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TransCanada Power Corridor: A National Grid Uniting Canada

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NOVEMBER 20, 2025

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ACRONYMS AND ABBREVIATIONS

AC	alternating current
AI	artificial intelligence
ASHPs	air source heat pumps
ECCC	Environment and Climate Change Canada
EGS	enhanced geothermal systems
EVs	electric vehicles
GHG	greenhouse gas
GPS	geothermal power systems
GSHPs	ground source heat pumps
HVDC	high-voltage direct current
ICTs	information and communication technologies
IEA	International Energy Agency
IFR	integral fast reactor
PV	photovoltaic
SMRs	small modular reactors
VPPS	virtual power plants
WGSI	Waterloo Global Science Initiative

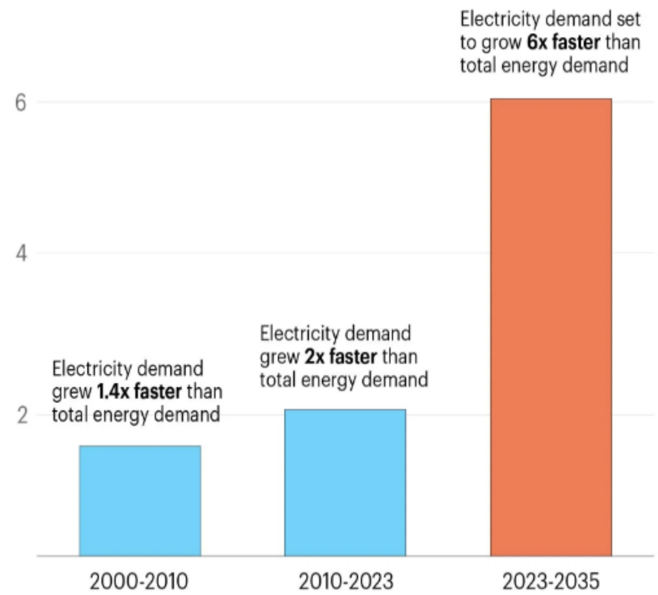
EXECUTIVE SUMMARY

Canada was shaped in the late 1890s as a nation — integrated by the "technology" of that era, the railroad. Similar to the immense impact of the railroad on Canada's economy and capabilities in Canada's early days, in this paper we present a transformational blueprint for Canada's transition to a sustainable, clean energy, and a highly robust economy. The blueprint developed in this report is to help transform Canada's energy landscape to be "fit-for-purpose" for the twenty-first century, enabling completely new sets of technological capabilities and new opportunities for high-value-add exports. Our vision is to establish "**broad-based electrification**" as the cornerstone of a national strategy, linked to a continent-scale 'West–East' power corridor. The national grid will not only serve as the backbone of Canada's energy system but will also function as a unifying national force for the growth of new enterprises, products and services, investment and employment opportunities.

The TransCanada Power Corridor is a "national infrastructure flagship project" — fully aligned with national priorities for sovereignty, export expansion and clean energy development. Establishing a national grid, capable of integrating all the diverse resources of each of the provinces, is a commitment to enhanced energy-security goals and balancing resource development across the energy landscape that meets Canada's international climate obligations.

There is an urgency to shape a timely response to emerging geopolitical risks and threats to Canada's sovereignty. The necessity lies in establishing a national energy economy that is resilient to the threats of climate-induced shocks and to "future proofing" critical infrastructure that supports national economic growth. The global trend towards a massive increase in electrification is clear and well established. The goal of this report is to amplify and build on the existing advantage of Canada's clean power grid. Accelerated expansion of the electricity sector with minimal dependence on the use of fossil fuels (<20 percent share in final energy consumption) is achievable in the 2050–2060 time frame. Timely investments in the transmission infrastructure for improved interconnection capability (2025-2035), rapid deployment of existing commercially proven technologies (2025-2040) and development of new transformative technologies in the 2035–2050 time frame will be necessary. Achieving a dramatic reduction in annual carbon emissions, greater than 70 percent, from the current level

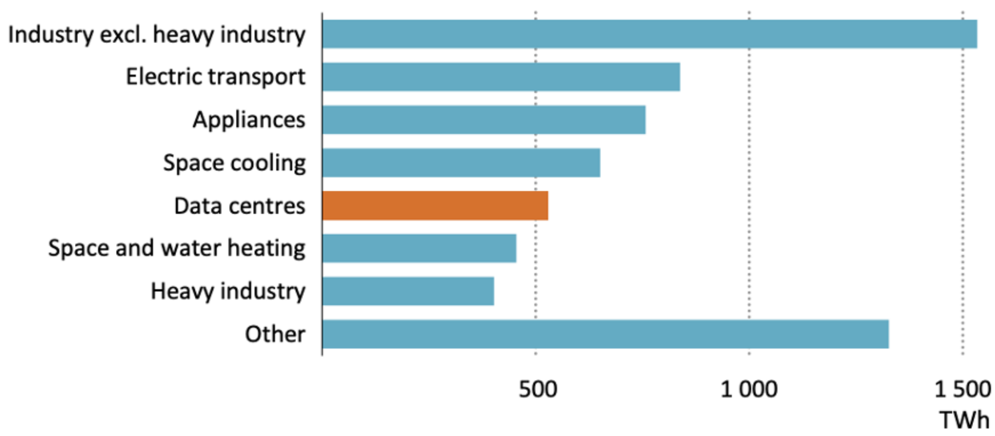
Figure 1: Growth and Electricity Demand



Source: IEA (2024). Accessed at: https://www.voronoiapp.com/energy/The-world-is-set-to-move-rapidly-into-the-Age-of-Electricity-2763#visualization of 700 Mt to 200 Mt is feasible and it meets the national obligations. The focus in this report is primarily on attracting new investments in this growth sector, with minimal reliance on policy instruments such as carbon tax, cap-and-trade or government subsidies.

The unique and unifying features of a national grid are its capacity to absorb, integrate and transfer clean energy resources reliably from each of the provinces for overall national benefit through enhanced electricity trade. A national grid — co-located with the existing railway right of ways where practical — can minimize land-use impacts and support faster permitting and approvals processes. Accelerated displacement of fossil fuels with non-carbon electricity generation (hydro, nuclear, geothermal, wind and solar with storage, and smart grids) and a deep resource base of critical minerals for the end-use sector are Canada's advantage. The strategy is to increase the share of electricity in the final energy demand to displace oil and gas as the primary energy carrier across all sectors of the economy. Clean electricity, as a high-value manufactured product, delivers measurable economic and environmental gains while providing a uniquely flexible, reliable, and secure access to energy for all end uses.

Figure 2: Increase in Electricity Demand by Sectors, 2024–2030



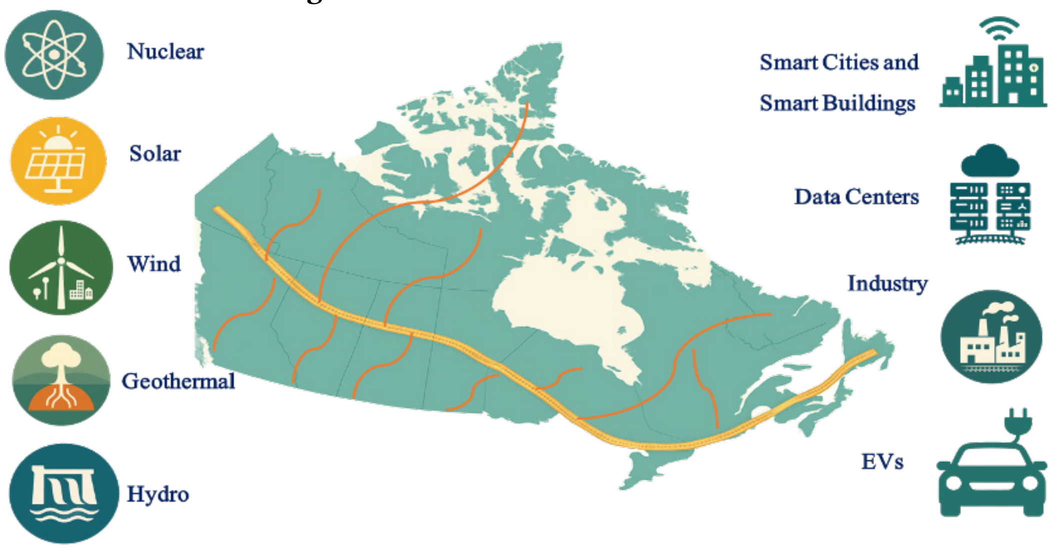
Source: IEA (2025).

Generation, transmission and intelligent distribution of electricity emerge as the enablers of a digital economy capable of accelerating artificial intelligence (AI)-enabled productivity gains for business enterprises, industry and services. The hardware, software and service offerings that drive the intangibles economy will remain integral to this new energy landscape, positioning Canada as a global powerhouse of innovation and technological prowess.

Transforming Canada's energy landscape requires a dramatic rethinking of how electricity is generated, distributed and managed through existing regulatory frameworks in each province. Bold thinking is the first step in the creation of a completely new set of industries and capabilities in Canada for the benefit of Canadians. The national competitive advantage shifts towards building capacity that delivers innovative, new and advanced system design, engineering, manufacturing, and operation and maintenance capabilities in support of the development and construction of this national, clean integrated energy system. This blueprint focuses on the question: "What future do we want to create?" to develop the necessary capabilities that will not only result in the creation of thousands of high-value new jobs but will also ensure other nations recognize Canada as a subject-matter expert in these transformational energy projects. The broader national goals of opening large export market opportunities — both products and services — in clean energy generation and the primary role of electricity in the intangibles economy aligns strongly with the urgency of developing a national power grid.

This vision of the TransCanada Power Corridor, linking all provinces and regions of Canada from the West to the East, is an integral part of a national grid to allow seamless flow of electricity for trade. This aspirational goal can only be achieved as part of a "whole-of-government, whole-of-society approach" requiring accelerated permitting and regulatory clarity. For substantial social, economic and political benefits of a unified country to be realized, development of this corridor is of utmost national urgency. Although the aspirational goal is a linked power corridor across Canada, a practical emergence of the concept will be through regional grids (West, Central and East) connected at key nodal points for maintaining system security and to allow seamless flow electricity for trade. This report highlights key recommendations for future work to address significant challenges of governance, regulation, trade and finance.

Figure 3: TransCanada Power Corridor



Source: Authors.

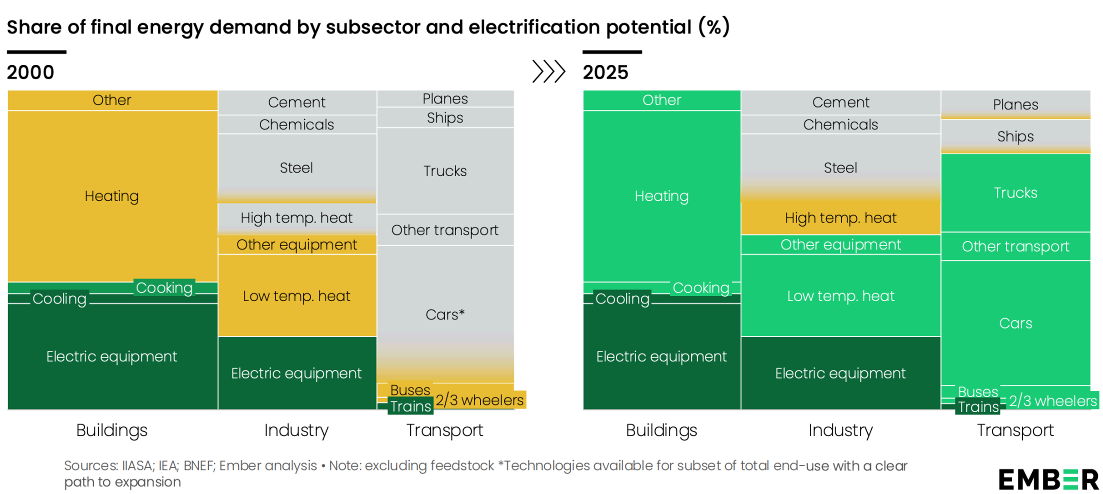
INTRODUCTION

A blueprint for Canada's sustainable transition to a clean energy economy must be developed to not only reimagine Canada's energy landscape, but to promote the establishment of a TransCanada Power Corridor[1] in lieu of additional oil and gas pipelines. The necessity of this undertaking lies in building a national energy economy that is resilient to the threats of geopolitical risks and to "future proofing" critical national infrastructure against climate-induced shocks. The emerging financial costs of mitigating the risks of climate change has serious potential to undermine the fiscal capacity of households, businesses and governments. Broad-based electrification offers an effective and potent pathway to enhance growth in national economic productivity.

Canada's energy system sits at the centre of a converging storm and requires a timely response to emerging geopolitical risks and threats to Canada's sovereignty. Historically, the use and dominance of fossil fuels (coal, oil, gas) has been a significant positive contributor to our economic and social well-being. Paradoxically, fossil fuel carbon emissions are at the core of a destabilizing force driving global warming and disrupting the integrity of the bio-physical environment (land, water, air) upon which all primary resources depend to sustain livelihoods.

The establishment of a high voltage TransCanada Power Corridor — from the West to the East is proposed here — preferably co-located with existing railway right of ways where practical — as the backbone of a national project. Accelerated displacement of fossil fuels with non-carbon electricity generation (hydro, nuclear, geothermal, wind and solar with storage) is an advantage that Canada has over many jurisdictions and offers the potential for deep decarbonization through a high share of electricity in the final energy demand. Electricity would replace oil and gas as the primary energy carrier for all sectors of the economy delivering significant economic and environmental benefits. As shown in Figure 3, greater than 75 percent of primary energy demand can be electrified economically.

Figure 4: Potential for Final Energy Demand to be Electrified Economically



Source: Ember (2025).

Why a National Project?

Energy security and national security are the twin pillars at the core of national sovereignty. The combined diverse energy resources of each province comprise a large strategic national endowment and, when integrated into a national transmission and electricity trading system, becomes a unifying national advantage that offers the possibilities of enhanced trade across provincial boundaries and improving Canada's national productivity. Global trends indicate anticipated demand for electricity increasing sixfold within the next decade (see Figures 14a and 14b below).

Generation, transmission and intelligent distribution of electricity emerge as the backbone of a digital economy capable of accelerating AI-enabled productivity gains for business enterprises, industry and services. The primary source of new economic value rests on creation of an intangibles economy enabled by access to clean, affordable electricity.

The national narrative must, therefore, necessarily shift away from future investments in oil and gas pipelines to investment in the creation of an west–east power corridor that facilitates the seamless transfer of energy from each province into a national grid. The vision presented in this report of an west–east power corridor satisfies the requirement for a key national strategy: a unifying force that combines social, economic and environmental benefits for all of Canada.

Canada's Energy System is at a Crossroads

The rupture of an established trading and security relationship with the United States not only poses a unique risk to Canada's national sovereignty but it compounds the difficulties of achieving a low-carbon transition. In addition, the cascading and unpredictable impacts of climate change — evident in the increasing frequency and severity of fires, floods, droughts, hurricanes, extreme heat and cold — pose fundamental threats to our social and economic well-being.

Canadians rely primarily on fossil fuel resources to meet the demand for energy services dominated by transport (oil), buildings (natural gas), industry and manufacturing (oil/coal/gas), and food production (fertilizers). At end use, the dependence on fossil fuels is the primary source of greenhouse gas (GHG) emissions (CO_2): ~75 percent of national carbon emissions. Canada is also a major exporter of oil and gas.[2]

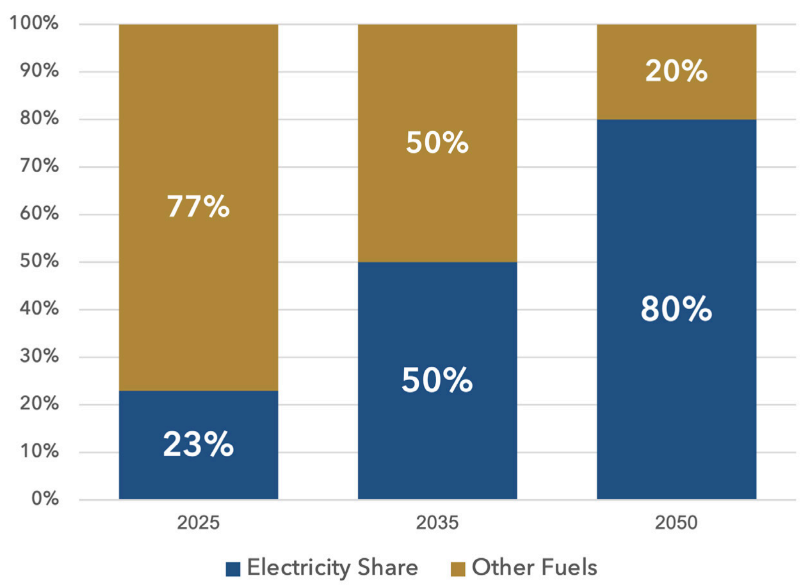
This blueprint promotes a national strategy for an accelerated transformation of the existing energy infrastructure away from dependence on fossil fuels. Deep decarbonization is achievable through direct displacement of fossil fuels and the substitution of energy demand through electrification of heating, cooling and mobility requirements.[3] The creation of a clean, robust and resilient energy system as the backbone for Canada's future prosperity rests on an increasing share of electricity in final energy consumption.

Figure 5 (below) demonstrates the progression away from nonrenewable fuel types toward a broad-based electrification model of Canada's energy system. It demonstrates the phased electrification targets to be met in order to achieve 80 percent of total energy consumption as electricity by 2050. Although this is a challenging vision involving a massive expansion of the electricity sector, it is a necessary transformation for addressing the urgency of maintaining Canada's sovereignty.

To achieve the intermediate stepping stone of 50 percent for electricity's share of the total by 2035, from the current 23 percent in 2025, would be a generational shift, and requires rapid approvals of the existing system's expansion plans by the provinces. For example, Ontario's plan[4] is in lockstep with the vision presented in this report of the transition required to address the formidable challenge, the targets to be achieved decade over decade and the outcomes in terms of carbon reduction emissions consistent with Canada's national commitments. In light of the expediency, there is a compelling need for critical decisions to be made by 2027 supported by analysis, approvals and investment decisions to proceed with specific projects.

As projects and proposals begin to come to fruition between 2027–2035, further development of a pipeline of new projects linked to investment decisions must be established through a national framework, preferably by the Government of Canada's Major Projects Office, for initiation and completion in the 2035–2050 time frame. The TransCanada Power Corridor is a national flagship project, achieved through integration of regional hubs (West, Central, East) connected and operated as part of a national grid allowing substantial benefits of electricity trade across Canada over the coming decades.

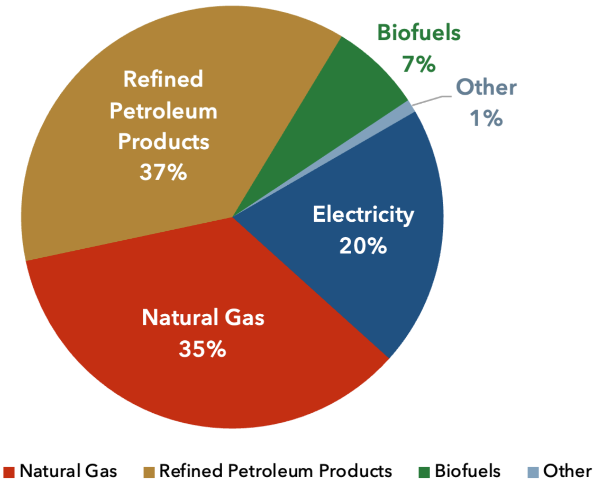
Figure 5: Canada: Electricity Share of Final Energy Consumption



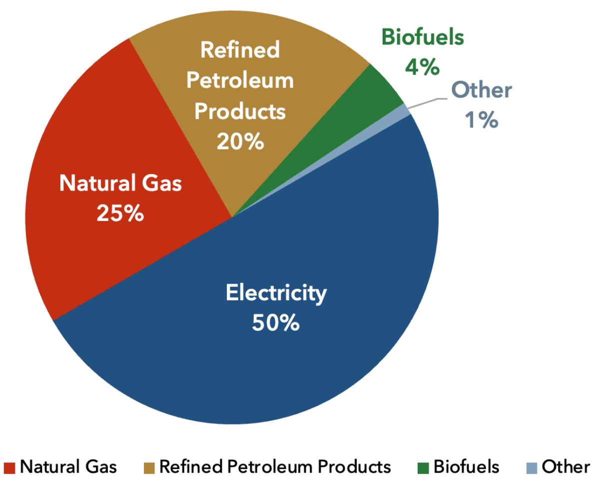
Source: Author. For 2025 share, see Canada Energy Factbook (2025).

Figures 6a and 6b: A Comparative Perspective of Final Energy Consumption for 2025 and the Projected Energy Demand Forecast for 2035 and 2050

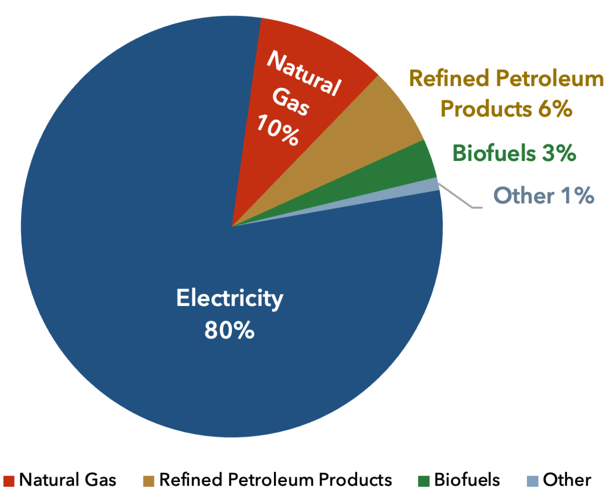
Canada: Energy Consumption by Fuel Type (2025)



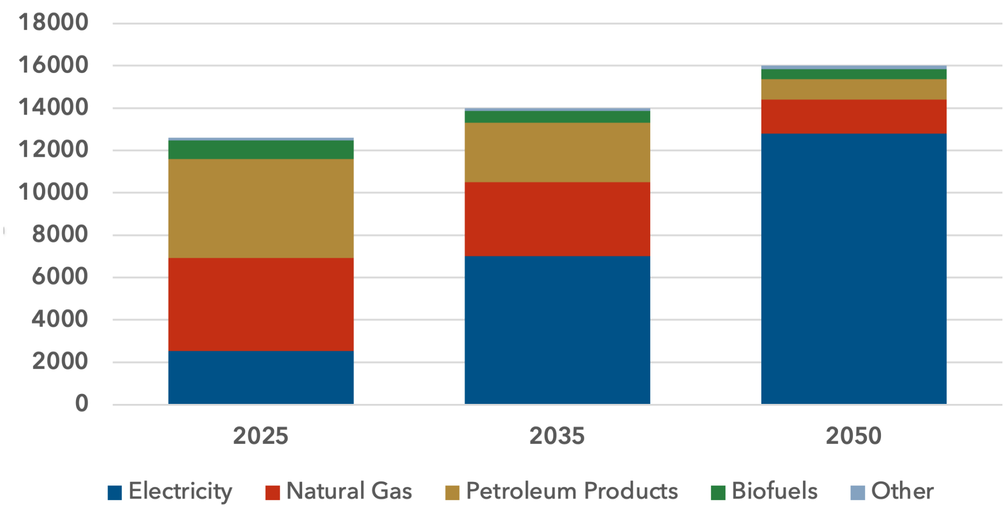
Canada: Energy Consumption by Fuel Type (2035)



Canada: Energy Consumption by Fuel Type (2050)



Canada: Energy Consumption by Fuel Type (2025, 2035, 2050)



Source: Authors. For 2025 share, see Canada Energy Factbook (2025).

In order to meet these electricity consumption demands and adjust investment/shares in renewable energy, displacement of refined petroleum products and other non-renewables were calculated accordingly (see Table 1 below).

Table 1: Projected Electricity System Growth Requirements for a Canadian Broad-based Electrification Strategy

Metric	2025	2035	2050
Total energy consumption (PJ)	12,600 [3500 TWh]	14,000 [3900 TWh]	16,000 [4450 TWh]
Oil and gas share of total (PJ)	8,500	~7,000	~3,000
Electricity share of total (PJ)	2,520 (~23%)	7,000 (~50%)	12,800 (~80%)
Electricity system growth requirements (TWh)	700	~1,950	~3,550
Installed electricity capacity (GW)	80	~220	~400

Data Sources: Intergovernmental Panel on Climate Change (2021) and Canada Energy Factbook (2025).

Notes: 1PJ= 0.27778T Wh; Emission factors for combusted oil are 0.073 Mt CO2e per PJ and 0.053 Mt C02e per PJ for natural gas.

A Reimagined Energy Landscape for Canada: Journey to 2050

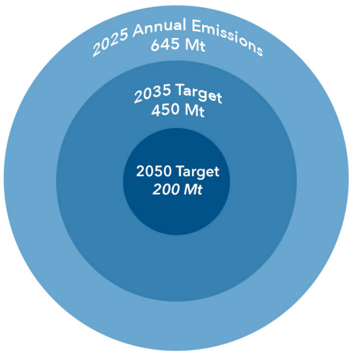
Reimagining Canada's energy infrastructure for the twenty-first century requires revisiting Sir John A. MacDonald's vision of Canada. Given the historical challenges of early nation-building in the late 1890s, leveraging the key enabling technologies of that era — the railway and railroad — as unification tools proved to be a successful endeavour. Leveraging the key enabling "technology" of that era, the railway and the railroad, proved to be a good bet.

> *The TransCanada Power Corridor is the critical enabler to establish broad-based electrification of the entire economy as the cornerstone of a national strategy for improving productivity and reducing the threats to sovereignty. A continent-scale national grid, linking the West to the East becomes the backbone of Canada's national energy system with opportunities for enhanced trade in electricity across the provinces.*
>
> *The objective of minimal dependence on use of fossil fuels (<20 percent share in final energy consumption) by 2050 can be achieved through a national flagship project underpinned by a strong commitment to the principles of collaborative federalism and advancement of Canada's collective national interest.*

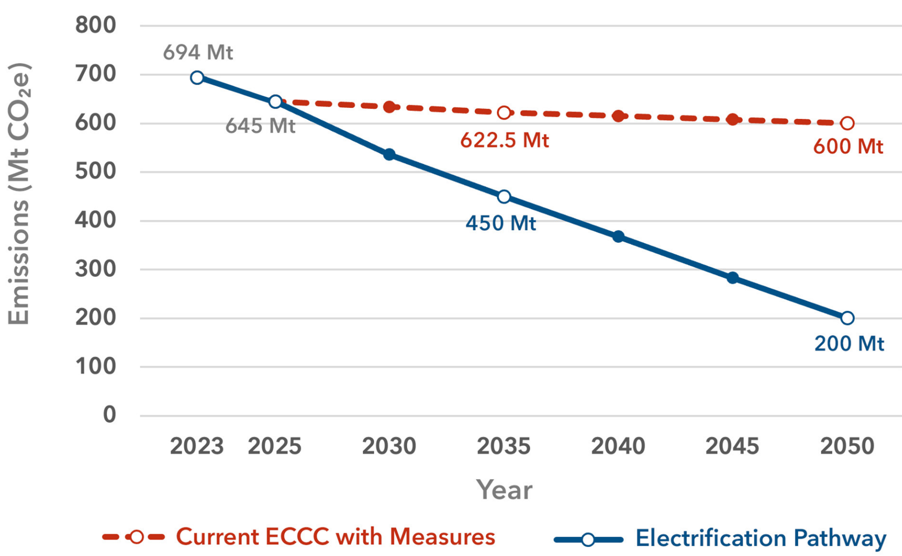
Figure 7 below demonstrates the net positive effects of deep electrification on GHG emissions reduction. Environment and Climate Change Canada's (ECCC's) projection anticipates a reduction to just above or below 600 Mt by 2040 under current measures. The energy-displacement scenario presented in this report envisions a much more aggressive emissions drop, reaching around 200 Mt by 2050.

Figure 7: Projected Reduction of GHG Emissions in Canada (2023–2050)

Canada's Emissions Pathway: 2025 → 2035 → 2050



Source: CEA Advisory Council Report, Authors.



A clean, electrified energy landscape will not only deliver economic, social and environmental benefits, but also serve as a transformative national project — creating new talent, skill sets and technological capabilities, as well as avenues of growth that would otherwise be impossible to establish in Canada. An "electrons-based" energy system will drive information and communication technologies (ICTs) and the potential of AI-enabled value-creation for all sectors of the economy.

The energy system today is a mirror to the past. It is deeply rooted in the endowment of natural resources within each province and the historical context of its development. The choices that were made reflect the accommodation and compromises among leaders and communities in the past. The complex linkages that underpin the development, design, operation, delivery and flow of energy services from extraction to production and final use must be considered in the investment analysis for the initiation of such a project. In addition, review of the entire context of regulation and management of a national grid in Canada would be necessary given the primacy of provincial jurisdiction over natural resources.

To begin, we ask the question, "What future do we want?" and then work backwards to identify the pathways and technologies that can bring about a transformative change of an energy system no longer dependent on fossil fuels. The entire infrastructure supporting the end-state of a low-carbon energy ecosystem is feasible by considering the promise and potential of emerging technologies across the entire supply chain from generation, transmission and distribution and end-use applications.

Outlined below are the necessary building blocks comprising the major features of the overall energy system architecture for Canada to 2050: generation capacity of each province; transmission and distribution of energy with integration of each province's diverse energy supply into a national grid; and the development and distribution of energy to end users through smart grids and distributed local-level resources.

In lieu of oil and gas as the primary vectors for meeting Canada's energy demand, an electrified future with dedicated investments to support a high-voltage national electricity transmission corridor (high-voltage direct current [HVDC] or alternating current [AC]) as the primary carrier of energy services for inter- and intra-provincial requirements is envisioned.

This vision requires a rapid transformation of Canada's energy system that is no longer dependent on fossil fuel resources at the base of the energy pyramid. Electricity emerges as the key energy input across all sectors of the economy. The availability and the diversity of supply resources within each province introduces flexibility to displace oil and gas resulting in meaningful lowering of emissions and mitigating the threats of climate risk.

Electricity is a high-value manufactured product and a core enabler of the transformation required for a low-carbon energy economy. Smart (intelligent) distribution of electricity through decentralized networks will shape all aspects of our lives — where we live, work, play, learn, communicate and plan for thriving communities.

Global trends are accelerating the demand for electricity: adoption of digital technologies in business and industry (generative AI, data centres), electric mobility for transport (electric vehicles [EVs], mass transit, fleets and heavy trucks), space cooling and heating (heat pumps, geo-exchange). Diverse primary energy resources in each province (hydro, wind, solar, nuclear, geothermal and bioenergy) are capable of displacing fossil fuels throughout the energy supply chain.

With the compounded benefits of achieving a low-carbon energy system through the development of clean energy resources, a deliberate investment strategy for infrastructure development is required to shape and meet the demand for electricity. A commitment to promote an increase in the share of electricity in final energy demand will act as a spur for increased economic productivity in industry and commercial enterprises.

Measurable, Tangible Action

The clearest tangible action is to increase the share of electricity in final energy consumption. The current existing share of electricity in final consumption is at 23 percent. In two steps, the share of electricity in final energy use must rise to 50 percent by 2035 and 80 percent in 2050. Clean electricity development and its increasing share in the final energy consumption becomes the propellant of economic growth and the foundation for new economic value creation — the intangibles economy. Such an ambitious transformation necessarily involves a change of the vectors of energy transfer: displacement of oil and gas pipelines by a national power transmission corridor — a departure from energy transfer by molecules of hydrocarbons with electrons from hydro, nuclear, solar and wind, and geothermal resources.

The pathway to 2035 is an intermediate stepping stone that builds on the existing system's expansion plans of each province with clear commitments to investment decisions required for specific projects in the next 24 months. The investment decisions for the intermediate (2035–2050) time frame would be governed by a consideration of new and emerging innovations, technologies and feedback from lessons learned in the early phase. A "stage-gate" approvals process for critical investments in a broad portfolio of clean energy technologies will be an iterative process that allows for adjustments and the incorporation of new technologies to deliver the end-state of 80 percent share of electricity in total consumption in the 2050–2060 time frame.

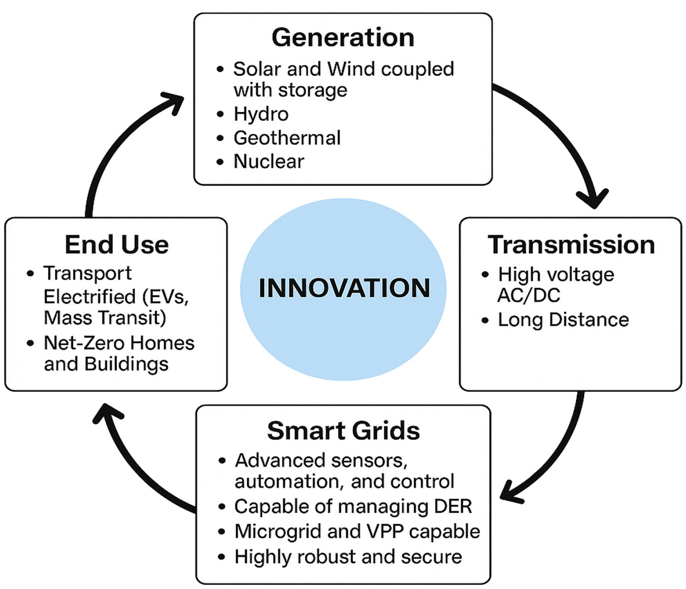
The basic building blocks for the transformation include:

- **Transmission**: High voltage (AC or DC) lines over long distances including interconnections with provincial grids.

- **Generation**: A clean electricity supply mix, adjusting for the natural resource endowment of each province and its technical and economic feasibility, will be a combination of primary non-carbon resources that include:
    - hydro;
    - nuclear;
    - wind and solar (on a large scale) with storage; and
    - geothermal resources (shallow and deep).
- **Smart Grids:** A highly sophisticated and resilient modern grid with advanced sensors and two-way communication capabilities to manage the flow of electricity also allowing for efficient management of distributed energy resources (DERs), micro-grids, and virtual power plants (VPPs) with a strong digital presence (ICT and AI applications).
- **End Use**: Electrified transport (EVs, mass transit, fleets and freight), and a transition to net-zero homes, which are ideally 100 percent electrified and, as much as possible, include on-premise solar photovoltaic (PV) generation. Advanced heat pump technologies for heating and cooling offer cost-effective electrified solutions in the commercial and industrial sectors for process heat.

All of the above offer a clear pathway for cost-effective displacement of oil and gas with electricity.

Figure 8: Flow Diagram Demonstrating an Innovative Pathway



Source: Authors.

The core elements of a clean energy system comprise generation linked by transmission of electricity (HVDC or AC) over long distances along an east–west national corridor, combining different forms of generation across provinces as inputs into the national grid. The national grid serves as the backbone for fully and effectively utilizing each province's resource base, enabling trade, seamless interprovincial transfers, and the balancing of supply and demand across Canada's interconnected networks. This is technically feasible and has been demonstrated over the past six decades in the operation of the existing system, although currently, the flows are mainly north–south to US markets.

The core elements of the energy system shown in Figure 8 are described further in the "Transmission" and "Generation" sections below.

The national grid enables cost-effective integration and expansion of the provincial resource base in support of a broad-based electrification strategy for end-use energy services in all sectors including transport (EVs, mass transit, freight), net-zero homes and buildings (heating and cooling with heat pumps) and industrial process requirements.

Smart grids will be integral to the distribution system supporting distributed resources (small-scale generation, micro-grids and VPPs). With the emergence of AI and the digital economy, smart urbanization enabled through distributed energy resources demonstrates a clear pathway for efficiency and productivity gains in all end use sectors of the economy.

Canada's reimagined energy landscape will require a *fivefold increase* in the installed electricity system capacity from 80 GW (2025) to 400 GW (2050) resulting in a decrease of carbon emissions from 700 Mt to 200 Mt (see Table 1). The scope and scale of the bold vision presented here means Canada's future electricity system will displace 12,800 PJ of oil and gas energy, delivering 3550 TWh, serving all sectors of the economy by 2050. The intermediate stepping stone to 2035 is intended to calibrate the decisions required for achieving the target for the 2050–2060 time frame. The formidable challenge for Canada's energy transition rests on being able to achieve a fivefold increase in the installed system capacity with near-zero or low-carbon solutions by 2050.

The massive expansion of electricity requirements is directly related to the displacement of oil and gas, and the new demand emerging from data centres and expected growth of AI applications across the economy.

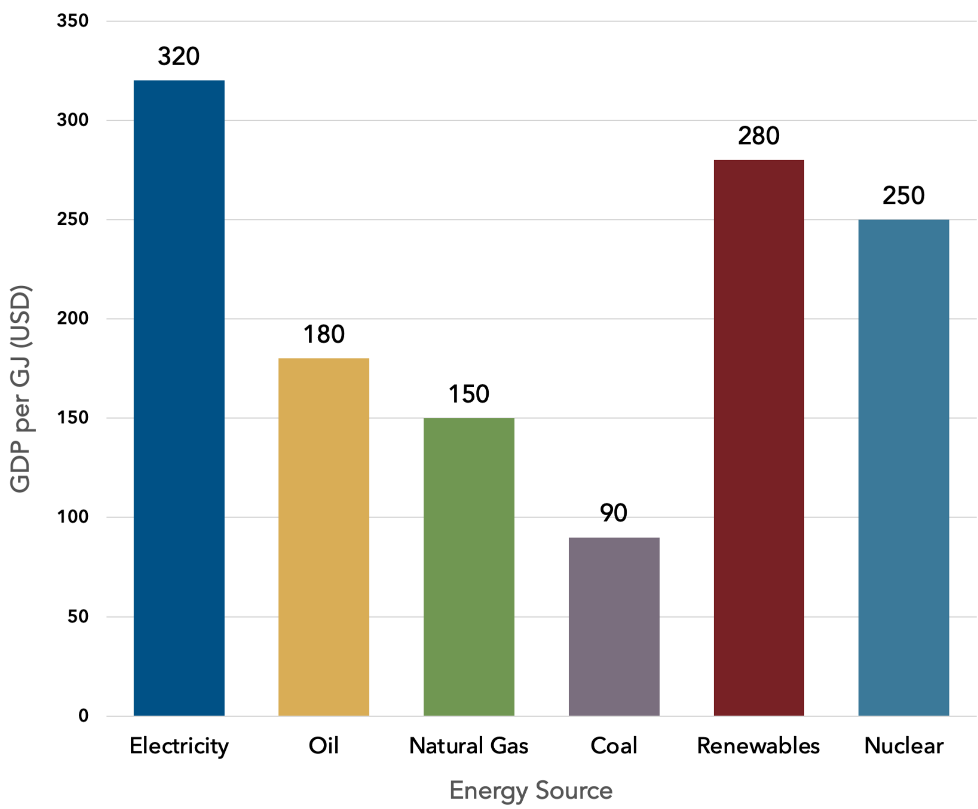
The most cost-effective and rapid pathways for electrification with the greatest potential to reduce greenhouse gas emissions are found in sectors where commercially available technologies already exist. These include transportation (electric vehicles, freight, mass transit, and rail); buildings for space heating and cooling (air-source and geo-exchange heat pumps); and industry (electric arc furnaces for steelmaking and electrified process heating in manufacturing). The displacement of 4,000 PJ of oil corresponds to an emissions reduction of approximately 292 Mt CO_2e, while displacing 4,000 PJ of natural gas yields a reduction of about 224 Mt CO_2e.

Why Electricity? The Economic Value of Electrification is High

Electricity's contribution to GDP growth is greater by a large margin in comparison to fossil fuel resources. Electricity is a higher-quality form of energy — more efficient and versatile — and those sectors relying heavily on electricity (for example, technology, services, manufacturing) tend to have higher productivity per unit of energy. Electricity intensity (electricity consumed per dollar of GDP) is generally lower than total energy intensity, indicating greater economic output per unit of electricity. For example, energy intensity (energy consumed per dollar of GDP) in Canada has declined by ~39 percent since 1971.[5] This reflects improved energy efficiency, structural shifts in the economy (such as advanced manufacturing, ICT) and adoption of cleaner technologies.

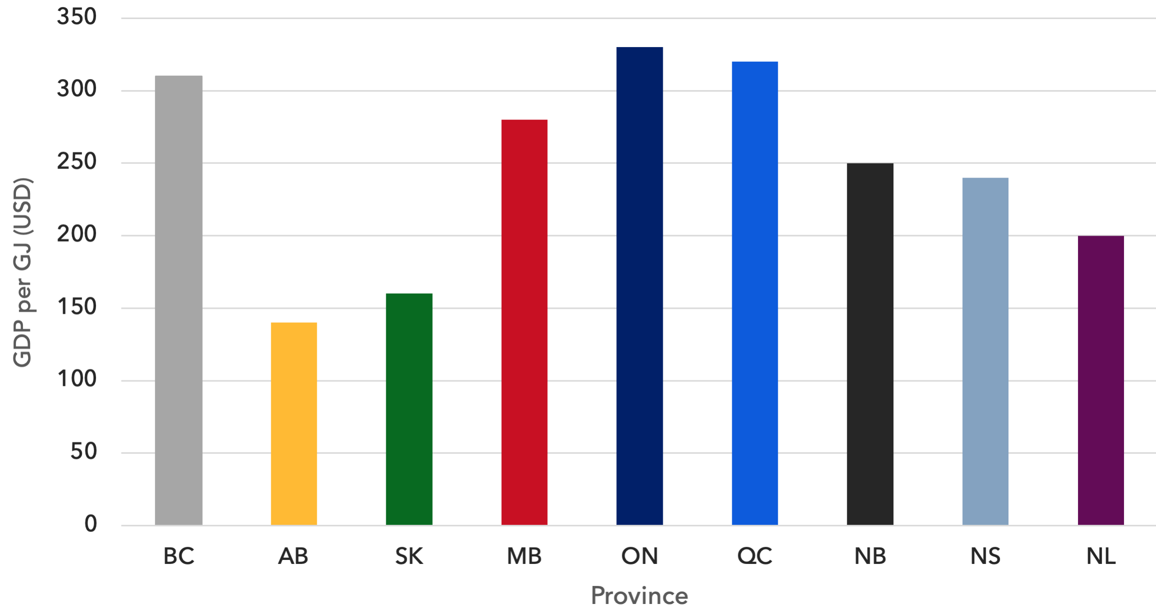
Electricity delivers the highest GDP per gigajoule (GJ), reflecting its role in high-value sectors like services, tec, and manufacturing (Stern and Cleveland 2009; Fouquet and Pearson 2011). Figures 9a and 9b below are a visual comparison of GDP output per unit of energy by source in Canada with renewables and nuclear indicating a stronger productivity profile compared to coal, oil and natural gas.

Figure 9a: GDP per Unit of Energy Use by Resource Type in Canada



Source: Authors, from data compiled from: Government of Canada (2024); Our World in Data (2024); U.S. Energy Information Administration (2024); Statistics Canada (2024); Enerdata, (2024); Energy Hub (2024).

Figure 9b: GDP per Unit of Energy Use by Province in Canada



Source: Authors, from data compiled from (ibid.).

Ontario and British Columbia lead in energy productivity, with the highest GDP per GJ, reflecting efficient energy use and strong service-based economies. Quebec and Manitoba also show high productivity, likely due to their reliance on hydroelectric power. Alberta and Saskatchewan have lower GDP per GJ, reflecting energy-intensive industries such as oil, gas and mining. Newfoundland and Labrador and Nova Scotia show moderate productivity, influenced by mixed energy sources and economic structures.

The sectoral differences demonstrate how oil sands and heavy industry are energy intensive but contribute less to GDP per unit of energy, whereas commercial, public and the ICT sectors, which are more electrified, show higher GDP returns per unit energy (Canada Energy Regulator 2019).

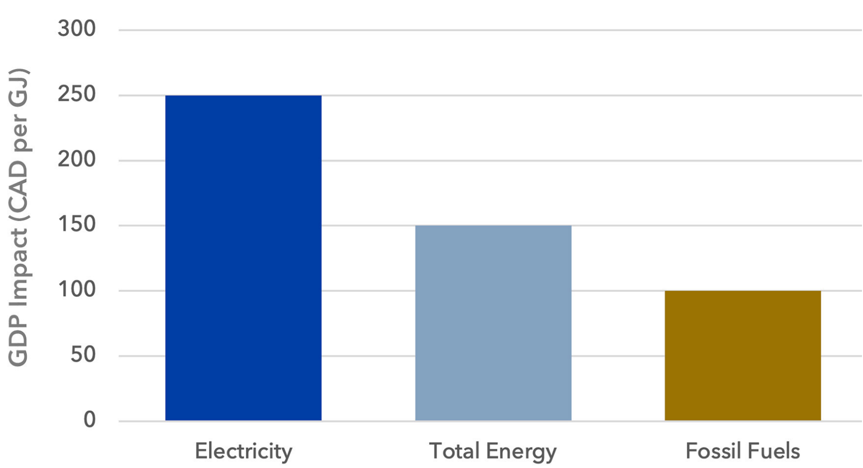
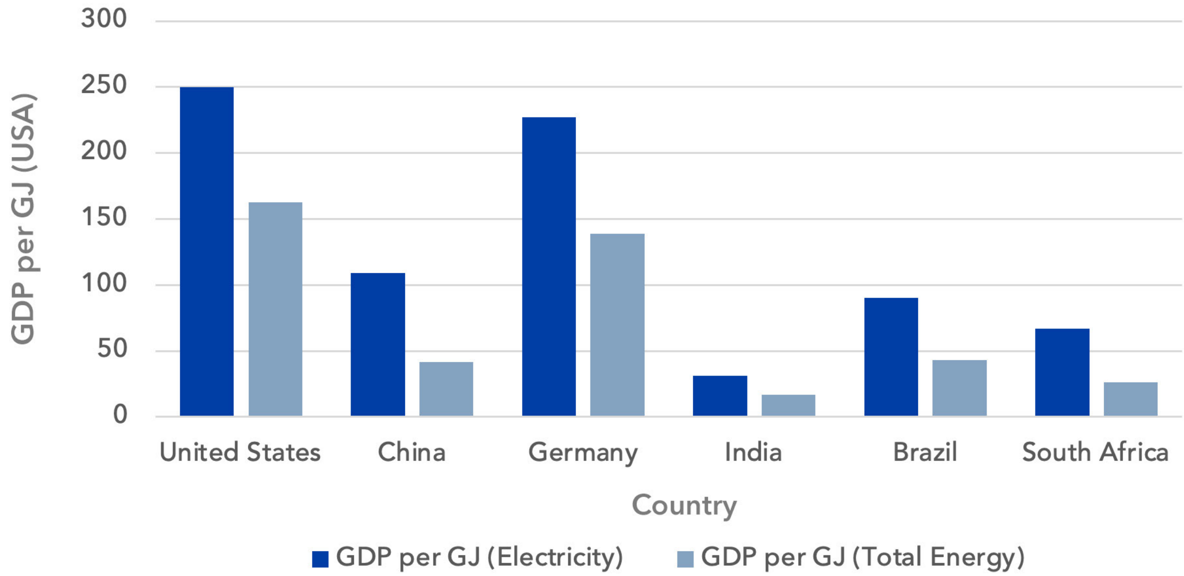


Figure 10: Comparative GDP Impact per Unit of Energy

Source: Authors, from data compiled from: Government of Canada (2024); Our World in Data (2024); U.S. Energy Information Administration (2024); Statistics Canada (2024); Enerdata, (2024); Energy Hub (2024).

Electricity use yields higher GDP per GJ than total energy use in most countries, especially in developed economies such as the United States and Germany. This suggests that electricity is a more productive form of energy, likely due to its use in high-value sectors like services, technology and manufacturing. In countries such as India and South Africa, the gap is narrower, reflecting a more fossil-fuel-intensive energy mix and lower economic output per unit of energy.

Figure 11: A Comparison of National GDP per GJ of Electricity with GDP per GJ of Total Energy



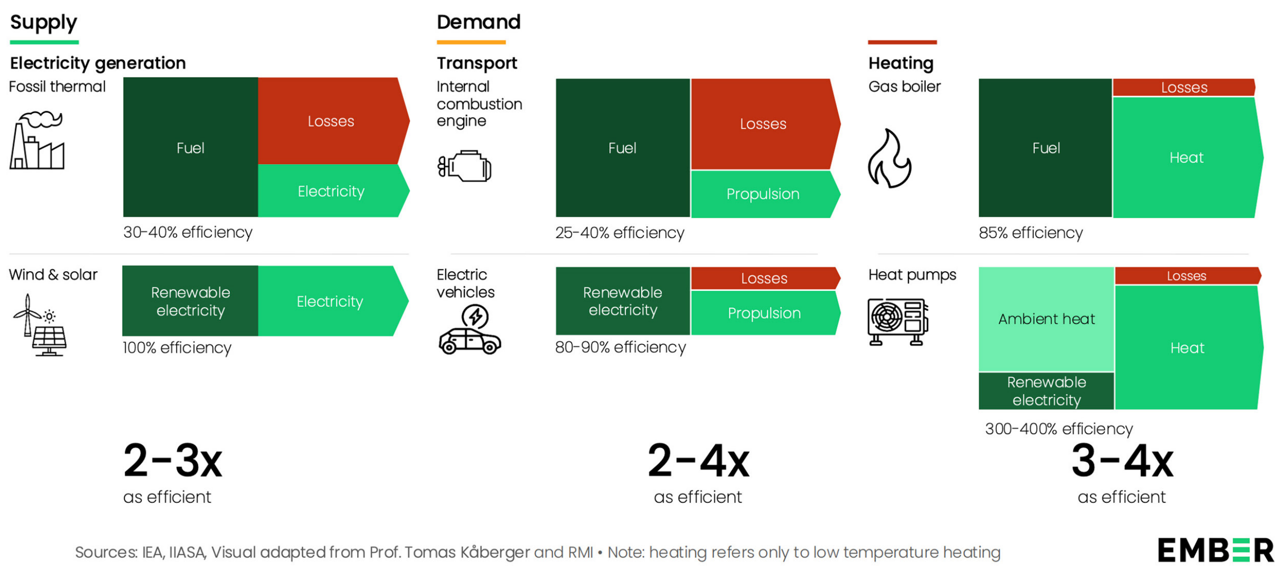
Source: Authors, from data compiled from (ibid.).

Electricity demand has a stronger correlation with GDP growth than total energy demand primarily because of its facilitation of automation, digital infrastructure and high-value services best described as the intangibles economy.

Global trends show a compelling steady increase in the new net demand for electricity and increasing share of electricity in primary energy consumption. With the emergence of AI and its applications in all sectors of the economy, data centres are a new primary driver of demand. Additionally, other drivers of increasing electricity demand include industrial electrification, cryptocurrency mining and increasing electrification of buildings and vehicles. Projections of future load all predict significant growth (Tsuchida et al. 2024; National Academies of Sciences, Engineering, and Medicine 2025).

The rising share of electricity in primary energy use reflects both the growth of the intangibles economy and the influence of technological advancements, greater efficiency of inputs to the manufacturing sector and flexible applications in the service sector. An increasing share of electrification in final primary energy consumption delivers twin benefits: new wealth creation and a clear pathway to decarbonization through clean energy technologies and products across industrial and consumer sectors.

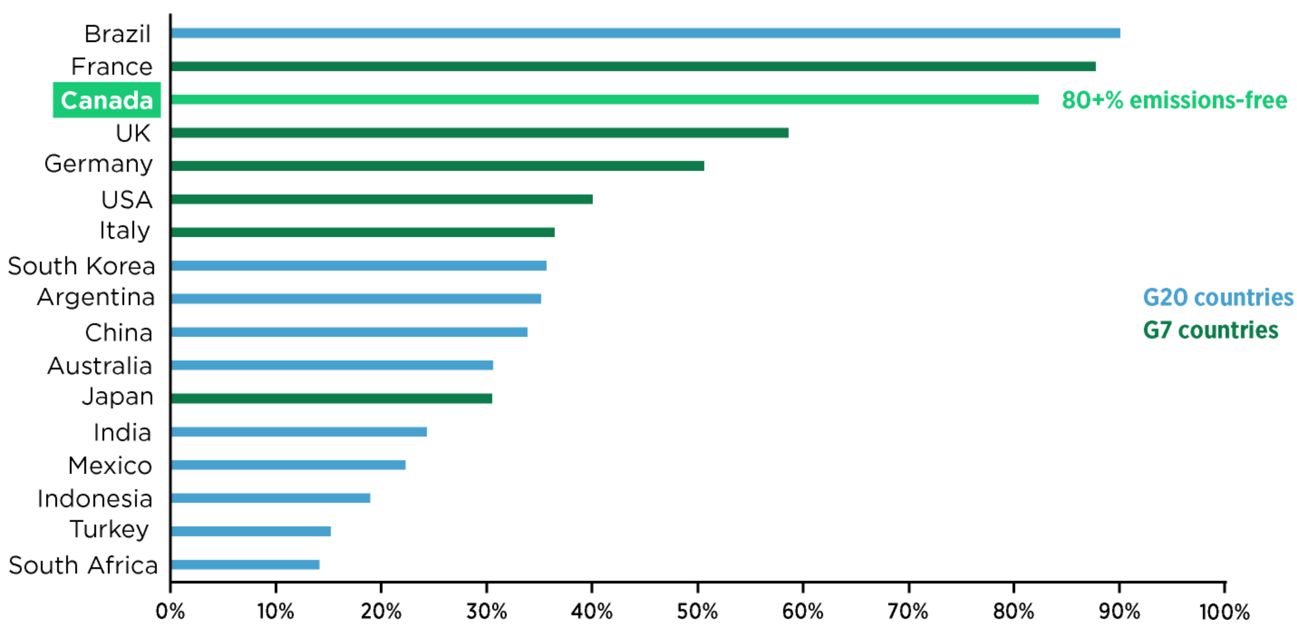
Figure 12: Efficiency Advantage of Electrotechnolgies



Source: Ember (2025).

Canada's current share of 23 percent electricity is at par with advanced economies such as France and the European Union.

Figure 13: Share of Non-emitting Electricity Generation



Source: Canadian Electricity Advisory Council (2024).

Global historical trends attest to the increasing role for electricity in supporting a productive economy. For example, note China's share increasing steadily after 1980 and then outstripping the advanced economies, reflecting its industrial growth and electrification of the economy.

Figure 14a: Share of Electricity in Final Energy Consumption for the United States, European Union, China and Japan (1960–2024)

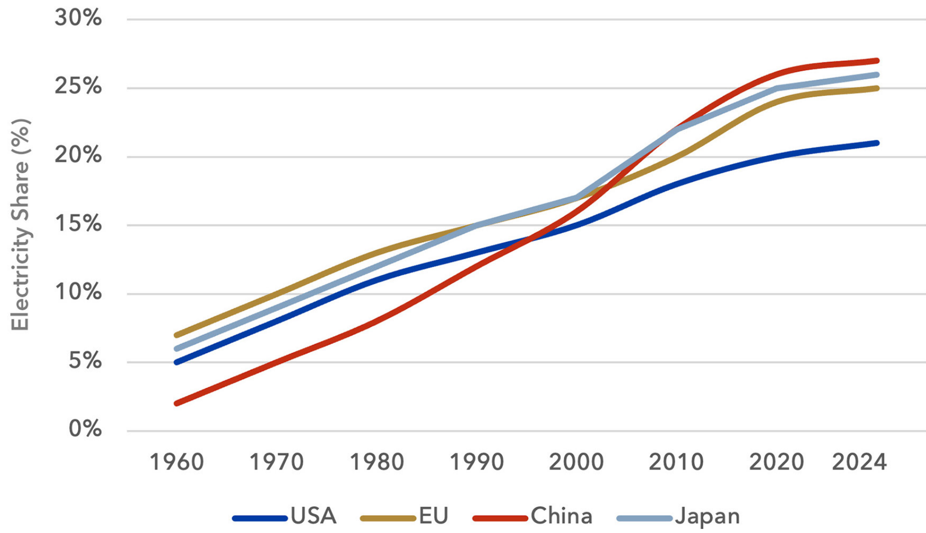
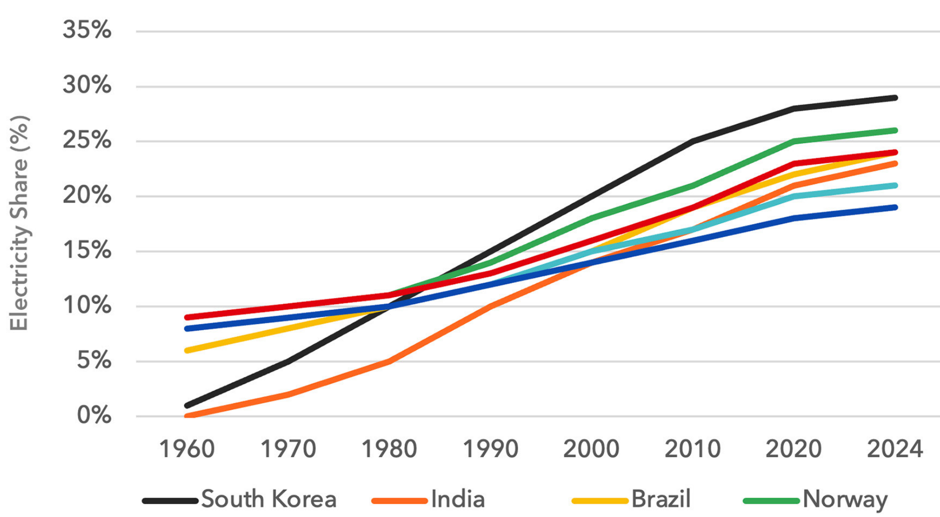


Figure 14b: Share of Electricity in Final Energy Consumption for South Korea, India, Brazil, Norway, France, Germany and the United Kingdom (1960–2024)



Source: Authors, data sources from: International Energy Agency (2021b; 2021c; 2025).

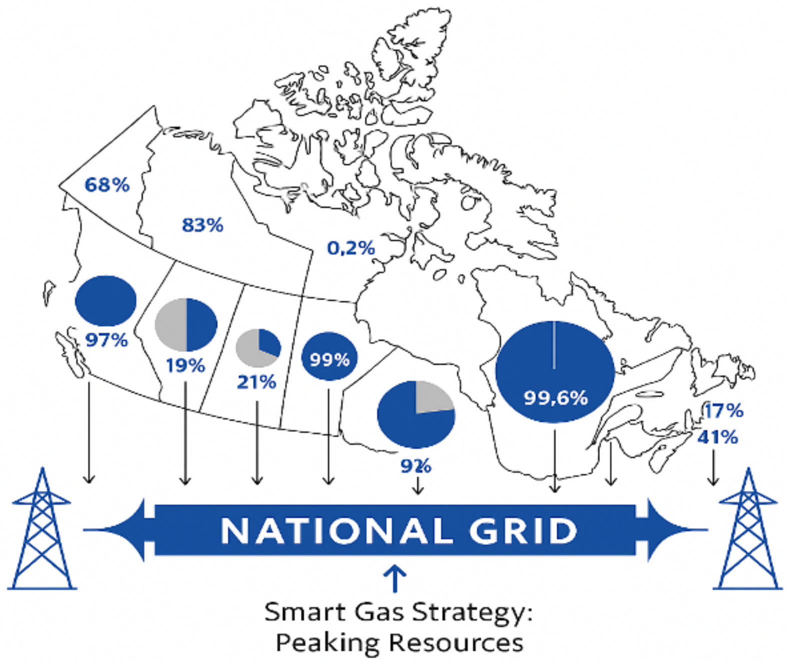
In summary, the focus here is on broad-based electrification as the primary national strategy to improve economic productivity and efficiency while achieving aggressive yet essential goals to ensure Canada meets its national and international obligations.

TRANSMISSION

TransCanada Power Corridor: High Voltage System

Canada has one of the world's cleanest electricity systems (see Figure 13 above), with more than 80 percent of its electricity supply being emissions-free, and its vast land mass offers abundant clean energy resources that can be developed to deliver a cost-effective supply of abundant, affordable energy.

Figure 15: TransCanada Power Corridor



Source: Adapted from Canadian Electricity Advisory Council (2024, 9).

Role of Natural Gas

The goals of energy security and substantial reduction of GHGs on a continent-wide scale are achievable via enhanced electricity trade, utilizing Canada's low-carbon electricity advantage and significant reductions in fossil fuel use. A "smart gas strategy" for natural gas as a peaking resource will remain an important part of system operations as a cost-effective response for maintaining grid reliability to provide flexibility for use of variable renewable resources. Figure 15 provides a visual demonstrating how Canada's provinces and territories already possess substantial proportions of non-emitting electricity resources (reflected in the blue segments of the embedded pie charts) which provide a strong foundation for an integrated national grid, while a limited smart-gas peaking strategy offers the necessary flexibility to manage higher peak loads and periods of renewable intermittency during the transition. A ten to twentyfold increase in clean electricity trade across Canada from current levels would be required to deliver on such lofty goals but the transition can be achieved over the next 40 years through the development of the necessary transmission infrastructure.

Delivering electricity in the order of 2,000 TWh annually over long distances — comprising a mix of hydro, nuclear, geothermal, wind and solar with storage capabilities — as an integrated system would require a grid capable of handling significantly higher peak loads compared to the existing system. This implies a need for construction of additional HVDC/AC lines for interconnecting provinces and building new substations with real-time monitoring, advanced fault response capabilities, reliability and the balancing of supply and demand over a vast geography for flexibility and security of supply. The illustrations below (Figures 16a and b) are a visual depiction of the potential opportunities if the high-voltage grid is co-located with the freight transport infrastructure.

Figure 16a, 16b: Concept Illustrations of the High Voltage Grid and Freight Transport

Source: Stock image and AI generated composite of the potential for integrating railway right of ways with the power grid.

Major expansion of electricity trade buttressed by interconnections and transmission links acting as regional hubs between provinces is integral to the potential benefits and economic development goals to be enabled by a national grid. When electricity trade is fully integrated into a national system, it can become a powerful source of mutual benefit at the regional levels and a promising pathway to a low carbon economy.

A historic opportunity for a dramatic shift in thinking and support for a national energy strategy has been presented in this report, in light of current geopolitical developments. What is required is the recognition that energy security, national security and our commitment to protecting national sovereignty are linked. Thus, enabling energy transfers on a large scale across provinces as trade in electricity also allows Canada to exploit its low-carbon electricity advantage to become fully integrated with energy trade and national climate change policies.

Barriers to Be Overcome

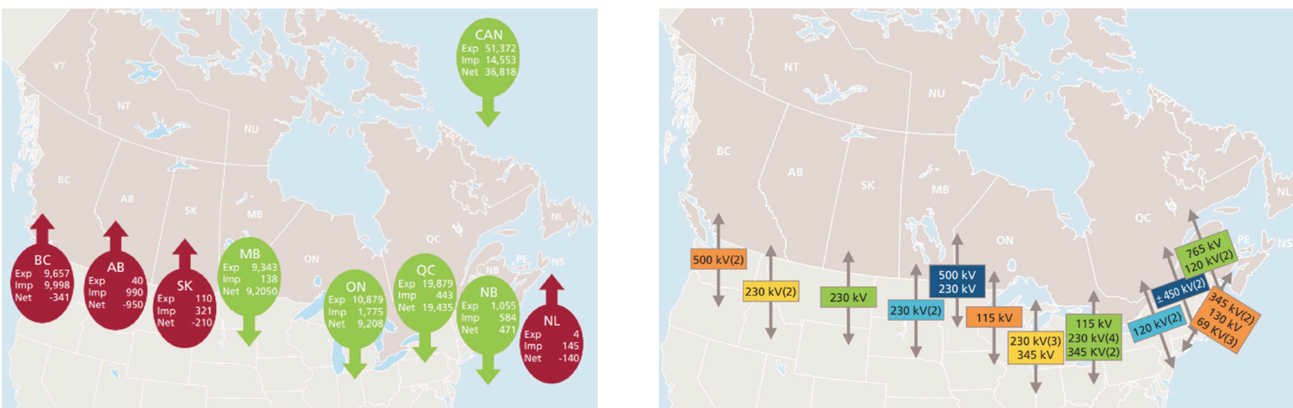
Lined up against a vision of a national power corridor capable of fostering expanded electricity trade across provinces are a number of formidable forces. The weight of history is one, but geography, long distances and large investment costs are others. The most difficult aspect of planning is the political calculus of the day, which conspires against a long view of an energy trade strategy to help realize the fullest potential of clean electricity within the Canadian energy system.

The paradigm of "province-wide self-sufficiency" dominates the public discourse and is prevalent in regulatory and system planning decisions. Support for expansion of electricity generation and transmission facilities — on a vastly increased scale — as part of a deliberate national strategy to foster interprovincial trade is either limited or met with hostility. Twinning Canada's electricity trade strategy with climate change goals (through high-value electricity production and transmission) has the potential to deliver vast economic prosperity with a much lower national carbon footprint.

Existing System is Balkanized

The existing electricity system is balkanized along provincial jurisdictions primarily serving trade flows on a north–south axis with minimal linkages across interprovincial boundaries.

Figure 17a, 17b: Canada's Existing Transmission System: Flows North–South

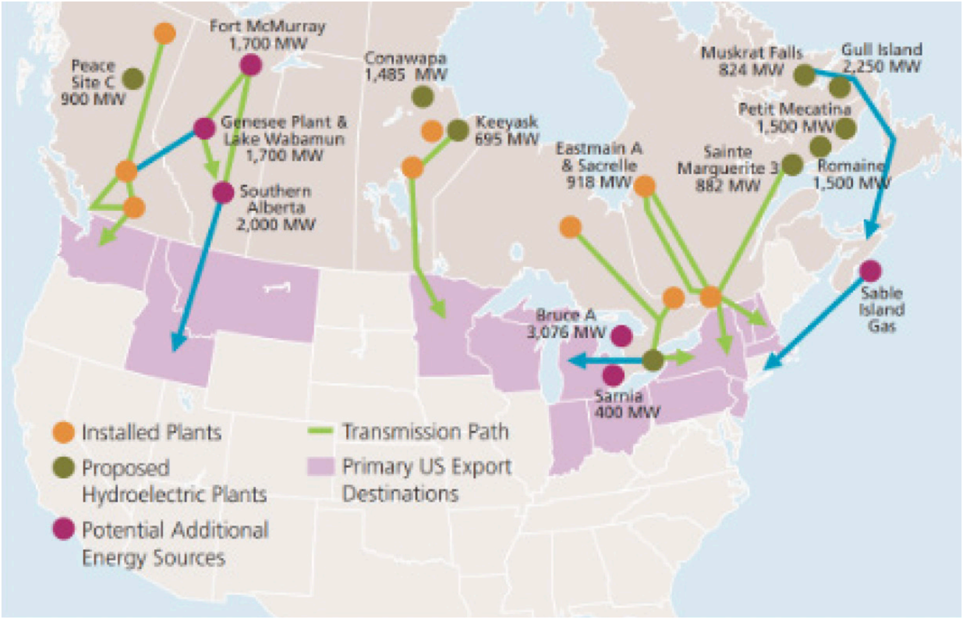


Source: Nathwani (2015, pp.104-105).

The transmission capacity envisaged to allow the development of new hydro and nuclear generation are shown above. They are still focused on power transfer along a north–south axis to serve US markets. The power grid of the future must be capable of transmitting a diverse mix of electricity generation supply sources that can strengthen the economic potential of each province in an west-east direction as shown below (Figure 18).

The figures below demonstrate the existing interconnection flow of power from Canadian hydro sites to a limited number of US states. The trade patterns reveal the north–south flows into the US markets and highlight the role of interconnection capacity. Current electricity trade is primarily based on long-term fixed rate contracts (for example, Quebec into New England states). The level of trade across provincial boundaries is low because of a lack of enabling infrastructure.

Figure 18: Map Charting Electricity Trade Flows North–South



Source: Nathwani (2015, 111).

Figure 19: Map to Chart the Potential Route for East–West Energy

Source: Van Uytven (2023).

Railroads and the Power Corridor

Currently, electrification of the transportation sector is primarily focused on EVs, but it will spread widely to other modes such as trucking and freight and passenger transport by rail in the coming decades. Inter-regional and continent-scale energy markets is one lens through which to view the dynamic context of rail electrification in concert with an east–west power corridor.

A detailed evaluation and consideration for the siting of a new power transmission corridor, co-located with existing railroad right of ways where it is practically feasible, is strongly recommended. A detailed evaluation and consideration for the siting of a new power transmission corridor, co-located with existing railroad rights-of-way where practicable, is strongly recommended. In addition, siting opportunities along major highways and near brownfield sites should be assessed to expand available routing options. The primary goal of this strategy is to minimize environmental impacts and accelerate the permitting and approvals process.

Figure 20: A Map of Canada's Railroad Right of Ways

Source: Van Uytven (2023).

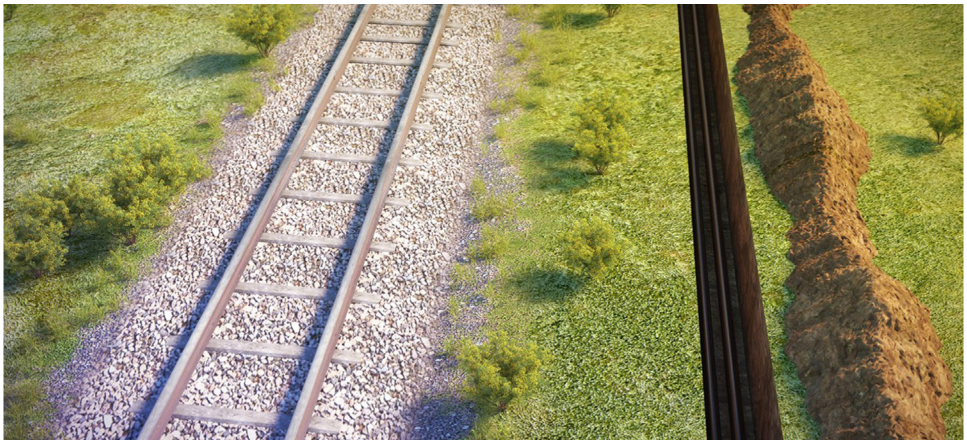
Canada's railroads, brought to completion by a dogged commitment to a unifying force for national identity, remains an ideal connector between location-constrained renewable resources (distant hydro, wind and solar in each province) that are increasingly in demand and major power markets. Railroad rights of way could be employed to site linear electric transmission infrastructure, providing a source of new revenues. Railway electrification and modernization of the stock with battery powered trains, with the capability to sell excess energy, including regenerative power, back into the grid, is technically feasible.

As other major sectors of the economy become electrified, the advantages of rail electrification integrated with a power transmission corridor presents a historic moment for transformative change. From an west–east perspective, much of Canada's electric transmission system remains a patchwork of provincial and territorial networks with limited interprovincial capacity. The proposed vision seeks to transform this fragmented structure into a cohesive, linear transmission backbone spanning the country.

Electricity transmission facilities capable of moving large amounts of power on a continental scale in the North American context have been well-established and developed over the past six decades. The benefits of an east–west interconnection, in the US context, have been documented in a comprehensive study by the National Renewable Energy Laboratory (Howland 2021).

Emerging power markets and the need to access remotely located renewable resources (hydro, wind, solar, geothermal) will increase the pressure to build greater transmission system capacity including major HVDC facilities. Building on well-established precedents,[6] an example of an innovative partnership between an electric utility and a railway company is the SOOGreen HVDC underground link, over a distance of 560 km (Iowa to Illinois), connecting the Midcontinent Independent System Operator and PJM energy markets. The line installed within the Canadian Pacific Railway's right of way not only reduced the time for permitting but has minimal visual impairment given the land-use footprint is substantially low compared to an overhead HVDC line requiring approximately 30 m of right of way. This concept is equally relevant for siting a transmission corridor in the vicinity of highways or other brownfield sites.

Figure 21: SOOGreen HVDC



Source: SOOGreen HVDC Link Project, Renewable Energy World (2020).

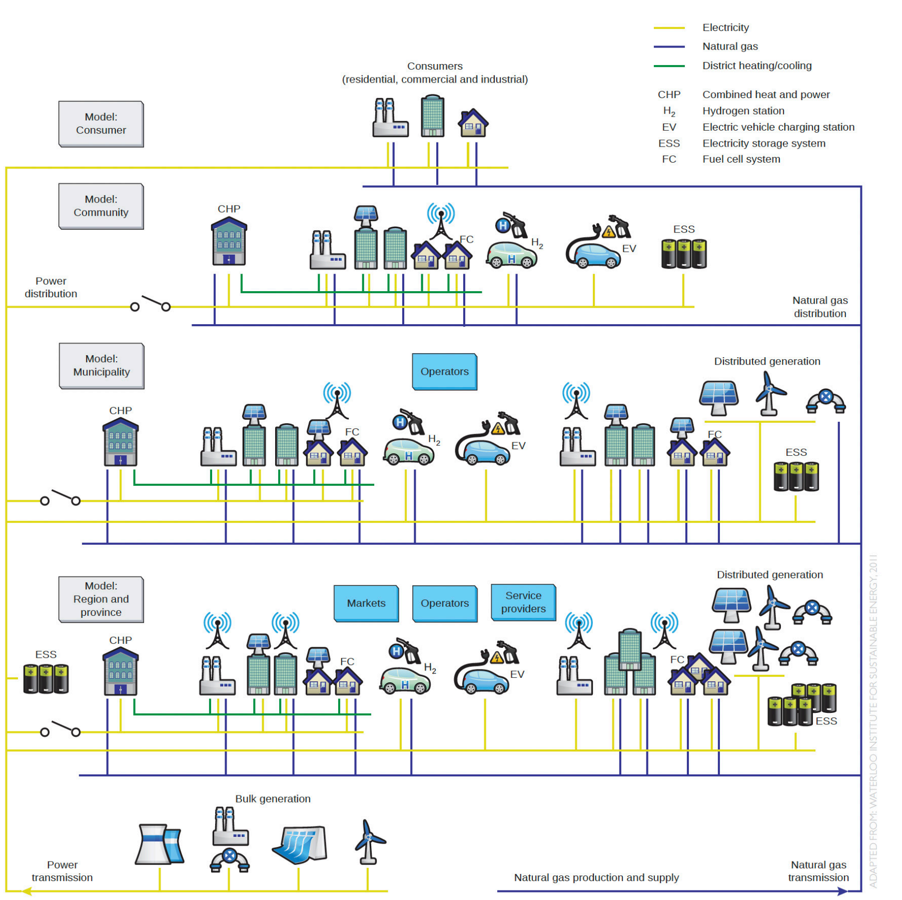
The potential for a convergence of the electricity sector and the railroad sectors needs to be explored further. Potential benefits include:

- Improved timeliness for approvals and community acceptance during the planning and permitting process. An existing rail right of way as a corridor for power transmission has significant potential for reducing land-use impacts and environmental challenges related to greenfield development.
- Technical innovations and emissions reductions. A more flexible, digitalized railroad network, with major battery installations, control and monitoring systems, catenary systems and two-way power flows and control for freight transport would allow cost optimization and emissions reductions by eliminating fossil fuels in freight transport.

Smart Distribution Grids

While the energy systems of the twentieth century were built on cheap and abundant fossil fuels, those of the twenty-first century will rely on pervasive information and communication technologies (ICT). These systems will enhance efficiency, integrate diverse energy resources, and connect smart distribution networks to a high-voltage national transmission grid designed for resiliency and optimized performance.

Figure 22: An Energy Diagram of Full Integration of All Sources

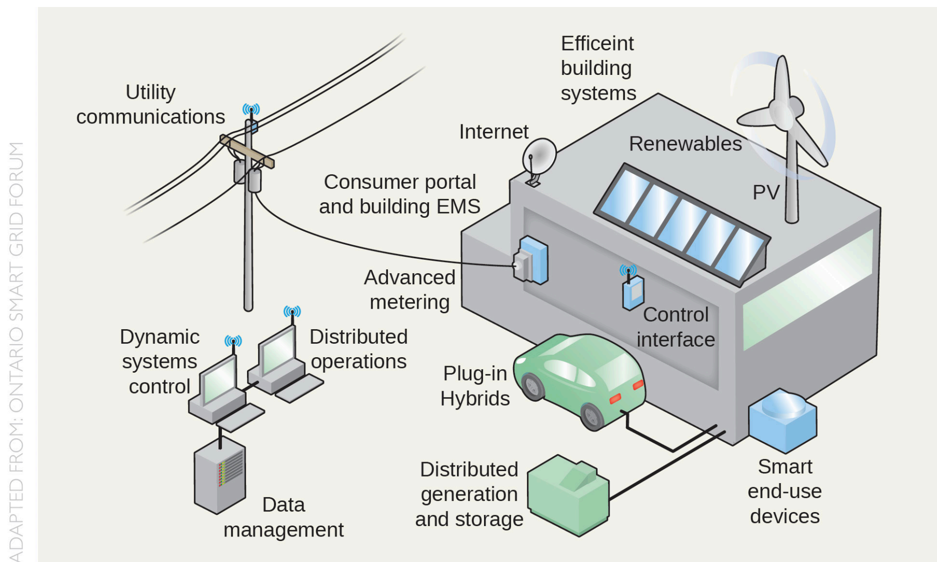


Source: WGSI, (2012, 93).

Diverse systems, components, devices and sensors enabled through ICTs can respond — almost symphonically — in real-time to the differentiated needs and demands of consumers, communities, municipalities and regions. A seamless integration of diversity is the paradigm-shifting potential of an intangible economy. An ICT-enabled clean energy system and AI-enabled productivity boost opens the energy sector to unprecedented levels of human-machine interaction without the environmental burdens that come from traditional fossil fuel-based systems.

Energy supply and consumption, through deployment of digital infrastructure, supports demand response and load balancing. Integration of EVs, heat pumps, smart buildings with solar panels storage as part of VPPs help influence behaviours of individuals with real-time pricing while adding to overall system stability and resilience.

Figure 23: A Visual of a Smart System



Source: WGSI (2012, 93).

Information-rich smart grids that coordinate electricity supply with energy storage units, including batteries and superconducting technologies, can be sited close to dense urban loads, while communication technologies and demand-response systems that enable real-time balancing of supply and demand from local generation to the grid, to enhance the sustainability and resilience of the overall system (Waterloo Global Science Initiative [WGSI] 2012, 36–45; 90–101).

De-centralized energy generation and use within the distribution network are capable of reducing peak demand on the transmission system capacity requirements through EVs connected to solar panels, localized storage and bi-directional power flows converting photons to electrons displacing oil with minimum impacts on land use. Exponential growth in global EV sales is projected to reach twenty-two million units in 2025 — up 25 percent from 2024 — with EVs accounting for one in four new vehicles sold worldwide. Under current policies, their share of global auto sales is projected to rise to about 40 percent by 2030. The conversion of major parking lots into EV charging stations can further reduce oil dependence, ease pressure on the transmission system, and enable more effective land use in urban areas.

Figure 24: EVs in a Parking Lot as Localized Generation

2 kW EV Charging Station

10 kW EV Charging Station

30 kW EV Charging Shade Structure

300 kW EV Charging

Source: Authors compilations, stock images.

Transmission Summary

Harmonization of provincial regulatory approaches with an overlay of a national framework for enhanced east–west trade in electricity will be critical to realizing benefits for all Canadians.

The scope of efforts related to harmonization of provincial regulatory mandates can be targeted toward changes in the regulatory requirements and adjustments only for approvals of investment decisions and cost-recovery of interconnection and transmission facilities. The role of the federal government would be limited to assistance necessary for financing and developing a national grid. To allay concerns related to the intrusion of federal authority into provincial jurisdiction, all other aspects of provincial regulatory authority over the development and approval of in-province resources can remain unchanged within the mandates of the provincial energy regulators.

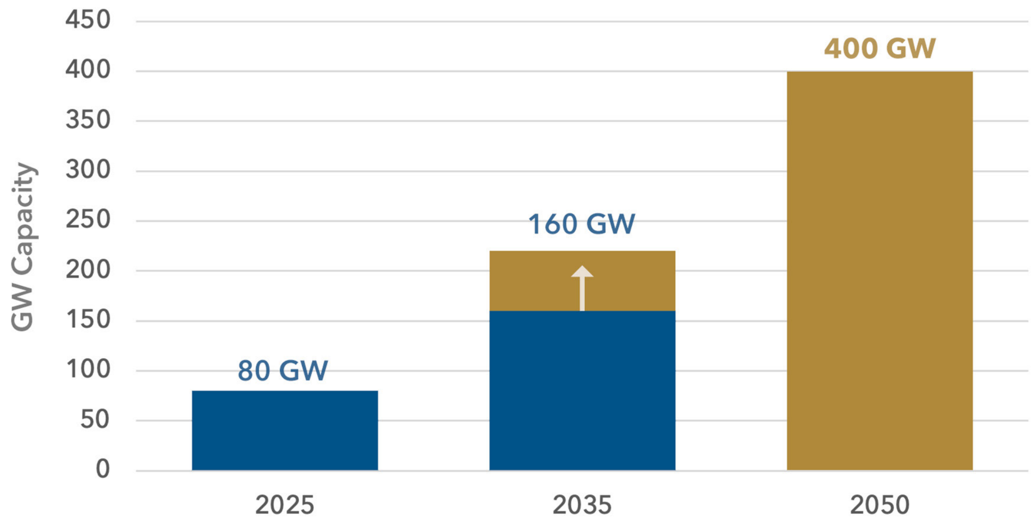
A deliberate strategy for increasing interprovincial exports of clean electricity to be adopted by each province for national benefit is recommended.

GENERATION

The approach presented here to address the implementation challenge of rapidly expanding electricity generation capacity is to build on existing utility plans and projects, both approved and in development, and to close remaining gaps through commercially available technologies within the 2025–2035 timeframe. For 2035 and beyond, new concepts, technologies and innovations for potential integration within the changing supply-mix are described below.

Figure 25 below shows the gap emerging for system capacity additions required beyond existing plans if the share of electricity in final energy consumption increases from the current 23 percent to 50 percent in 2040 and 80 percent in 2050.

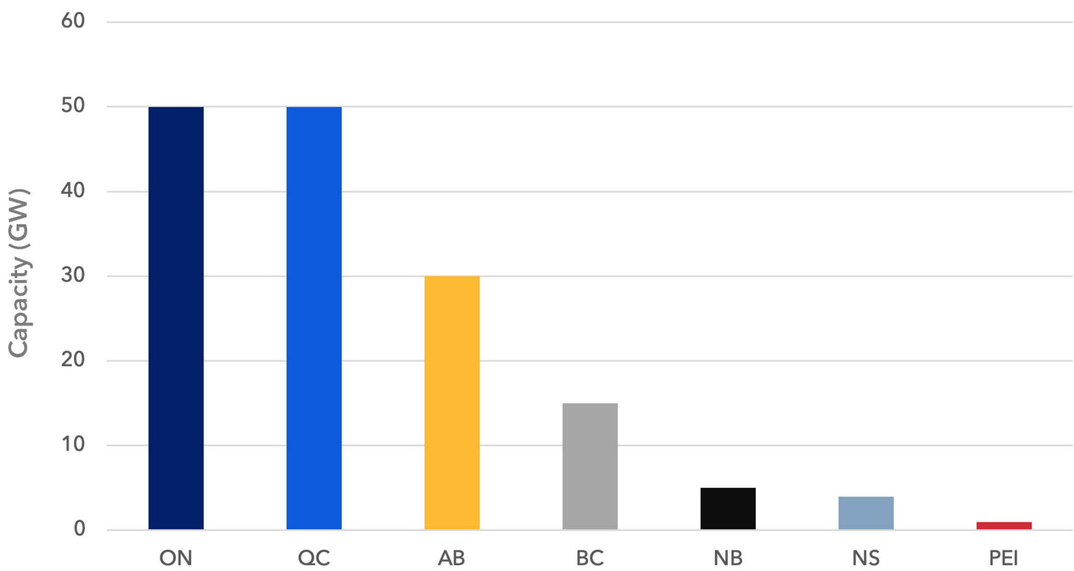
Figure 25: Planned vs. Visionary Electricity Capacity Expansion in Canada 2025, 2040, 2060



Source: Authors.

The chart below (Figure 26) shows the cumulative national capacity envisaged by system planners in 2025. These plans are based on economic and energy demand forecasts over the next 20 years, with new system capacity to be built as some of the existing assets come to their useful end-of-life and to accommodate new growth in demand.

Figure 26: Existing Planned System Expansion Capacity (by Province)



Note: These plans are summarized in Appendix A.
Source: Authors.

Table 2: Indicative Requirement of Installed Capacity for Each Energy Resource and Generation Potential the Resource Can Deliver to the Grid (TWh)

Energy Source	Capacity Factor	Installed Capacity (GW)	Generation Potential (TWh)
Nuclear	90%	~300 GW	2,400
Hydro	60%	~500 GW	2,600
Wind (onshore)	40%	~700 GW	2,500
Solar PV	20%	~1,500 GW	2,600
Natural Gas			
Peaking	30%	~300 GW	800
Baseload	85%	~300 GW	2,200

Source: Authors.

As is shown in Figure 25, a fivefold increase in the installed system capacity by 2050 would be necessary to achieve an 80 percent share of electricity in final energy consumption. Table 2 above illustrates the capacity factors of different energy resources and the expected energy generation potential from each of the options. It should be noted that the generation potential is more than adequate to meet the demand, and an optimal mix of supply resources can be developed that meets the national requirements.

The task for system planners is to optimize across the available primary resources and develop a supply-mix that delivers electricity services reliably and meets the test of affordability. The strengths and limitations of each technology, in addition to the social and environmental acceptability and land use considerations associated with each energy option, would be integrated into an operational plan.

Meeting the demand growth for electricity requires a bold vision and a commitment to large-scale investment in a diverse portfolio of generation technologies. A seamless integration of transmission with generation resources available across the entire Canadian landscape enhances the value of different sources from each province, compensating for the technical limitations and operational attributes of each technology.

For example, the intermittent nature of wind and solar can be accommodated through the installation of large-scale storage facilities (batteries or pumped hydro). The limitations of load following characteristics of nuclear power can be compensated by the "smart" use of natural gas as peaking plants, or low outputs from hydro generation during droughts can be managed through capacity transfers across interprovincial boundaries.

The national grid (described in the section "Transmission" above) not only becomes a symbol of a unifying political force but will allow for the optimization of energy resources across the country, providing low-cost affordable electricity services reliably to homes, businesses and industry.

A low-carbon electricity ecosystem will remain at the core of the transition.

Generation: Building on Existing Strengths

Canada is in an enviable position with an existing low-carbon-intensity power system (see Figures 6a and 6b). The profiles for Alberta, Saskatchewan and Nova Scotia show a larger role for fossil fuels in the existing system. For the period 2025–2035, the most effective pathway for implementation is to build on the existing system expansion plans developed by the utilities in each of the provinces based on established and commercialized technologies for system expansion.

However, when looking to the evolution of the energy landscape to 2050, there is significant potential for all provinces to reduce the carbon intensity of the electricity system and to expand the share of electricity in final energy consumption.

A balanced portfolio of renewables (wind and solar with storage) integrated with baseload generation options (nuclear, hydro, geothermal) and natural gas for peaking purposes is necessary for a reliable, flexible and resilient overall system. The intermittency of variable renewable generation is compensated with large-scale energy storage systems for grid stability. Regional siting of major hydro, nuclear and geothermal technologies from British Columbia to the Prairies to Ontario, Quebec and Atlantic Canada introduces diversity and flexibility to enhance trade from east to west.

Table 3: Canada's Current System Expansion Plans (2025–2040) and Recommendations for Development (2040–2050) Per Province

Province / Territory	Current System Expansion (to 2025-2040)	2040-2050 Future Options
Ontario	50 GW: 6,000 MW (Darlington small modular reactors (SMRs) 1,200; Bruce up to 4,800; hydro refurbishments; 3,000 MW storage)	Generation IV nuclear, broader SMR fleet, storage scale-up, renewables integration: wind/solar, hydro
Québec	50 GW: 8,500 MW by 2035 (60 TWh Hydro-Québec plan, hydro/wind expansion, 600 MW seasonal exchange with Ontario)	Expanded hydro, wind, storage, hydrogen exports, interprovincial trade
Alberta	30 GW: 1,365 MW renewables (Buffalo Plains, Travers, Paintearth, Dunmore), coal phase-out, gas as backup	Enhanced geothermal (using oil and gas expertise), advanced nuclear (SMRs, integral fast reactor [IFR]), long-duration storage, hydro imports (Mackenzie River project), wind/solar
British Columbia	15 GW: 4,062 MW (Site C 1,100; Calls for Power ~2,962), $36B transmission upgrades	Expanded hydro, large-scale storage (pumped hydro), wind/solar, geothermal potential
Manitoba	8 GW: 652 MW (600 MW wind call; Pointe du Bois 52 MW upgrade)	Expanded hydro, wind/solar with storage
New Brunswick	5 GW: 2,200 MW (1,400 wind; 200 solar; 600 SMR)	Next-generation SMRs, offshore wind, hydrogen integration, tidal
Newfoundland & Labrador	4,050 MW (Bay d'Espoir U8; Churchill Falls uprate; Gull Island ~3,900 potential; offshore wind-to-hydrogen export)	Offshore wind-to-hydrogen, expanded Churchill/Gull Island hydro, storage integration, tidal
Nova Scotia	4 GW: 550 MW (local renewables + solar); offshore wind roadmap (5 GW by 2030); hydrogen hubs (EverWind, Bear Head)	Offshore wind and hydrogen hubs, tidal energy potential, storage

Province / Territory	Current System Expansion (to 2025-2040)	2040-2050 Future Options
Prince Edward Island	1 GW: 30 MW (Eastern Kings windfarm expansion); imports from NB; net-zero grid target by 2040	Offshore wind, interties for reliability, tidal power
Saskatchewan	3,375 MW (wind/solar up to 3,000; first SMR 315 by 2034; ~60 MW hydro uprates)	Full-scope nuclear (uranium fuel cycle, SMRs, IFR), geothermal, storage, gas, hydro
Yukon	Existing hydro, diesel, wind; microgrid pilots (Haeckel Hill Indigenous wind 2024)	Full-scope nuclear (uranium fuel cycle, SMRs, IFR), geothermal, storage, gas, hydro
Northwest Territories	60 MW (Taltson hydro expansion; diesel backup)	Mackenzie River hydro complex (~13,000 MW potential), Intertie to Alberta/SK
Nunavut	1.8 MW (diesel-dominated; small hybrid projects in Naujaat, Rankin Inlet)	Hybrid solar-wind-storage systems, community microgrids, long-term small nuclear options

Source: Extracted from provincial system expansion plans (see Appendix A).

Generation: Emerging Options and Concepts

Drawing upon the insights emerging from the global summit report *Equinox Blueprint Energy 2030: Energy 2030 – A Technological Roadmap for a Low-Carbon, Electrified Future* (WGSI 2012), the choices, options and pathways for clean electricity generation solutions that constitute the building blocks of a national system are described and highlighted. For meeting the high growth in demand for electricity in the coming decades, a suite of innovative technologies and emerging concepts, it is necessary to consider options beyond projects in the existing system expansion plans. Highlighted below are emerging options and concepts that include hydro, wind and solar with large-scale storage, geothermal and nuclear.

Hydro

Canada has a long history of the development of major hydro projects, and hydro power remains an important source of clean energy that contributes to the low carbon intensity of Canadian electricity generation. The existing system expansion plans across Canada (mainly BC, Manitoba, Quebec, Newfoundland and Labrador, and Atlantic Canada) include several new hydro projects with increased capacity.

The Mackenzie River Complex: In addition to the planned increases of hydro capacity, a recent (2015) study of the potential of harnessing the Northwest Territories' Mackenzie River for hydro power on a massive scale is a contender for further evaluation (Gingras 2015). Such a development could be advanced in the 2035–2050 time frame with detailed technical, economic and site evaluations and decision timelines in the 2025–2035 time frame. Such a project is consistent with the vision outlined here, predicated upon a massive increase in clean electricity production to displace fossil fuels from the economy. By any standard, the proposed project is enormous, similar in scale to Quebec's giant James Bay Hydroelectric Complex.

The Mackenzie River's significant hydroelectric potential, if developed, yields an overall capacity of ~13,000 MW, with a capacity factor of 80 percent availability. Characterized by flows of up to 9,000 cubic meters per second per second, steep shorelines avoiding wide-area submersion and large lakes acting as flow regulation reservoirs, the Mackenzie River project includes an upstream water control structure, six downstream powerhouses and 10,000 km of transmission lines to bring the power to Edmonton.

The complex would generate 92 million MWh annually, equivalent to producing 525,000 barrels of oil per day. This clean energy could be part of a cleaner mix of supply for Alberta (10,000 MW) and Saskatchewan (3,000 MW) to allow a transition from use of high-carbon footprint thermal generating stations to low-carbon hydroelectric power stations. For investment decisions, the project development can be staged and timelines sequenced to match requirements as thermal generating stations approach the end of their expected life spans.

The Mackenzie River presents several unique characteristics. First and foremost is the fact that its riverbanks are generally steep, from 15 to 40 m, that dams of 20 to 30 m would flood only a very limited area, despite the river's enormous power generating potential. The proposed development consists of seven individual projects, including one water control structure and six run-of-the-river electric power generating stations, harnessing a combined head of 138 m, and representing a capacity of over 13,000 MW (Figure 27). Additional projects may also be envisaged on the Great Bear, Liard and Slave Rivers.

To connect the Mackenzie Hydroelectric Complex to the Alberta power grid near Edmonton, some 10,000 km of transmission lines will be needed, based on a 735 kV transmission technology scenario, a technology pioneered in Canada and used successfully in both Quebec and the United States for nearly 50 years. At an estimated present cost of 1.5 million dollars per km (2015 data), a single line has a transmission capacity of approximately 2,000 MVA; 10,000 km of 735 kV lines would therefore cost approximately $15 billion. Incorporating appropriate static VAR compensation, line capacity can be increased to approximately 2,800 MVA.

Figure 27: Mackenzie River Hydroelectric Complex

Site of the Mackenzie – 2 Project (Bassin des Murailles) and Map of the proposed Mackenzie River hydroelectric complex. Note the steep riverbank typical of the Mackenzie River landscape.
Source: Gingras (2015).

The project cost estimates and an assessment of financial viability would need to be updated and more detailed analysis of all technical aspects would be necessary. This major hydro power development on the Mackenzie River is highlighted as a potential contributor to the national mix of clean energy generation in the 2040–2050 time frame. It is a major undertaking and has not yet been identified as part of the system expansion plans by any of the provinces.

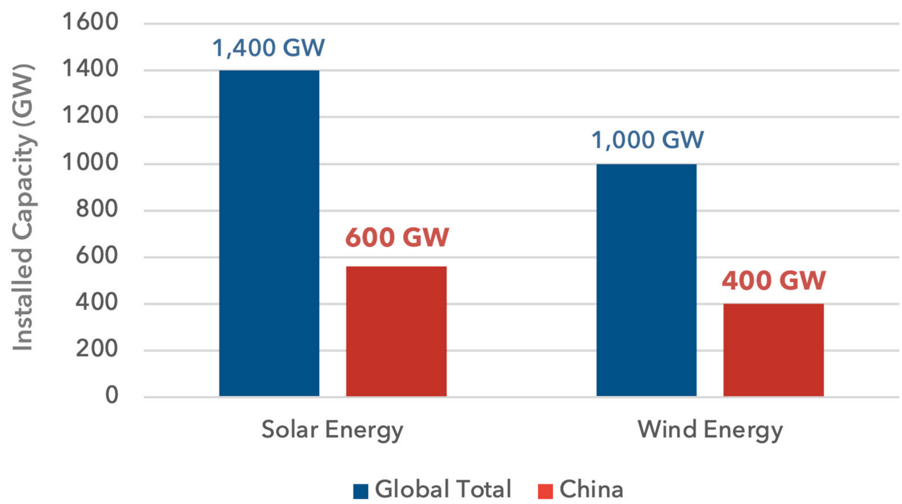
Large-scale Solar and Wind with Storage

Solar and wind offer substantial potential for electricity production with no direct contribution to GHG emissions. Even from a total lifecycle GHG emissions footprint standpoint, solar and wind energy emissions are a small fraction of what coal, oil, or natural gas would emit. To meet the 80 percent electrification end-state vision, a substantial increase in the installed capacity of wind and solar will be a necessary contribution to a low-carbon energy system. As shown in Table 2, deployment of ~1500GW solar and ~700GW of wind capacity is envisaged given lower capacity factors of the resources.

Globally, the scale of solar and wind energy installations has grown dramatically with an installed solar capacity of about 2200 GW and about 1136 GW of wind capacity at the end of 2024. The leading countries to date are China (by far the largest) with the United States, India and Germany among the top four. As a block, the European Union also has a large amount of solar and wind installed capacity – approximately 338 GW and 231 GW of solar and wind installed respectively at the end of 2024. In particular, the International Energy Agency (IEA) has indicated that solar energy has become the cheapest source of new electricity, which explains why solar power (specifically utility-scale and distributed PV) is the largest source of new electricity-capacity additions globally in recent years. Per The IEA's "Renewables 2025" report, global annual solar PV additions for 2025 will be nearing ~600 GW which is truly astounding.

Figure 28 provides a current snapshot of the dominant share of wind and solar installed capacity in China compared to the global installed capacity. China leads in manufacturing, deployment and innovations in solar and wind technologies with greater than 40 percent of the global share. The shift towards renewables is accelerating due to cost competitiveness, climate commitments and technological advances including China's great focus and strides to electrify its energy landscape and prepare for ever increasing energy demand.

Figure 28: A Graph Demonstrating Global vs. China's Installed Capacity of Solar and Wind Energy



Source: Authors, data compiled from IEA (2025).

The variable and intermittent nature of solar and wind electricity generation means that they are only partially dispatchable, thus requiring large-scale storage for effective integration into electricity supply grids. The quality of solar and wind resources also varies across provinces. In this regard, the role of natural gas will remain critical as a peaking resource for the grid. A national grid as the backbone of an electrification strategy which also incorporates large-scale storage capacity is another key feature enabling a trading system for large transfers across provincial jurisdictions over long distances as part of an overall optimized national electricity grid.

Large scale storage is, therefore, an important requirement and a technology option to enable solar and wind to "mimic" the characteristics of baseload generation and subsequently assume a greater role within the national energy supply mix. Effective use of grid-scale storage will also minimize the need to curtail solar and wind generation when there is grid congestion, transmission limits, and/or any overall system imbalances.

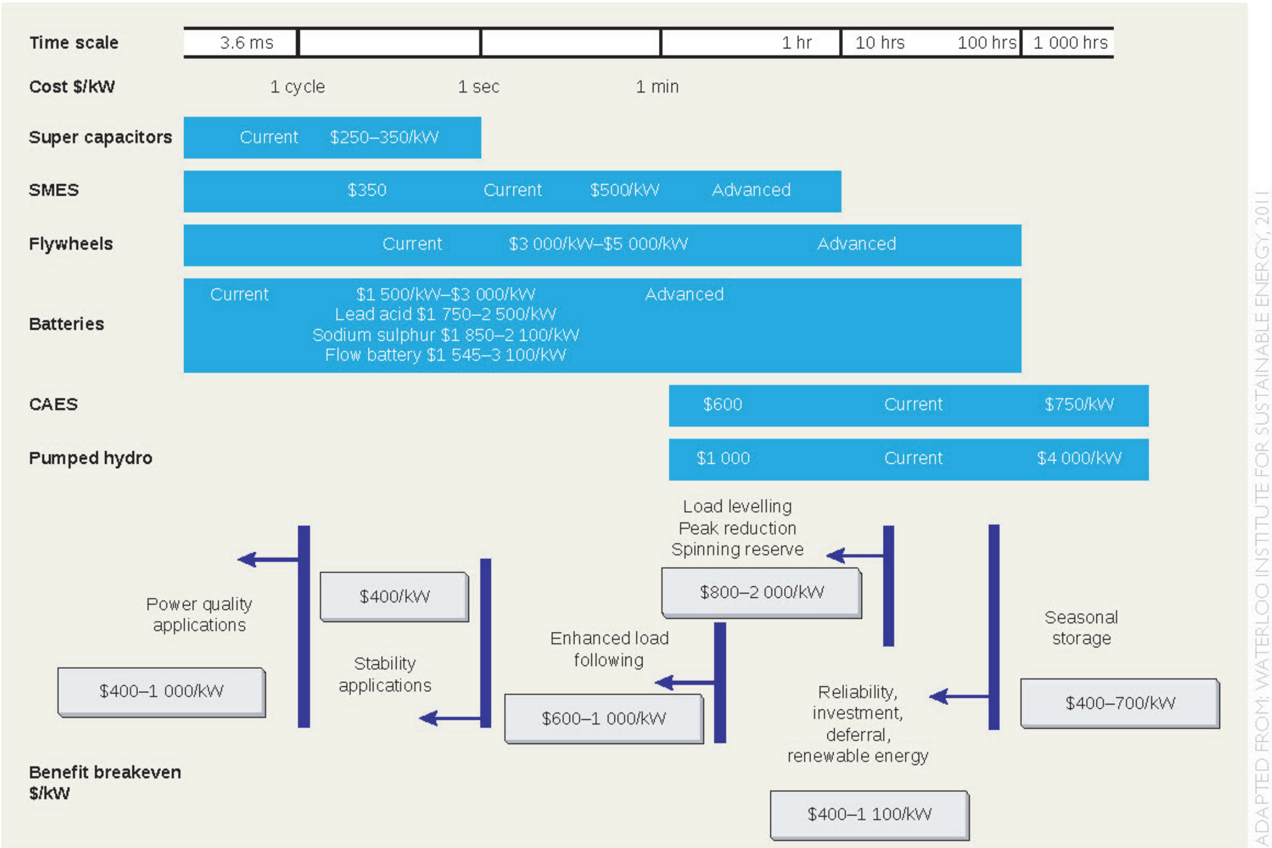
As renewables penetration continues to expand in many countries and regions, the intermittency issue will require a combination of innovative grid management techniques, smart grid technologies, dispatchable back-up resources, and increasing use of energy storage. Several options exist and have been implemented around the world for managing the variability of wind and solar resources, each with strengths and weaknesses that differ across scale and situation. These include the use of natural gas generation as a complement to wind output generation, demand management or storage.

As stated earlier, solar and wind coupled with large-scale storage can provide energy on a large scale with characteristics that nearly match those of baseload power. Increased storage capability with effective integration of smart grid technologies at the distribution level offers the most promising pathway for reducing overall costs and decreasing transmission system load and imbalances.

There has been a dramatic rise in the deployment of energy storage in different parts of the world primarily thanks to the exponential growth of renewables, in particular solar energy. Energy storage products have now been successfully deployed in high numbers across residential, commercial, and utility sectors in various countries. As expected, most deployments (in terms of total capacity) have been due to utility-scale installations. Top five countries in the world for energy storage are China, US, UK, Australia, and Chile with approximately 314 GWh of capacity at the end of 2024. China by far leads total installations with 64 percent of 315GWh followed by the US at 26 percent (Visual Capitalist 2024; Elements 2024; IEA 2024).

The evolution of energy storage both in terms of cost and technology has been very interesting providing great insights into effective technology selection and development and how costs can indeed be dramatically reduced with efficiency and volume. For instance, at a major clean energy and energy electrification conference held at the University of Waterloo, in Canada in February 2012 (WGSI), although in many ways at its infancy at the time, the potential for grid-scale energy storage and its benefits were highlighted and discussed as shown in Figures 29 and 30 below. Although some of the technologies highlighted then such as supercapacitors and flow batteries remain key areas of interest with unique attributes, the main energy storage technology of today evolved to be based on Lithium-Ion chemistry dominating all new energy storage installations meeting many of the grid services requirements. There is no doubt there will be further innovation in energy storage and other chemistries resulting in on-going cost and performance improvements. The key point to be made, however, is that energy storage costs of the current offerings have dropped so dramatically that large-scale deployments to meet a variety of system needs including addressing intermittency of large solar and wind installations is completely practical.

Figure 29: A Historical Perspective on Potential Grid-Scale Storage Solutions

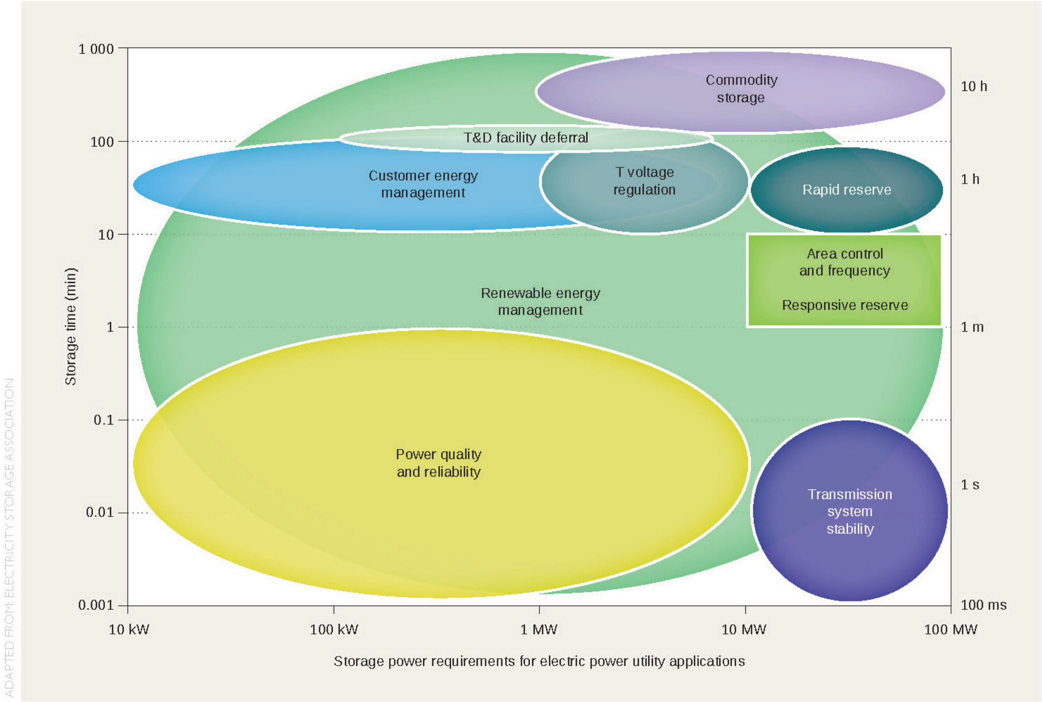


Source: WGSI (2012), compiled from data from Culver (2010).

As shown in Figure 30, no single storage system can match the multiple device requirements for large-scale grid application; the capabilities must be matched to the context and specific requirements of the grid operator.

Superconducting magnetic energy storage (known as SMES) can deliver energy across a wide range of timescales, providing rapid response and exceptionally high efficiency, which makes them particularly well-suited for stabilizing grids with high shares of intermittent renewable energy. With storage capacities of up to 5,000 MWh, they represent a powerful option for large-scale renewable integration alongside battery technologies (Ali, Woo and Dougal 2010).

Figure 30: Storage Power Requirements for Power Utility Application



Source: WGSI (2012, 60).

In summary, solar and wind capacity, installed on a large scale and coupled to storage, will allow provinces to maximize their contributions to the national grid based on their own unique solar and wind potential. Furthermore, large growth in the deployment of these technologies will create new engineering, manufacturing, and service sectors in Canada by localizing the production and support of the corresponding components and systems for solar, wind, and storage.

Strategic placement of solar and wind capacity, integrated into a national grid, allows for significant optimization of cost through daily or seasonal arbitrage of energy supply and demand. The reduced prices for consumers can only be realized as a national benefit through a grid that serves all provinces.

Geothermal Power

Geothermal energy is a large resource capable of providing a significant proportion of energy demand. The immediate potential for geothermal resources to play a major role in Canada's clean energy transition is geothermal energy for buildings. Air source and ground source heat pumps (Geoexchange) are commercially established technologies for use in buildings, providing a cost-effective pathway to displace natural gas for heating and cooling requirements.

Deep geothermal resources at depths greater than 1 km to 10 km (enhanced geothermal systems [EGS]) offer limitless potential for electricity generation without geographic limitations.[7] Research and technological challenges — primarily related to drilling costs — are being addressed. Demonstration of scale applications as well as demonstration projects to "de-risk" the technology show promise and allows a pathway for investors to finance specific projects (Norbeck and Latimer 2023).

Shallow Geothermal Resources for Building Heating and Cooling

Ground source heat pumps (GSHPs) combined with air source heat pumps (ASHPs) offer the option to displace natural gas directly and can play an important role in reducing grid-related system costs in a renewable-heavy grid. Building heating is a major driver of peak winter electricity demand in Canada, and widespread electrification without sustainable technology choices could impose significant consumer costs.

Widespread deployment of shallow geothermal energy resources for commercial, industrial and residential direct heating purposes is the most direct and cost-effective pathway for efficient home heating and cooling. Net-zero homes with good building design and geothermal as the primary resource for heating coupled with solar and storage batteries in a VPP configuration is a practical and feasible choice.

A recent study from the Canadian Gas Association (2019), "Implications of Policy-Driven Electrification in Canada," highlights several scenarios and challenges, indicating high costs of a scalable national level electrification.

By contrast, when GSHPs are incorporated into the modelling, the projected costs decline sharply. With a 10–30 percent market share, GSHP adoption could reduce total costs by $49–$148 billion over 30 years, while full adoption would yield nearly $500 billion in savings. The savings stem from GSHPs' superior efficiency in cold climates. Unlike ASHPs, they do not experience significant performance degradation in winter, thereby reducing peak electricity loads and lowering associated generation and transmission costs. Although GSHPs are more expensive to install, the decrease in system-wide electricity generation ($494 billion) and energy costs ($137 billion) far outweighs the additional $137 billion in equipment expenses under full adoption.

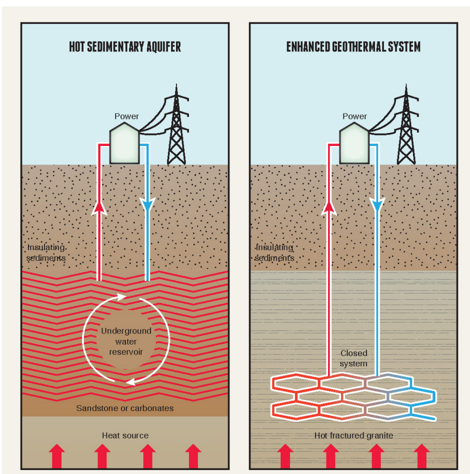
A comprehensive analysis of grid costs and the benefits of a national-scale mass deployment of geothermal heat pumps across the United States (2022–2050), based on commercially available technology, yields an undiscounted cumulative savings of more than US$1 trillion for the grid decarbonization scenario (Xiaobing Liu et al. 2023) to 2050.

Ground source heat pumps installed with energy efficient building envelopes in single family homes can become primarily a grid cost reduction tool when deployed on a national scale. Even in the absence of any other decarbonization policy, GSHPs offer the benefits of a substantial reduction of CO_2 emissions, GSHPs reduce the cost of power on the grid, as well as the marginal system cost. Policy makers could create targeted incentives that encourage GSHP adoption and avoid strategies that inadvertently exclude this cost-saving technology from Canada's decarbonization goals. Large-scale deployment of GSHPs lowers grid infrastructure investment, as well as reduces the cost of power for all grid consumers — even those who do not have the technology installed.

Enhanced Geothermal Systems for Electricity

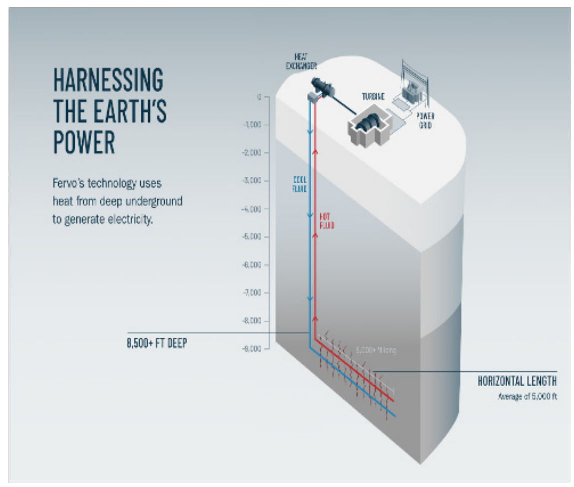
With deep drilling (more than 4 km), enhanced geothermal power systems can provide an abundant source of clean baseload electricity from hot dry rock sites without geographic limitations. Enhanced geothermal power is a renewable energy resource available anywhere in Canada with the greatest potential for development in Alberta and Saskatchewan. Given the strength of geotechnical expertise (drilling and extraction capabilities of the oil and gas sector), investing in EGS alone could provide a large share of electricity demand. If the oil and gas sector can pivot away from fossil fuels extraction to geothermal, it makes this resource a complementary technical option to the use of variable resources such as wind and solar, helping to stabilize grids as they expand and make an important contribution to reduction of carbon emissions.

Figure 31: Hot Sedimentary Aquifer and Enhanced Geothermal System



Source: WGSI (2012, 66).

Figure 32: Harnessing the Earth's Power



Source: Gates (2025).

Demonstration phase EGS projects are underway in several countries: France, Germany, Finland, Australia, while the United States has revived a national geothermal program for EGS (Alijubran and Horne 2024; U.S. Department of Energy 2019; Augustine 2016).

The first phase of an operating plant in Nevada, with a 400 MW capacity when completed in 2028, has been commissioned by Fervo Energy at Cape Station.[8]

Overall, geothermal resources for electricity generation (Schulz and Livescu 2023; Geothermal Resources Council 2016; Roberts 2018) and shallow geothermal resources (GSHPs and ASHPs) offer the most promising pathway for displacing fossil fuels: heating and cooling services in buildings and electricity for transport and industry.

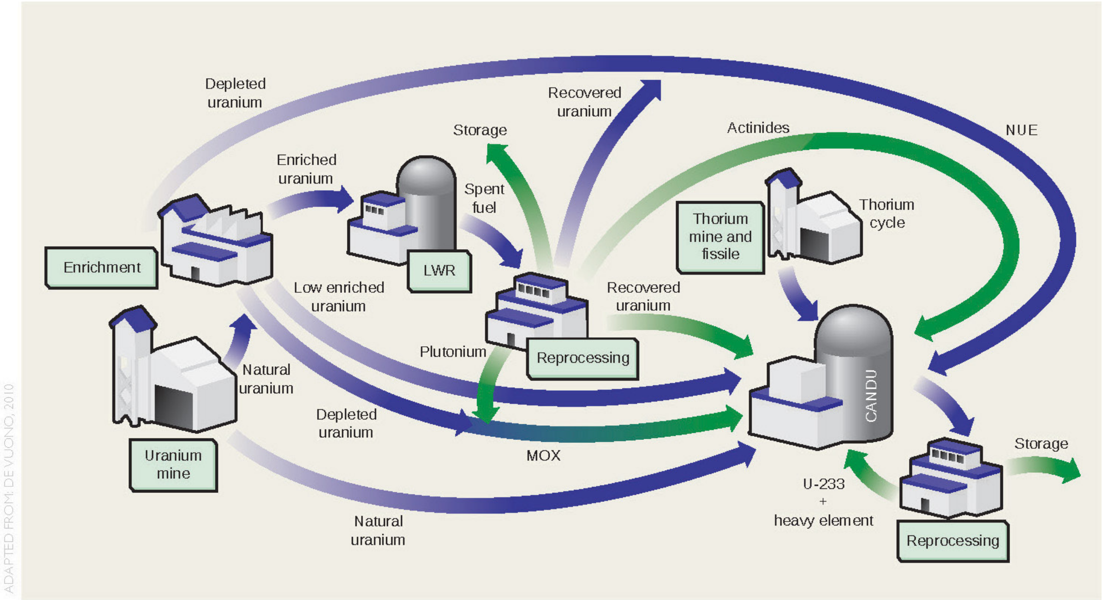
Nuclear Power

A significant build-out of the existing technological base[9] (namely, Generation III+ reactor systems) — and a widespread adoption of Generation IV technologies that comprise fast neutron reactors with closed fuel cycles to reduce nuclear waste — offers the possibility of providing energy on a terawatt scale, making nuclear fission sustainable over many decades to come.

Among the low-carbon options that are currently available for energy generation, nuclear power is unique in that it harnesses an energy source that is more highly concentrated than fossil fuels. This occurs despite the fact that reactors currently deployed almost exclusively use thermal neutrons, which extract less than one percent of the fuel's energy content. If Canada is to move away from reliance on GHG-producing fossil fuels in electricity generation, it is difficult to imagine how this can be achieved without a transition to advanced nuclear technologies.

Advanced nuclear technologies hold enormous potential to become a significant part of the future baseload picture. These novel design concepts aim to close the nuclear fuel cycle by eliminating high-level nuclear waste, reducing the threat of proliferation and providing an inexhaustible source of energy.

Figure 33: Advanced Nuclear Fuel Cycle Concepts Allow for better Utilization of Uranium and Close the Nuclear Fuel Cycle



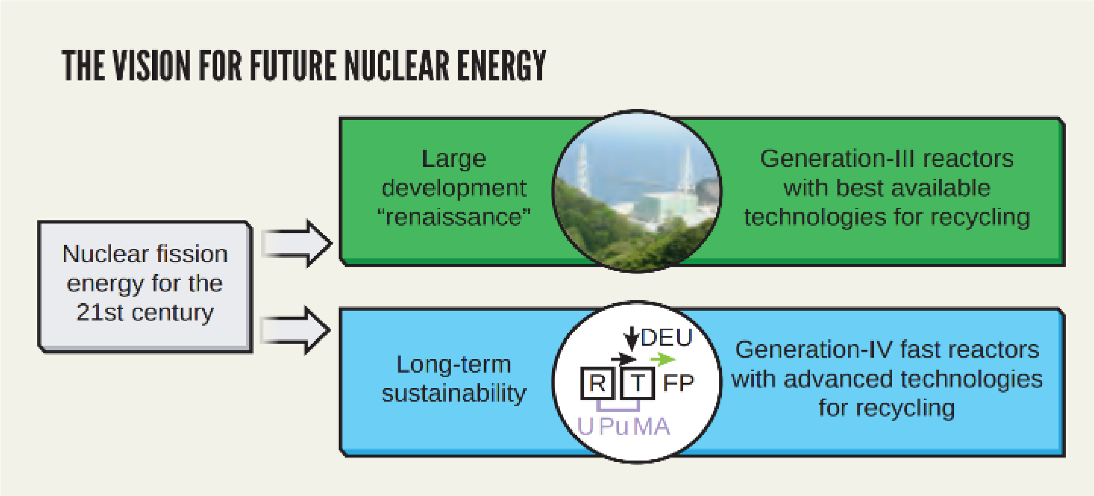
Source: WGSI (2012, 74).

While these Generation IV design concepts are an excellent example of the scalability and potential of nuclear energy, they need to be understood within the array of nuclear technologies available. From the perspective of a long-term energy transition, an expansion of the existing base of established Generation

III reactor technologies in the near-term provides a credible pathway for a phased transition to Generation IV technologies.

As Canada seeks to reduce dependence on fossil fuels and accelerate the transition to a low-carbon electricity system by 2050, advanced nuclear technologies can complement existing renewable resources. New reactor designs, such as the Integral Fast Reactor (Archaambeau et al. 2011; Hannum et al. 2005) designs and the emerging SMRs can provide reliable, low-carbon baseload electricity to support electrification of transport, heating and industry.[10] These reactors help close the nuclear fuel cycle by reusing and burning nuclear waste, reducing long-term storage requirements and operating with liquid metal coolants at near-ambient pressures, which minimizes the risk of loss-of-coolant accidents. Importantly, these designs are incompatible with weapons proliferation, helping address longstanding public concerns related to nuclear technologies (International Atomic Energy Agency 2020; Ultra Safe Nuclear Corporation 2024; General Atomics Electromagnetic Systems 2025; World Nuclear Association 2025).

Figure 34: Future for Nuclear Energy



Source: WGSI (2012, 79).

Accelerating the development of these technologies would require updates to regulatory frameworks and broader public acceptance. With an existing base of nuclear expertise in the design and operation of large nuclear reactors in Ontario and an established supply chain to support nuclear expansion in Canada, the next step in developing national prowess is to further develop Saskatchewan's uranium resource for added-value creation along the chain.

The re-imagined future for the nuclear sector is for Canada to become a provider of full-scope nuclear fuel cycle services — mining, fabrication of fuel for different customer markets, reprocessing of existing high-level used fuel and advancing next generation reactors capable of re-using the waste for electricity generation. This could be led by Saskatchewan and Ontario. For the 2035–2050 time frame, this is a compelling pathway for abundant energy supplies to fuel the transition to electricity.

SUMMARY

TransCanada Power Corridor: A National Grid Uniting Canada

This report has developed a vision for reimagining the architecture of Canada's energy landscape enabled through development of an east–west power corridor — a national grid — that links all the provinces and regions of Canada as part of seamless flow of energy trade through electrification. This can only be accomplished by reducing fragmentation across provincial jurisdictions as part of a whole-of-government, whole-of-society approach. If substantial social, economic and political benefits of a unified country are to be realized, then Canada must treat the TransCanada Power Corridor as a project of national urgency, akin to the construction of the transcontinental railway in the nineteenth century.

Highlighted below are the "Conclusions" and "Recommendations." Specifically, the recommendations address the challenges of governance, regulation, trade and finance.

Conclusions

- The TransCanada Power Corridor links the entire continent from the West to the East and represents more than an energy project; it is a nation-building enterprise that fuses climate security, energy sovereignty, infrastructure resiliency, innovation and technology development, and national prosperity into a single strategic vision. Its success depends not only on technical feasibility but on urgent and collaborative governance, the recognition of electricity as a strategic trade asset, and the establishment of a robust financial architecture aligned with national purpose.
- Canada's prosperity and sovereignty are best secured by re-imagining the national energy landscape with an East–West TransCanada Power Corridor — a national electricity grid — for energy transfers across provincial boundaries.[11] High-voltage (DC or AC) transmission towers, co-located where practical with rail/highway right of ways, serves as the backbone of an electrified energy economy fit-for-purpose for the twenty-first century.
- The objective of minimal dependence on the use of fossil fuels (<20 percent share in final energy consumption) by 2050 is feasible through broad-based electrification of the economy. Diverse pathways and opportunities for electrification exist within each province to support a clean energy economy.
- One consequential impact is a massive growth, fivefold increase, in electricity demand increasing from ~700 TWh (2025) to ~1,950 TWh (2035) and ~3,550 TWh (2050), with installed capacity expanding ~80 GW to ~220 GW and finally ~400 GW.
- Success is contingent on timely investments in the necessary infrastructure and a focus on rapid deployment of generation and transmission technologies. The building of a national power grid

unlocks mutual benefits: a ten to twentyfold increase in interprovincial electricity trade, balancing diverse provincial resource endowments (hydro, nuclear, geothermal, wind and solar with storage) and creation of an energy system focused on electricity trade across Canada away from today's balkanized, north–south oriented flows.

- The end-state goal by 2050 is an energy economy with a share of clean electricity at 80 percent in total final energy consumption has the potential for eliminating ~8,500 PJ of oil and gas requirements from current consumption and enabling a decisive reduction in carbon emissions from the current levels of 700 Mt to 450 Mt in 2035 and 200Mt in 2050.

- Historical evidence shows electricity has delivered higher GDP per unit energy than fossil inputs. Electrification embodies not only an effective climate strategy, but it provides an overall economic growth strategy for improving national productivity. An investment strategy for the provision of abundant, clean, affordable electricity as the critical input for driving growth of the intangibles economy (AI, digital services, and advanced technologies in manufacturing and service sectors).

- The national grid as an enabler of an energy transition to deliver a clean energy future will require expansion of transmission capacity within each province (high-voltage DC/AC lines, modern substations and digital controls to manage grid reliability) and new interconnection facilities. Siting of the power corridor along rail/highway corridors — where practical — is a strategy to minimize land-use conflicts and accelerate permitting and community engagement.

- For power generation, four main building blocks are highlighted for system expansion that draw upon the existing resources and strengths within each province: hydro, nuclear, wind and solar with storage, and geothermal energy resources (shallow and deep). A "smart gas strategy" will be necessary for grid support, peaking requirements and optimization of intermittent generation.

- To meet the challenges of a massive increase in generation capacity (2035-2050), several transformative generation options have been identified that are not currently included in the system expansion plans of the provinces. These illustrative examples, will require further analysis, but offer opportunity pathways for future development:

    - A long lead time, high-impact opportunity for further evaluation of Mackenzie River Hydroelectric complex with a capacity of ~13,000 MW capable of producing ~92 TWh/yr to support decarbonization goals for Alberta and Saskatchewan.

    - Advanced nuclear technologies that can complement existing renewable resources and with new reactor designs (SMRs) that can provide reliable, low-carbon baseload electricity to support electrification of transport, heating and industry.

    - Advanced industrial innovation to leverage the drilling and geological expertise and know-how of the Alberta oil-and-gas sector for the cost-effective utilization of enhanced geothermal system for base load electricity generation allowing a global level scale-up of deep rock geothermal energy extraction.

- The Province of Saskatchewan offers a unique Canadian advantage to transition from uranium mining to full-scope provision of nuclear services including fuel fabrication to re-use of nuclear waste for electricity generation and to close the nuclear fuel cycle without geological disposal.
- Wind and solar technologies are now cost-effective established energy resources. Further economic value to be harnessed is through integrated large-scale storage capable of delivering firm dispatchable power.
- The suite of solutions on the customer demand side is highlighted, which include smart grids as enablers of smart urbanization to help reduce cost and risk. Aspects of this strategic development include targeting electrified transport, building retrofits, two-way smart grids and ICT-enabled demand response to flatten peaks, improve reliability and ensure affordability.
- A strategy that includes growth of a durable service-sector (the intangibles economy) with deployment of AI as the spur for productivity uplift across industry and services.

Recommendations

Governance and Regulation

Harmonization of provincial regulatory approaches with an overlay of a national framework for enhanced east–west trade in electricity will be critical to the realization of benefits for all Canadians.

Building on established approaches to collaborative federalism, further development of a structured partnership between federal, provincial, territorial, Indigenous and municipal governments, supported by private industry, unions, civil society and academic institutions would be necessary. Without such collaboration, constitutional disputes over natural resource jurisdiction and infrastructure approval processes will delay progress and erode public confidence.

In that spirit, it is recommended that a National Energy Infrastructure Council be established under the aegis of the recently announced Major Projects Office, or alternatively, the Canada Energy Regulator. The Council, chaired by the prime minister, becomes a single point of focus for convening premiers, Indigenous leadership and industry stakeholders for binding decisions.

The Corridor must be framed, not as a discretionary option, but as a project of national importance for integrating energy security, climate resilience, national security and sovereignty.

Electricity Trade as National Strategic Asset

The primary goal of an east–west corridor is to reverse the historic dependency of north–south flows of trade in electricity by creating a robust internal market capable of absorbing any surplus generation in any province and distributing it efficiently across provinces. This provides Canada with a clear pathway for linking energy security with national security and sovereignty, and a capacity to insulate Canada from future geopolitical trade disputes.

In addition, enhanced electricity trade across Canada increases leverage, positioning Canada as an indispensable clean-power supplier in North America, and it also increases global export capacity enabling liquefied hydrogen, green steel and critical-mineral processing powered by Canada's low-carbon electricity to compete internationally.

Just as wheat, oil, and minerals underpinned past national growth, abundant clean electricity and deep expertise and knowhow in clean electricity generation, engagement, and distribution must now become Canada's twenty-first century comparative advantages.

Finance: Aligning Capital with National Purpose

A transformative end-state vision for 2050 described in this report will require investment in infrastructure in the order of billions of dollars in capital in the 2050–2060 time frame. The scale of the change proposed cannot be funded solely through traditional ratepayer models.

A national financial architecture must be designed to attract private and institutional capital while ensuring public accountability. Several options exist that require further consideration and could include the following:

- establishing a Canada Clean Infrastructure Sovereign Fund, capitalized through federal green bonds and co-investment from the Canada Pension Plan Investment Board and major provincial funds;
- mobilizing public-private partnerships, but with safeguards against foreign capture of critical infrastructure;
- creating a pan-Canadian green finance taxonomy, aligned with EU and Organisation for Economic Co-operation and Development standards, to attract global capital markets while preserving domestic oversight; and
- leveraging carbon border adjustment mechanisms in trade agreements to finance corridor expansion by tying Canadian exports to verifiable clean-energy inputs.

Any combination of the approaches outlined above allows flexibility to move away from reactive taxation and introduces a focus on market approaches for sovereign financing.

Final Conclusions

Canada can reduce its dependency on fossil fuels, US energy markets and foreign digital infrastructure by advancing broad-based electrification of the economy. It can position itself as a global middle-power leader in climate, energy and digital governance. The east–west power corridor is a constitutional project of our time — an indispensable step towards a sovereign, sustainable and resilient Canada in 2050.

This can only be accomplished, however, by reducing fragmentation across provincial jurisdictions as part of a whole-of-government, whole-of-society approach. If substantial social, economic and political benefits of a unified country are to be realized, then Canada must treat the east–west power corridor as a project of the utmost national urgency, akin to the construction of the transcontinental railway in the nineteenth century.

With a timely commitment to the TransCanada Power Corridor as enabler of clean electricity trade and transfers across provincial boundaries, Canada can future-proof its economy and decarbonize decisively.

END NOTES

[1] The TransCanada Power Corridor will emerge from an integration of regional grids — reflecting geography and existing system configurations in the West, Central and Eastern parts of Canada — connected at key nodal points for seamless transfers of electricity trade, reliability enhancements and security of the national system.

[2] This study focuses on national energy consumption and a vision for decarbonization that allows for a clear accounting of the emissions and strategies to meet the national targets for reduction of GHGs. The exports constitute Scope 3 emissions.

[3] Emphasis on electrification as an effective pathway to decarbonization is widely recognized. See Dion et al. (2022); Dion et al. (2021); Electric Power Research Institute) (2021); Energy Transitions Commission (2021); IEA (2021).

[4] Ontario's "Energy for Generations" plan was announced in June 2025. See https://www.ontario.ca/page/energy-generations.

[5] See Conference Board of Canada's "Energy Intensity," at https://www.conferenceboard.ca/hcp/energy-intensity-aspx-2/.

[6] Examples of transmission links that are in service include: Piedmont-Savoie Italy to France [+/-320kV, 200km., 2 circuits, 1200 MW], Norway to UK Sealink [+/-500kV, 700km, 1400 MW], The Celtic Interconnection, Ireland to France [+/-320kV, 570km, 700 MW], The Quebec to NYC Champlain-Hudson Power Express [+/-400kV, 540km, 1250 MW] and in Germany the Suedlink and SuedOstLink provide 8000MW of capacity with the Nordlink connecting Norway to Germany for an additional 1400 MW capacity.

[7] Recent Cascade Institute Reports provide key insights for advancing deep geothermal in Canada: Graham et al. (2022); Pearce and Pink (2024); Smejkal, Cosalan and Cortinovis (2025). Also see https://www.ga.gov.au/aecr2024/geothermal.

[8] The plant came online in 2023 with a capacity of 3.5 MW — enough to provide power to about 2,600 homes. With drilling of 24 planned geothermal wells at the facility, the plant is expected to start generating 100 MW of power in 2026 and an additional 400 MW will come online in 2028. See https://fervoenergy.com/.

[9] See Brouillete (2022, 7) and Canadian Nuclear Association (2024).

[10] Several recent developments in Canada include: "Feasibility of Small Modular Reactor Development and Deployment in Canada" by SaskPower, Énergie NB Power and Ontario Power Generation (2021), Canadian Small Modular Reactor Roadmap Steering Committee (2018); InterProvincial Government (2022).

[11] The TransCanada Power Corridor is envisaged as an integration of three regional grids (West, Central, East) linked through inter-connections across provincial boundaries.

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APPENDIX A

Provincial and Territorial Electricity Expansion Plans (2025–2045)

This appendix compiles existing and near-term expansion plans across all Canadian provinces and territories. Values reflect current installed capacity (from Canada Energy Regulator / NRCan data) and headline planned additions.

Province	Current Capacity (MW)	Planned Additions (MW)	Key Projects / Notes
Alberta	17,000	1,365	Buffalo Plains 494; Paintearth 190; Travers 465; Dunmore 216. Market-driven renewables growth, coal phase-out.
British Columbia	13,000	4,062	Site C 1,100; Calls for Power ≈2,962; $36B grid/ transmission upgrades.
Manitoba	6,100	652	600 MW new wind call; Pointe du Bois +52 MW upgrade.
New Brunswick	4,723	2,200	Wind 1,400; Solar 200; SMRs 600; NB–NS Reliability Tie, Indigenous-led renewables.
Newfoundland & Labrador	8,682	4,050	Bay d'Espoir U8 ~154; Churchill Falls uprate; Gull Island ~3,900 potential; offshore wind-to-hydrogen export.
Nova Scotia	3,206	550 (by 2026)	500 MW local renewables; 50 MW solar; offshore wind roadmap (5 GW target by 2030); hydrogen hubs (EverWind, Bear Head).
Ontario	39,600	6,000	Darlington SMRs (1,200 MW by 2036); Bruce new build up to 4,800; hydro refurbishments; ~3,000 MW storage.
Prince Edward Island	441	30	Eastern Kings windfarm expansion; imports from NB; target net-zero grid by 2040.
Québec	45,000	8,500 (by 2035)	Hydro-Québec 60 TWh plan ≈ 8–9 GW hydro/wind expansion; interprovincial trade (600 MW Ontario seasonal exchange).
Saskatchewan	5,000	3,375	Wind/solar up to 3,000 by 2035; first SMR 315 by 2034; ~60 MW hydro uprates.

Territory	Current Capacity (MW)	Planned Additions (MW)	Key Projects / Notes
Yukon	500	—	Hydro + diesel + wind mix; microgrid pilots; Haeckel Hill Indigenous wind (2024).
Northwest Territories	250	60	Primarily hydro; Taltson expansion (~60 MW); thermal/diesel backup.
Nunavut	100	1.8	Diesel-dominated; Naujaat ~1 MW; Rankin Inlet 0.3; hybrid ~0.5.
Canada (Total)	170,000	30.846	Aggregate of provincial/territorial plans (2025–2045 horizon).

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ACKNOWLEDGEMENTS

The authors acknowledge the valuable feedback and helpful insights provided by the reviewers and colleagues. We are truly thankful to the following: Steve Orsini (COU), Professor Shariyar Nasirov (Universidad Adolfo Ibanez, Chile), Barry Appleton (BSIA Scholar and Appleton Associates, Toronto), Professor Sidhu Tarlochan (Ontario Tech University), Professor Madjid Soltani (BSIA Fellow and International Business University, Toronto) and Professor Neil Craik, (University of Waterloo).

The authors also acknowledge the strong support and mentorship provided by Ann Fitz-Gerald, Director, BSIA.

Professor Nathwani acknowledges the financial support of National Science and Engineering Research Council (NSERC), University of Waterloo, Department of Management Science and Engineering, Discovery Grant RG PIN-2023-03314, Oct 2023.

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BALSILLIE PAPERS

ISSN 2563-674X • doi:10.51644/BAP87

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