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CLIMATE CHOICES

Electrification to meet net zero goals

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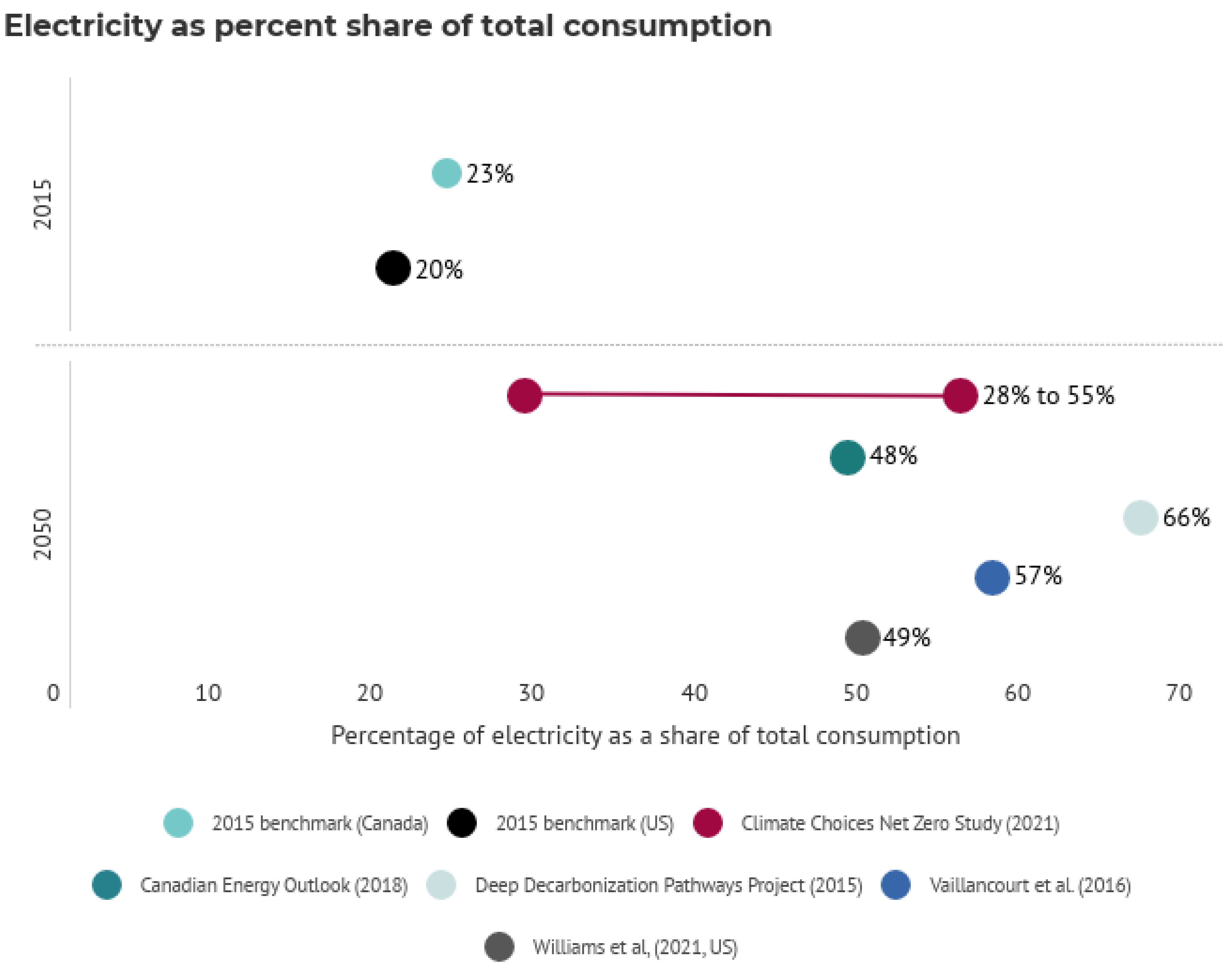
ABOUT THE **INSTITUTE**

Collaborative Research. Integrated Climate Policy. Better Choices.

About Climate Choices:

- **Federally-funded** climate policy think-tank
- **Independent** research agenda and policy recommendations
- **Board of Directors,** 30+ **Expert Panelists** well known in their fields
- **Advisory Group** provides strategic insight
- Professional secretariat of 24 focused on **research, engagement, and communications**

Widespread electrification enables achievement of net zero



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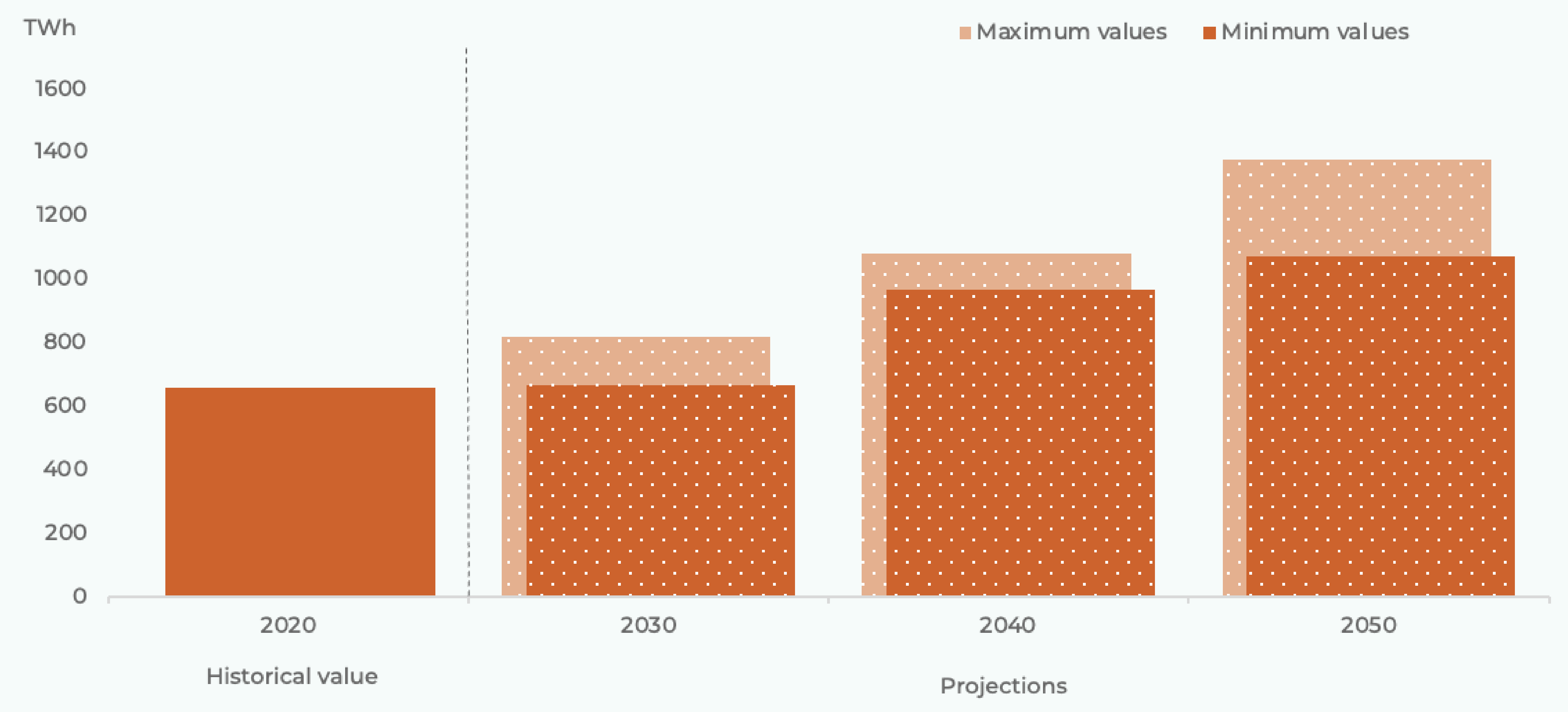
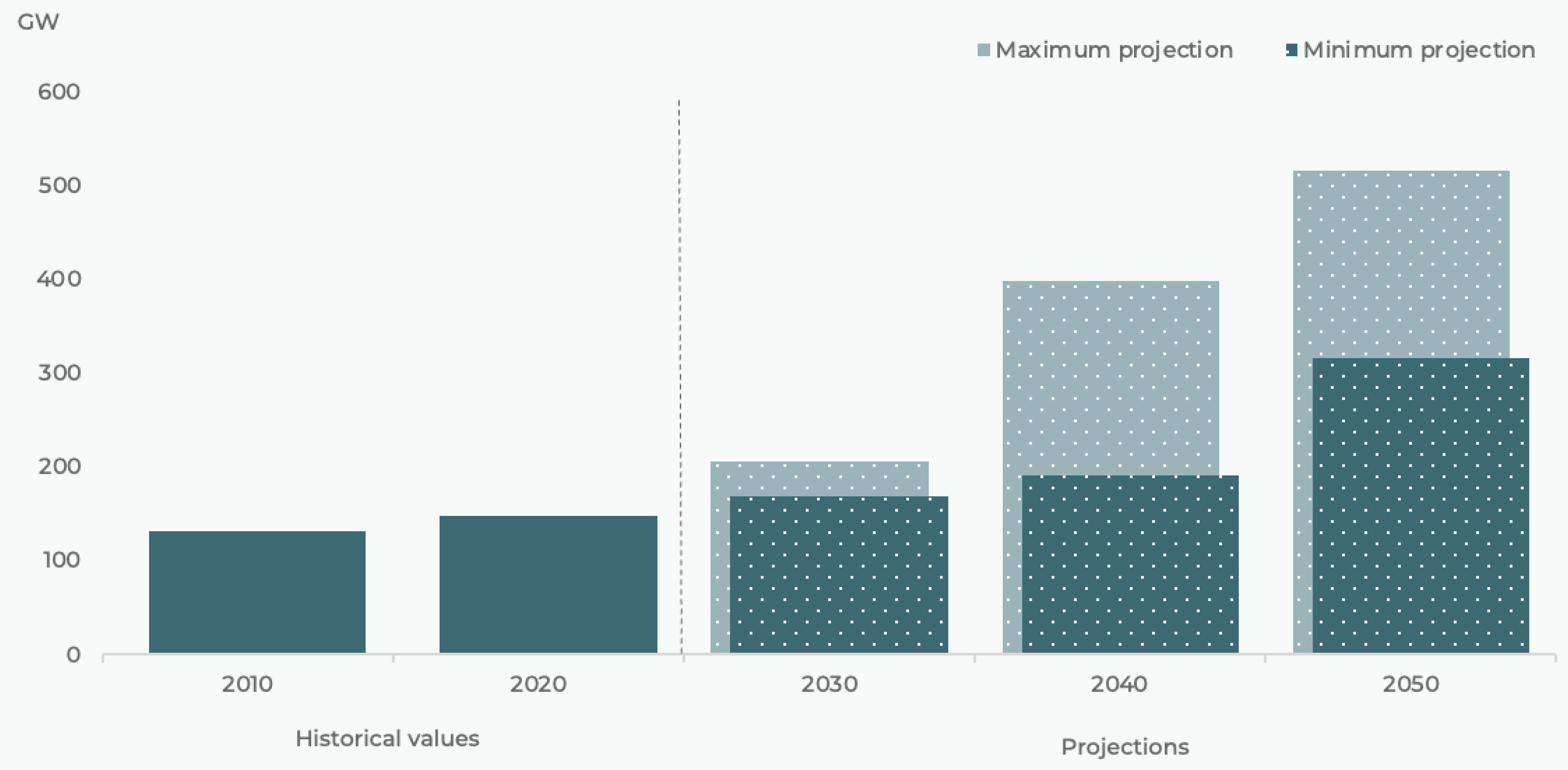
Lee, C. and A. Kanduth (2021). *It's time to double down on safe bets*. https://climatechoices.ca/its-time-to-double-down/

Electrification requires a bigger system

Projections of electricity generation across net zero studies in Canada



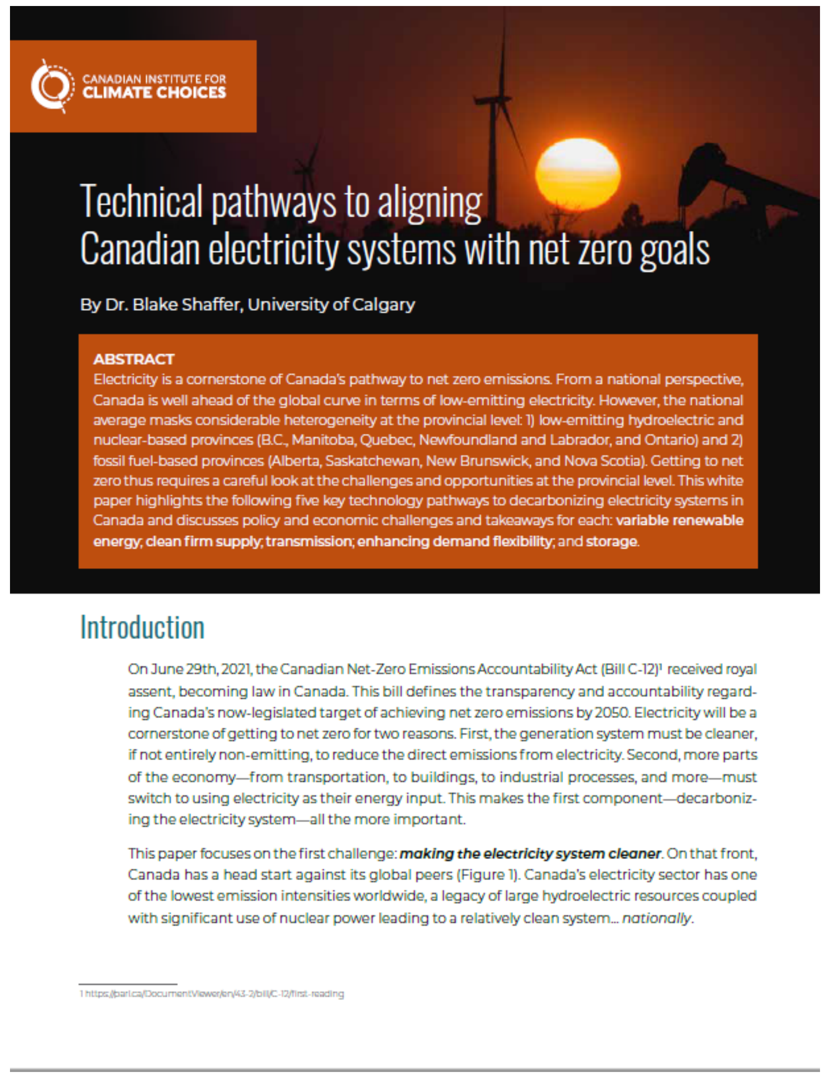
Projections of installed capacity across net zero studies in Canada



Studies:

Enabling electrification requires policy intervention

- **Ensure consistent targets and mandates** across provincial govts, utilities & regulators, and coherence with federal targets
- **Strengthen the carbon pricing signal** relative to what exists under the output-based approach for electricity
- Adopt **targeted policies for electrification**
- Pursue **greater integration of planning** across sectors and across demand and supply



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Technical pathways to aligning Canadian electricity systems with net zero goals

By Dr. Blake Shaffer, University of Calgary

ABSTRACT
Electricity is a cornerstone of Canada's pathway to net zero emissions. From a national perspective, Canada is well ahead of the global curve in terms of low-emitting electricity. However, the national average masks considerable heterogeneity at the provincial level: 1) low-emitting hydroelectric and nuclear-based provinces (B.C., Manitoba, Quebec, Newfoundland and Labrador, and Ontario) and 2) fossil fuel-based provinces (Alberta, Saskatchewan, New Brunswick, and Nova Scotia). Getting to net zero thus requires a careful look at the challenges and opportunities at the provincial level. This white paper highlights the following five key technology pathways to decarbonizing electricity systems in Canada and discusses policy and economic challenges and takeaways for each: **variable renewable energy; clean firm supply; transmission; enhancing demand flexibility;** and **storage**.

Introduction

On June 29th, 2021, the Canadian Net-Zero Emissions Accountability Act (Bill C-12)[1] received royal assent, becoming law in Canada. This bill defines the transparency and accountability regarding Canada's now-legislated target of achieving net zero emissions by 2050. Electricity will be a cornerstone of getting to net zero for two reasons. First, the generation system must be cleaner, if not entirely non-emitting, to reduce the direct emissions from electricity. Second, more parts of the economy—from transportation, to buildings, to industrial processes, and more—must switch to using electricity as their energy input. This makes the first component—decarbonizing the electricity system—all the more important.

This paper focuses on the first challenge: ***making the electricity system cleaner***. On that front, Canada has a head start against its global peers (Figure 1). Canada's electricity sector has one of the lowest emission intensities worldwide, a legacy of large hydroelectric resources coupled with significant use of nuclear power leading to a relatively clean system… *nationally*.

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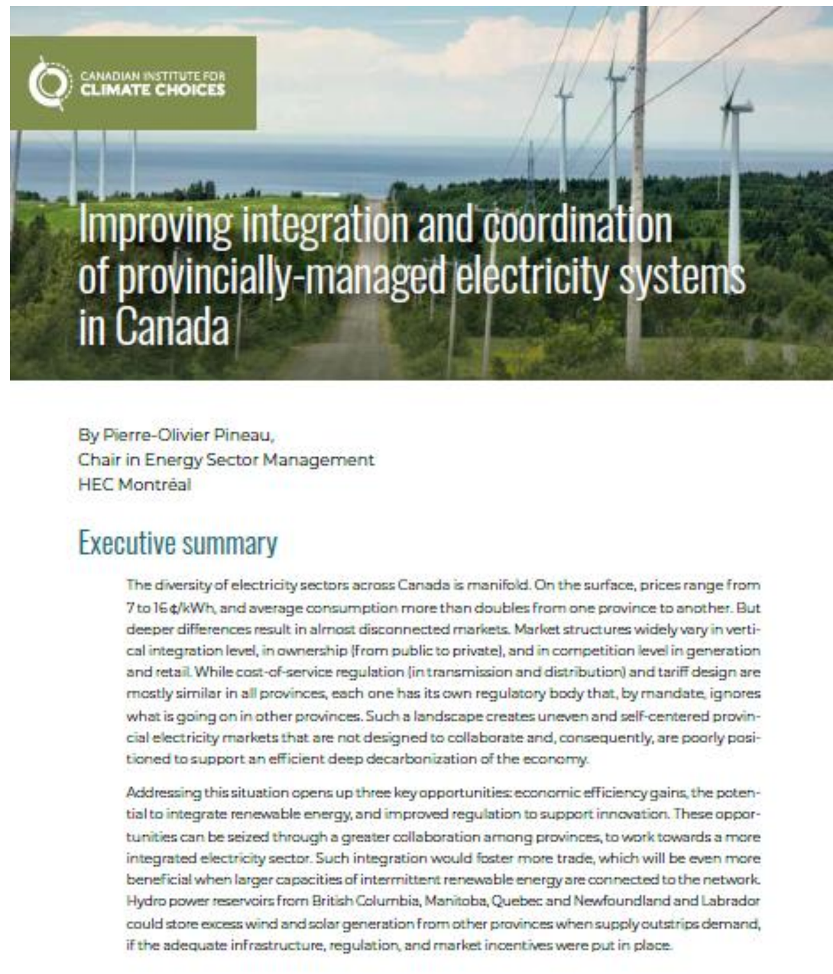
[1] https://parl.ca/DocumentViewer/en/43-2/bill/C-12/first-reading



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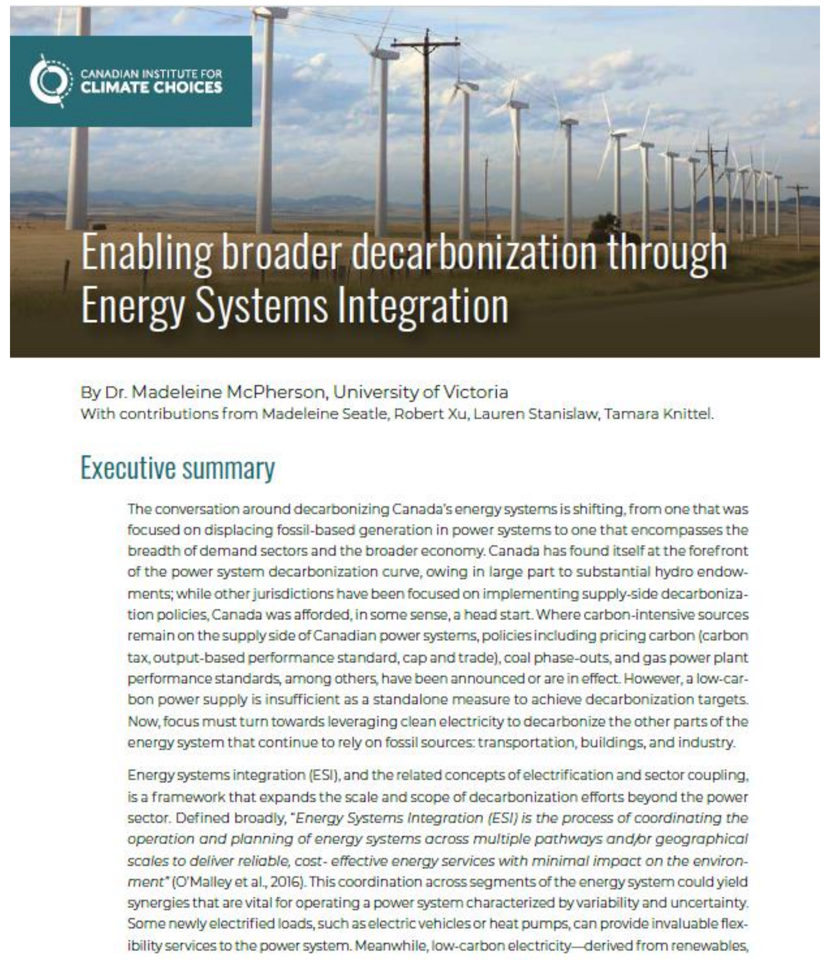
Improving integration and coordination of provincially-managed electricity systems in Canada

By Pierre-Olivier Pineau,
Chair in Energy Sector Management
HEC Montréal

Executive summary

The diversity of electricity sectors across Canada is manifold. On the surface, prices range from 7 to 16 ¢/kWh, and average consumption more than doubles from one province to another. But deeper differences result in almost disconnected markets. Market structures widely vary in vertical integration level, in ownership (from public to private), and in competition level in generation and retail. While cost-of-service regulation (in transmission and distribution) and tariff design are mostly similar in all provinces, each one has its own regulatory body that, by mandate, ignores what is going on in other provinces. Such a landscape creates uneven and self-centered provincial electricity markets that are not designed to collaborate and, consequently, are poorly positioned to support an efficient deep decarbonization of the economy.

Addressing this situation opens up three key opportunities: economic efficiency gains, the potential to integrate renewable energy, and improved regulation to support innovation. These opportunities can be seized through a greater collaboration among provinces, to work towards a more integrated electricity sector. Such integration would foster more trade, which will be even more beneficial when larger capacities of intermittent renewable energy are connected to the network. Hydro power reservoirs from British Columbia, Manitoba, Quebec and Newfoundland and Labrador could store excess wind and solar generation from other provinces when supply outstrips demand, if the adequate infrastructure, regulation, and market incentives were put in place.



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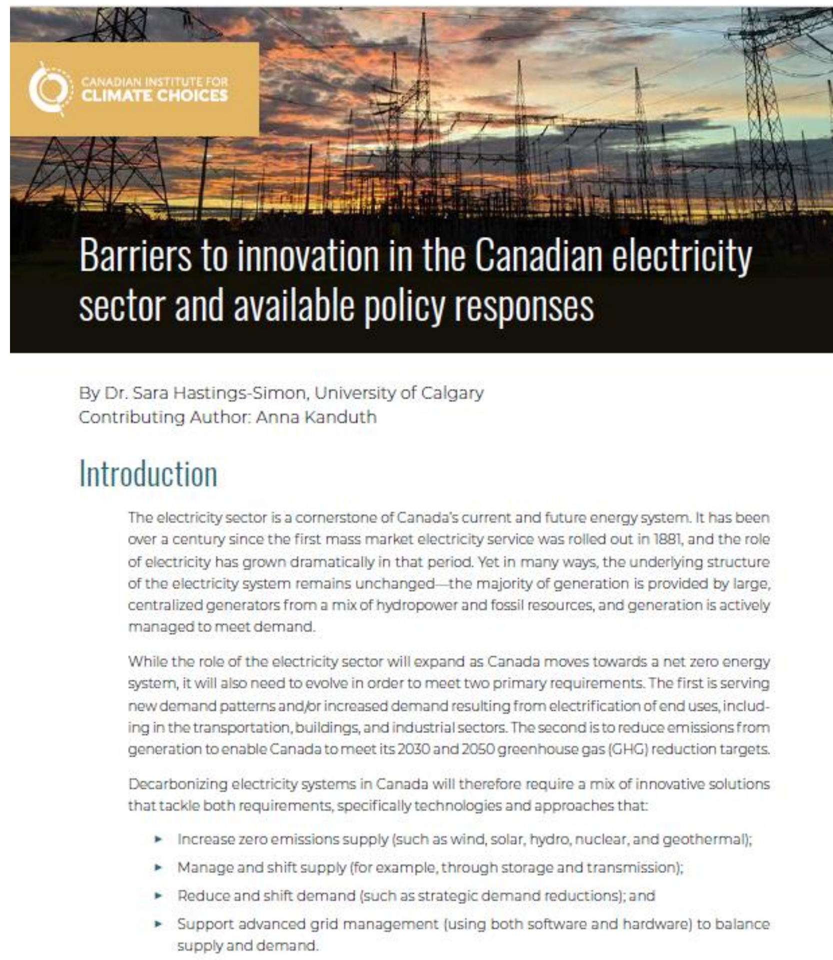
Enabling broader decarbonization through Energy Systems Integration

By Dr. Madeleine McPherson, University of Victoria
With contributions from Madeleine Seatle, Robert Xu, Lauren Stanislaw, Tamara Knittel.

Executive summary

The conversation around decarbonizing Canada's energy systems is shifting, from one that was focused on displacing fossil-based generation in power systems to one that encompasses the breadth of demand sectors and the broader economy. Canada has found itself at the forefront of the power system decarbonization curve, owing in large part to substantial hydro endowments; while other jurisdictions have been focused on implementing supply-side decarbonization policies, Canada was afforded, in some sense, a head start. Where carbon-intensive sources remain on the supply side of Canadian power systems, policies including pricing carbon (carbon tax, output-based performance standard, cap and trade), coal phase-outs, and gas power plant performance standards, among others, have been announced or are in effect. However, a low-carbon power supply is insufficient as a standalone measure to achieve decarbonization targets. Now, focus must turn towards leveraging clean electricity to decarbonize the other parts of the energy system that continue to rely on fossil sources: transportation, buildings, and industry.

Energy systems integration (ESI), and the related concepts of electrification and sector coupling, is a framework that expands the scale and scope of decarbonization efforts beyond the power sector. Defined broadly, "*Energy Systems Integration (ESI) is the process of coordinating the operation and planning of energy systems across multiple pathways and/or geographical scales to deliver reliable, cost- effective energy services with minimal impact on the environment*" (O'Malley et al., 2016). This coordination across segments of the energy system could yield synergies that are vital for operating a power system characterized by variability and uncertainty. Some newly electrified loads, such as electric vehicles or heat pumps, can provide invaluable flexibility services to the power system. Meanwhile, low-carbon electricity—derived from renewables,



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Barriers to innovation in the Canadian electricity sector and available policy responses

By Dr. Sara Hastings-Simon, University of Calgary
Contributing Author: Anna Kanduth

Introduction

The electricity sector is a cornerstone of Canada's current and future energy system. It has been over a century since the first mass market electricity service was rolled out in 1881, and the role of electricity has grown dramatically in that period. Yet in many ways, the underlying structure of the electricity system remains unchanged—the majority of generation is provided by large, centralized generators from a mix of hydropower and fossil resources, and generation is actively managed to meet demand.

While the role of the electricity sector will expand as Canada moves towards a net zero energy system, it will also need to evolve in order to meet two primary requirements. The first is serving new demand patterns and/or increased demand resulting from electrification of end uses, including in the transportation, buildings, and industrial sectors. The second is to reduce emissions from generation to enable Canada to meet its 2030 and 2050 greenhouse gas (GHG) reduction targets.

Decarbonizing electricity systems in Canada will therefore require a mix of innovative solutions that tackle both requirements, specifically technologies and approaches that:

- Increase zero emissions supply (such as wind, solar, hydro, nuclear, and geothermal);
- Manage and shift supply (for example, through storage and transmission);
- Reduce and shift demand (such as strategic demand reductions); and
- Support advanced grid management (using both software and hardware) to balance supply and demand.

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Project: Aligning electricity with net zero

- “The What”
  - Outline what needs to change in Canada’s electricity systems to support economy-wide net zero by 2050
- “The How”
  - Identify key barriers likely to impede transformation (market, policy/institutional, social or technical)
  - Recommend a core set of interventions
- Out of scope: policies directing targeting electrification
- Planned release: March 2022

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