Experience from around the world and within Canada has shown what can be most effective for reducing emissions while minimizing harmful effects on the economy.

Energy use and emissions trends in Canada reflect the influence of many factors, including a high standard of living, extensive endowments of energy resources, relatively low energy prices, a large land mass and variable climate, and the structure of the economy. However, a pathway exists to move Canada toward a low-emission energy future — and we know what we need to know to get started now.

Energy Use & Climate Change in Canada

One of the **top 5**



energy producers in the world

72%



of total primary energy comes from coal, oil, and natural gas

4th largest



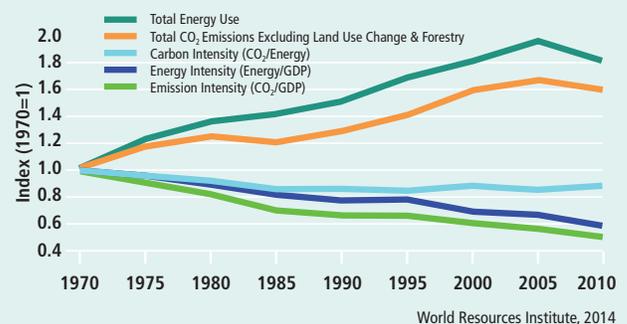
carbon dioxide emissions per capita among OECD countries

1.5°
celsius



is the average surface temperature increase in Canada over the last 60 years

Canadian Energy and Emission Trends



The energy and emission intensity of the economy is declining, but total emissions continue to rise as economic growth outpaces efficiency gains.

Technology Options for Transforming Canada's Energy System

Improvements in energy efficiency can result in early gains and be a foundation for further change. Deeper emission cuts will require shifting to low-emission energy sources and potentially capturing and storing carbon from continued fossil fuel use. All of this can be done with existing technologies and emission reductions can be immediately pursued across four main sectors.

ELECTRICITY

Fortunately, 80% of Canadians already live in provinces relying predominantly on low-emission electricity. Most electricity-related emissions in Canada come from coal-fired power plants, which are still an important electricity source in a few provinces. To reduce future emissions, all provinces must transition.

Options for reducing emissions from electricity:

- Replace remaining coal-fired power plants with low-emission alternatives.
- Expand low-emission generation in all provinces.
- Invest in electricity transmission, distribution systems, and energy storage to enable a flexible mix of energy sources and greater reliance on low-emission sources.

The costs of low-emission electricity generation, although generally higher than fossil fuel-based generation, have been falling rapidly.

BUILDINGS

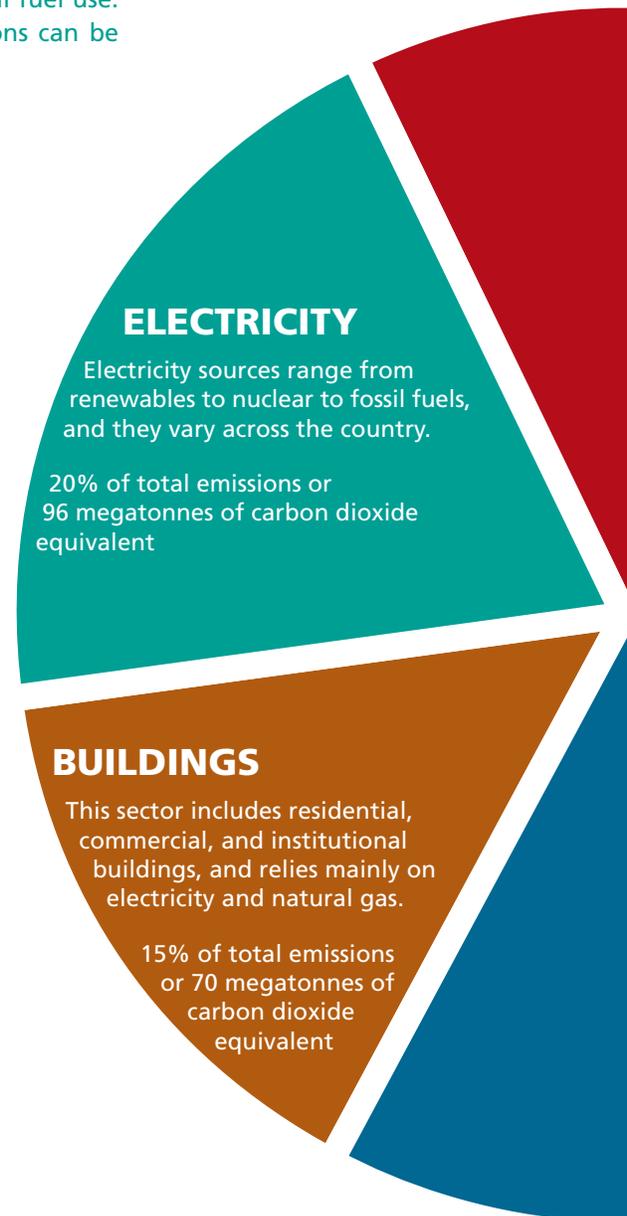
Space and water heating account for most energy use and carbon emissions in Canada's buildings sector.

Options for reducing emissions from buildings:

- Incorporate efficiency measures such as passive solar design, enhanced insulation, and heat pumps into new and existing buildings.
- Convert to low-emission electricity for space heating in highly efficient buildings.
- Invest in community heating systems that capture and use waste heat and rely on renewable energy.

Existing energy efficiency technologies can reduce heating and cooling demands by 60 to 90% over conventional construction.

ELECTRICITY AND BUILDINGS EMISSIONS HAVE NOT CHANGED SINCE 1990



Low-emission electricity will be critical for widespread emission reductions

TRANSPORTATION

The transportation of people and goods in Canada is almost entirely dependent on fossil fuels.

37% of total emissions or 178 megatonnes of carbon dioxide equivalent

INDUSTRY

Industry such as construction, manufacturing, and oil and gas extraction uses most of its energy to run equipment and as a heat source for material processing.

28% of total emissions or 136 megatonnes of carbon dioxide equivalent

TRANSPORTATION

Cars and trucks are the main sources of energy use and emissions in this sector. Road transportation is a large and growing source of Canada's emissions.

Options for reducing emissions from road transportation:

- Continue efficiency gains for all vehicles.
- Increase use of vehicles powered by low-emission electricity for passenger transportation and expand biofuels in freight transportation.
- Invest in urban planning and public infrastructure to support less emission-intensive transportation.

A shift to low-emission transportation of both people and goods will depend on development of appropriate refuelling infrastructure.

INDUSTRY

The need to produce high levels of heat accounts for 75% of industrial energy demand.

Options for reducing emissions from industry:

- Enhance efficiency by improving equipment, integrating processes (e.g., cogeneration of heat and power), and reducing energy used in material processing.
- Switch to low-emitting electricity and, where appropriate, biomass as an energy source.
- Implement carbon capture and storage when suitable.
- Monitor and repair leaks in natural gas production and distribution and reduce venting and flaring.

Emission reductions can also be encouraged by developing infrastructure to support low-emission technologies and by promoting collaborative research and sharing innovative practices and technologies.

TRANSPORTATION AND INDUSTRY EMISSIONS HAVE RISEN SIGNIFICANTLY SINCE 1990

A low-emission energy system is achievable with the right combination of stringent and flexible policies.

Policy as a precursor to change

A low-emission future for Canada will depend on the collective will and ambition of federal and provincial governments as well as other stakeholders. Expecting voluntary emission cuts will not be enough: if Canada wants to see widespread change, we should consider implementing stringent, compulsory, and economy-wide policies. Such policies include a price on carbon (e.g., through a carbon tax or cap-and-trade system) or a series of more flexible regulations — but there is no one solution that is ideal for all contexts. Regardless of the policies chosen, the best strategies should be able to adapt in response to emission trends, new technology, and social, economic, and political change.

DESIGN MATTERS

Across compulsory policies, good policy design will consider cost, environmental effectiveness, fairness, administrative feasibility, and political acceptability. There are many design features that can improve performance across these criteria. For instance, while traditional prescriptive regulations can be expensive, offering flexibility in how businesses and people reduce emissions can limit the costs of policy and encourage innovation. In addition, reducing emissions will be more challenging and costly for some businesses, individuals, and regions. Providing compensation to groups that are most negatively impacted can improve the fairness



of policy and make it more politically acceptable. Other features that can improve performance include having monitoring and penalty provisions, treating new and existing firms fairly, involving the public in decision-making, harmonizing policies both in Canada and abroad, and linking policies to binding and increasingly stringent emission limitations or to binding and increasingly high carbon prices.

EASING THE TRANSITION

In addition to compulsory policies, other types of policies are important for supporting emission reductions, reducing costs, and enabling change. For instance, governments can phase out subsidies for high-emission energy sources and make regulatory processes for implementing low-emission technologies more efficient. They can also make direct investments through reducing emissions from government buildings and assets, integrating urban and energy system planning, and developing infrastructure such as flexible electricity grids, vehicle refuelling stations, or pipelines. Finally, supporting research and innovation can speed up the adoption of existing low-emission technologies by making them more affordable, and potentially introduce new low-emission technologies.



Q&A with the Panel Co-Chairs

Q: Why should Canada reduce emissions if other countries aren't taking action?

Keith – Canada only accounts for 1.4% of global carbon emissions, but it is still one of the world's largest sources of emissions and has higher emissions, in absolute and per capita terms, than most OECD countries. Climate change is a global problem and requires a global solution. This means all major emitters need to achieve reductions to stabilize the climate. Canada will need to transition to a low-emission energy system to do its part.

Q: Do we really have the technologies we need to achieve major emission reductions?

Keith – Yes! Most of these technologies have been demonstrated, adopted, and deployed in highly variable circumstances around the world. However, these technologies generally remain more costly than conventional alternatives that rely on fossil fuels. This points to the need for stringent and compulsory policy. More innovation, fuelled by increased investments in research and development and other enabling policies, can also accelerate the pace of transition by reducing the costs of low-emission energy technologies in the future.

Q: Will emission reductions hurt the economy or Canadian competitiveness?

Paul – Emission reductions will not be costless for individuals, businesses, or society at large. Any cost increases, however, would likely not be out of line



Keith W. Hipel, Co-Chair



Paul R. Portney, Co-Chair

with costs faced by other countries. Impacts on the competitiveness of certain industries could also be managed through border adjustments, appropriate policy design, and policy harmonization. The best available evidence indicates that Canada can achieve large emission reductions of 60 to 90% while maintaining economic growth.²

Q: What can I do to reduce greenhouse gas emissions and help address climate change?

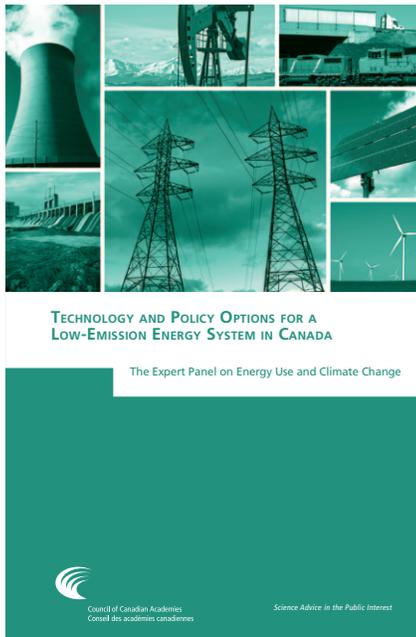
Paul – Individuals and businesses can do many things to reduce emissions, such as buying more efficient vehicles or equipment, investing in more efficient homes and buildings, or simply reducing energy use. Large reductions, however, will require addressing larger systemic issues that cannot be resolved by any one individual or firm, but will require government action. For this reason, you can also support the adoption of compulsory policies, as they will be required to prompt long-term change.

Going Forward

Climate change is a formidable challenge, combining the need for global action to protect a common resource — the Earth's atmosphere — with the need to accept costs now for the benefit of future generations. But the complexity of climate change as a technological and policy problem can be overstated.

The technologies we need to transition to a low-emission economy are available, and their prices are dropping. Major

energy system transitions typically unfold slowly, but they can be accelerated with the right government support. A transition to a low-emission energy system will not be costless, by any means. But with a combination of stringent and flexible policies, aided by continued technological innovation, Canada can undertake a transition to a low-emission energy system over the next several decades while maintaining a competitive, growing economy. Combating climate change is possible — and we know how to get started now.



TECHNOLOGY AND POLICY OPTIONS FOR A LOW-EMISSION ENERGY SYSTEM IN CANADA: FULL REPORT

This assessment was referred to the Council of Canadian Academies by Magna International Inc. in an effort to encourage a clearer understanding of the facts and options for moving toward a low-emission future. To complete the assessment, the Council assembled an 8-member multidisciplinary panel of experts from Canada and abroad with expertise in and demonstrated leadership in energy systems and technologies, economics, and public policy. The Panel's full report, *Technology and Policy Options for a Low-Emission Energy System in Canada* is available free of charge on the Council's website www.scienceadvice.ca.

To learn more about the Council's current assessments, or to refer a new question for assessment, visit www.scienceadvice.ca or email info@scienceadvice.ca.

Endnotes

- ¹ See the Intergovernmental Panel on Climate Change's *Fifth Assessment Report* for a full review of the scientific evidence on climate change.
- ² See Bataille *et al.* (2014) and the National Round Table on the Environment and the Economy (2009).

EXPERT PANEL ON ENERGY USE AND CLIMATE CHANGE: **Keith W. Hipel, FRSC, FCAE (Co-Chair)**, University Professor, Systems Design Engineering, University of Waterloo (Waterloo, ON); **Paul R. Portney (Co-Chair)**, Former Professor of Economics, University of Arizona and former President, Resources for the Future (Santa Barbara, CA); **F. Michael Cleland**, Private Consultant (Ottawa, ON); **Debra J. Davidson**, Professor of Environmental Sociology, Department of Resource Economics and Environmental Sociology, University of Alberta (Edmonton, AB); **Eddy Isaacs, FCAE**, Chief Executive Officer, Alberta Innovates – Energy and Environment Solutions (Calgary, AB); **Mark Jaccard, FRSC**, Professor, School of Resource and Environmental Management, Simon Fraser University (Vancouver, BC); **Vicky Sharpe**, Board Director and Senior Fellow, International Institute for Sustainable Development (IISD) (Toronto, ON); **Sara Jane Snook, FCAE**, Independent Engineering Consultant (Halifax, NS).



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This *Report in Focus* was prepared by the Council based on the Report of the Expert Panel on Energy Use and Climate Change.