



2025

OUTLOOK FOR  
**NUCLEAR ENERGY**  
IN CANADA

Executive Summary





# Overview

The Canadian Nuclear Association (CNA) commissioned a study in 2024 to understand the potential energy needs of Canada out to 2050, along with the potential role of nuclear in that future scenario. The study examined existing Canadian electricity demand forecasts, emerging demand trends, and characterized the associated potential for nuclear energy development. This Executive Summary is a brief, non-technical version of the full report.

---

The study developed three demand forecasts (minimum, reference, and maximum) considering decarbonization of the economy, economic development, such as from critical minerals and AI, and population growth. The firm generation capacity capable of supplying the total energy demanded at peak demand times was identified. The reference demand scenario is used in this study to characterize the potential need for new nuclear. This reference demand scenario forecasts that the total required available generation capacity at peak demand by 2050 will be 2.4 times the capacity available today. In comparison, the high-demand scenario shows a need for tripling today's capacity.

The reference scenario, combined with a need to displace the existing use of fossil fuel baseload generation in the country, reflects **a need to develop 150 GW of additional firm generation capacity**. Analysis of the nature of the demand shows that this requires 115 GW of new non-emitting baseload generation, along with an additional 35 GW of flexible generation.

The sheer magnitude, shape, and pace of this demand growth are beyond the ability of any one energy supply type to address. All energy generation technologies, including nuclear, will be needed in the transformation of Canada's energy future. Notably, nuclear energy is a critical component of the solution because there are many attributes that make it ideally suited to supply significant amounts of baseload demand.



**Of the 115 GW of identified new baseload demand, the CNA's work puts forward low, medium, and high build cases for capacity deployment by the nuclear energy sector. The build cases consider both large nuclear (totals ranging from 13 to 30 GW) and smaller nuclear (ranging from 3.5 to 21 GW).**

---

For the high build case, the combined estimated total could be over 50 GW of new nuclear by 2050. This high-build case would meet ~45% of the needed 115 GW of new baseload capacity, or 33% of the total need for 150 GW of new firm generation capacity. As a result, the pace of demand growth will require the deployment of an additional 100 GW of firm non-nuclear supplies from as many sources as can be economically developed.

The CNA study also looked at several economic implications of deploying nuclear and other alternatives. Findings show that nuclear energy can offer significant economic advantages – nuclear is less capital-intensive, more affordable for ratepayers, and provides greater returns on government incentives like Investment Tax Credits (ITCs). As a result, wherever and whenever it is practically feasible to deploy new nuclear, it should be.

Given the scope of the challenge, Canada must take rapid and decisive action to initiate new nuclear deployment in Canada, advance nuclear power plant site development across the country, and speed up the timeline for bringing new facilities into commercial operation.

Realizing this ambition will require Canada's federal and provincial governments to collaborate with industry and other partners immediately. It is vitally important that governments align public policy and raise public awareness of Canada's demand growth challenge.



# Perspectives on Canada's Growing Demand

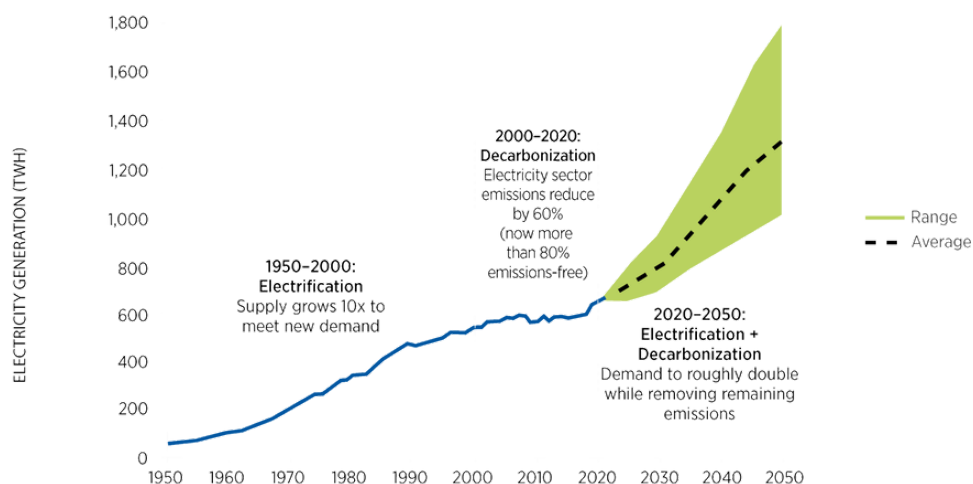
The CNA analysis examined three aspects of existing Canadian electricity demand forecasts: the demand that might arise for electricity from decarbonizing Canada's economy; the shifting nature of energy demand; and, other emerging demand trends primarily related to greater economic development.

## Decarbonizing Canada's Economy

Over the past decade, numerous studies have estimated Canada's potential annual energy demand for electricity to achieve a net-zero economy. In our analysis, the CNA reviewed many of these studies, including the Canada Electricity Advisory Committee's (CEAC) *Powering Canada: a blueprint for success*. The CEAC report summarized a range of forecasts

as summarized in Figure 1, taken from the CEAC report, and concluded that Canada can expect a 2 to 3 times growth in demand for electricity generation over the next 25 years. While this challenge is significant, the CEAC noted it believes it is achievable, given Canada's tenfold expansion of its electricity system tenfold from 1950 to 2000.

Figure 1: 100 Years of Electricity Generation in Canada



Source: Natural Resources Canada, "Powering Canada: A blueprint for success" (May 2024)



The CNA critically evaluated various annual energy demand forecasts, including the Canada Energy Regulator's (CER) *Canada Energy Future 2023*, and the Trottier *Canadian Energy Outlook 2024*.<sup>1</sup> The CNA found that, after accounting for outliers and outdated data, most studies align closely in forecasting total 2050 annual energy demand in the range of 1250–1400 TWh (compared with 618 TWh in 2023).<sup>2,3</sup> The alignment of the net forecast energy demand is remarkable given that these reports had substantially different assumptions on the role of many options for decarbonizing the economy: electrolytic hydrogen, biofuels, and carbon capture.

Research also identified the potential for an additional 15% of electrification demand based on an average of the higher of the demand forecasts surveyed. This additional demand reflects some accommodation of yet-to-be-resolved approaches to the many hard-to-decarbonize sectors not addressed by the surveyed studies.



**Given the scope of the challenge, Canada must take rapid and decisive action to initiate new nuclear deployment in Canada.**



# Shifting Nature of Energy Demand

Understanding energy demand is critical to evaluating how to supply it best. For this report, energy demand is divided into the need for supply capacity to meet the hourly profiles for baseload, intermediate, peak and reserve types of demand:

- **Baseload** is demand that exists all the time (24 hours a day, 7 days per week, 365 days per year);
- **Intermediate** demand that reflects the normal daily, weekday/weekend, and seasonal variability above baseload but excluding peak needs, and requires flexible supply capacity; and,
- **Peak and Reserve** demand, which rarely occurs. For example, Peak demand occurs less than 2% of the time, while the need for Reserve capacity is even more rarely used, reflecting the additional capacity needed to comply with regulatory requirements and ensure grid reliability against extreme events and outages.

The Strapolec analysis, for this report, applied this framework to demonstrate that future demand growth due to decarbonization of the economy alone will have a significant need for new baseload capacity of about 63 GW. Consistent with the CEAC recommendation to focus on innovation and demand side management (DSM),

the Strapolec analysis recognized emerging innovations within the electricity system enabled by smart charging of electric vehicles (EVs), and the integration of dual fuel heat pumps. These innovations were estimated to increase baseload by 11 GW and reduce the need for flexible intermediate supplies by 21 GW.





# Other Demand Drivers

Since the development of the aforementioned electricity demand forecast due to decarbonization, research has identified many additional drivers of electricity demand growth, which are factored into the CNA's analysis. These include: industrial behind-the-meter hard-to-decarbonize applications; increased provincial expectations for industrial activity due to the auto sector transition to EVs, critical minerals resource development, and hydrogen production for export; increased projections for population growth in Canada; and demand due to Artificial Intelligence (AI) driven data centre growth.

## **A) Industrial behind the meter (BTM) combined heat and power (CHP).**

One of the hard-to-decarbonize electricity demand drivers is industrial need for heat. Currently, many sectors use combined heat and power technologies to provide both behind-the-meter electricity, as well as to supply their heating demand. With the advent of small nuclear reactor technologies that can offer high-temperature outputs as well as electricity, there is a potential demand for small modular reactors (SMRs) in industrial applications, a form of electrified decarbonization not included in the previously mentioned studies. This could add 15-20 GW of need for baseload generation capacity.

## **B) Provincial Expectations for Industrial Growth – Critical Minerals, EVs, and Hydrogen**

A survey of provincial utility forecasts of electricity demand was conducted, and recent demand forecast updates were found for Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland-Labrador, and Alberta. While these provinces are recognizing different levels of electrification in their forecasts, analysis of the data from these provinces indicates an anticipated industrial load growth of 11 to 16 GW. This growth is independent of the electrification assumptions for decarbonizing the economy and hence has been treated as an increment over the previously mentioned studies surveyed. This new industrial demand has emerged primarily from developing critical mineral resources, retooling of the auto sector towards EVs and batteries, and the emerging potential development of hydrogen electrolysis facilities for export in Atlantic Canada.



**Assessment of the available utility forecasts for these provinces suggests a potential 10 – 15 GW of new baseload demand by 2030-2035.**





### C) Population Growth

Recent StatsCan medium case population growth is 4.8% higher than assumed in any of the studies (52.5 million residents by 2050). A 4.8% impact on demand growth has been assumed in the Reference Demand Scenario. While the StatsCan forecast carried a high growth case of 61.6 million residents, or a further 17% growth, this estimate has not been reflected in this study.



**This demand for new baseload supply represents 2.3 times Canada's current total nuclear and hydro baseload capacity.**



### D) Artificial Intelligence (AI) Driven Data Centre Growth

The subject of AI implications on electricity demand growth from data centres and the impact on the grid has been receiving substantial and growing media coverage in the last year. A May 2024 Electric Power Research Institute (EPRI) report summarizes the implications in terms of the data centre demand growing to up to 9% of total electricity demand. The CNA study evaluation of the EPRI report analysis concluded that 3 to 5 GW of new needed baseload should be added to the Reference Demand Scenario 2030 forecast. The Maximum Demand Scenario includes doubling that to 10 GW by 2050 on the assumption that growth in data centre needs will not stop in 2030.



# Demand Scenarios



Based on all of the factors described above, the CNA has developed three scenarios that outline the potential electricity demand for 2050 (Figure 2).

- The **Minimum Demand Scenario** uses the decarbonization electrification forecast of net energy demand described in Figure 1, including the aforementioned 11 GW of baseload that may result from DSM innovations, but excludes provisions for industrial growth.
- The **Reference Demand Scenario** builds on the decarbonization-induced demand from the Minimum Demand Scenario and adds the minimum range value for: industrial behind-the-meter generation; industrial growth; AI data centre growth; and population growth (applied to the decarbonization component of demand).
- The **Maximum Demand Scenario** reflects the higher end of the ranges for the items captured by the Reference Demand Scenario. It includes further allocations of 7 GW potential for AI-enhanced DSM and 15 GW for export capacity reflective of current proportions.

Figure 2 shows that in the *Minimum Demand Scenario*, Canada will need 2x its existing capacity. In contrast, the *Reference Demand Scenario* shows a need for 2.4x existing capacity and the *Maximum Demand Scenario* a need for 3x or triple the existing capacity.

Focusing on the *Reference Demand Scenario*, the analysis highlights a dramatic increase in demand for baseload supply, projecting the need for 115 GW of new non-emitting baseload capacity by 2050. This new supply would also replace the 9 GW of fossil-fueled baseload generation in use in 2021. This demand for new baseload supply represents 2.3 times Canada's current total nuclear and hydro baseload capacity. This scenario also shows that, in addition to the 19 GW of existing flexible hydro, 55 GW of new flexible intermediate, peaking, and reserve capacity will be required, assuming that the existing 17 GW would have to be replaced by 2050.

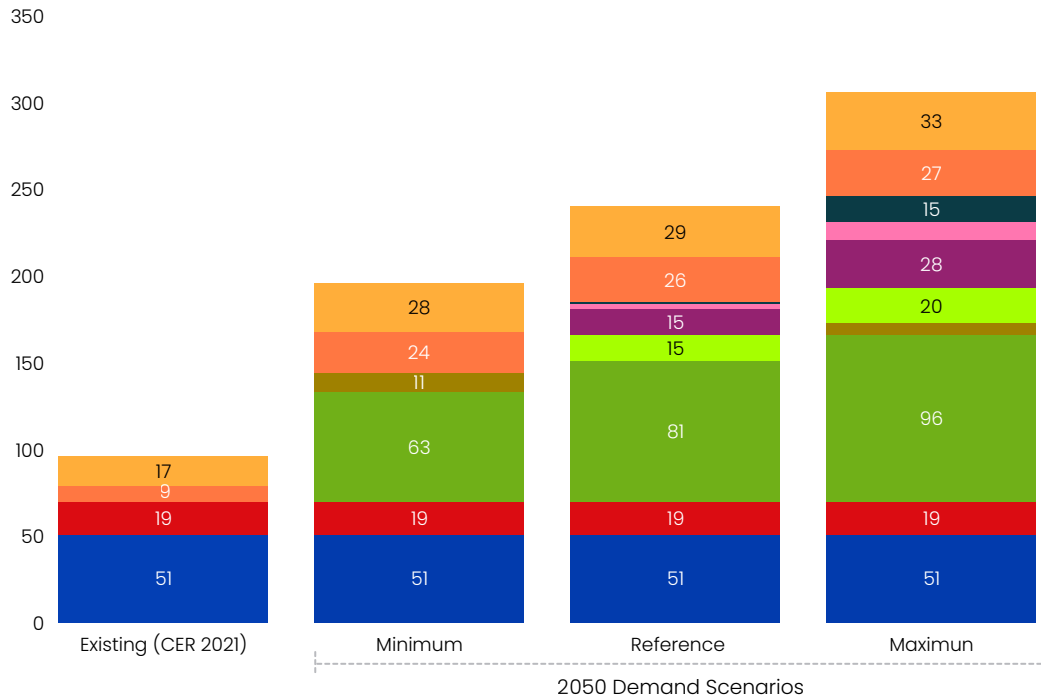
In the *Maximum Demand Scenario*, baseload requirements could rise to 173 GW by 2050, necessitating the construction of 3.5 times Canada's existing nuclear and hydro baseload generation.

Recognizing the long timeframe of major construction projects, all of the demand scenarios underscore the critical need for immediate action to start to build new non-emitting generation capacity.



Figure 2: Forecast Demand Scenarios for Capacity

## Canada's Clean Economy 2050 Electricity Demand Scenarios (GW Capacity, Derated at Peak)





# Timeline for Demand Growth

Figure 3 illustrates a potential demand growth curve for the Minimum and Reference Demand Scenarios, highlighting the challenging pace by which supply must be developed to ensure that Canada retains a reliable electricity system with no material risk of blackouts. The growth profile reflects that illustrated by the CEAC report, with the additional new industrial demand being realized by 2040. The figure reflects the need for 115 GW of new baseload by 2050 within the total of 240 GW of capacity. The figure extends to 2060 to illustrate that demand will not stop in 2050 and that ongoing capacity development should be anticipated. To meet demand under the Reference Demand Scenario, 30–36 GW of new supply will be required by 2035.

After including approximately 4 GW from announced nuclear projects, there remains a near-term shortage of 26–32 GW, which is followed by ongoing growth of 6 GW/year of new baseload demand. Even if all existing fossil assets are retained, significant gaps remain in the ability of Canada's electricity sector to supply this demand. It is clear that, in addition to new nuclear, other technologies like hydro, renewables, and gas-fired generation with carbon capture will be essential. Building the necessary capacity within the near and medium-term timelines poses significant challenges, especially given the lengthy development periods for new infrastructure.

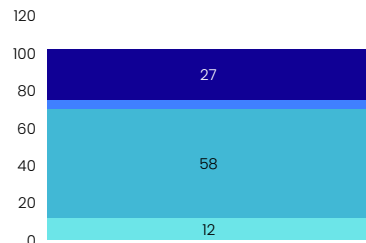
Compounding this challenge is that provincial needs vary. Ontario requires the most additional capacity due to its size, while Alberta, Saskatchewan, and Nova Scotia face steep challenges to transition away from fossil fuels.

Canada's dispatchable low-GHG generation options are limited, with nuclear, hydro, and biomass offering the most likely viable solutions, though each has significant hurdles. Non-dispatchable renewables like wind will require firming technologies to ensure reliability, underscoring the complexity of Canada's energy transition.



Figure 3: Demand Growth Timeline

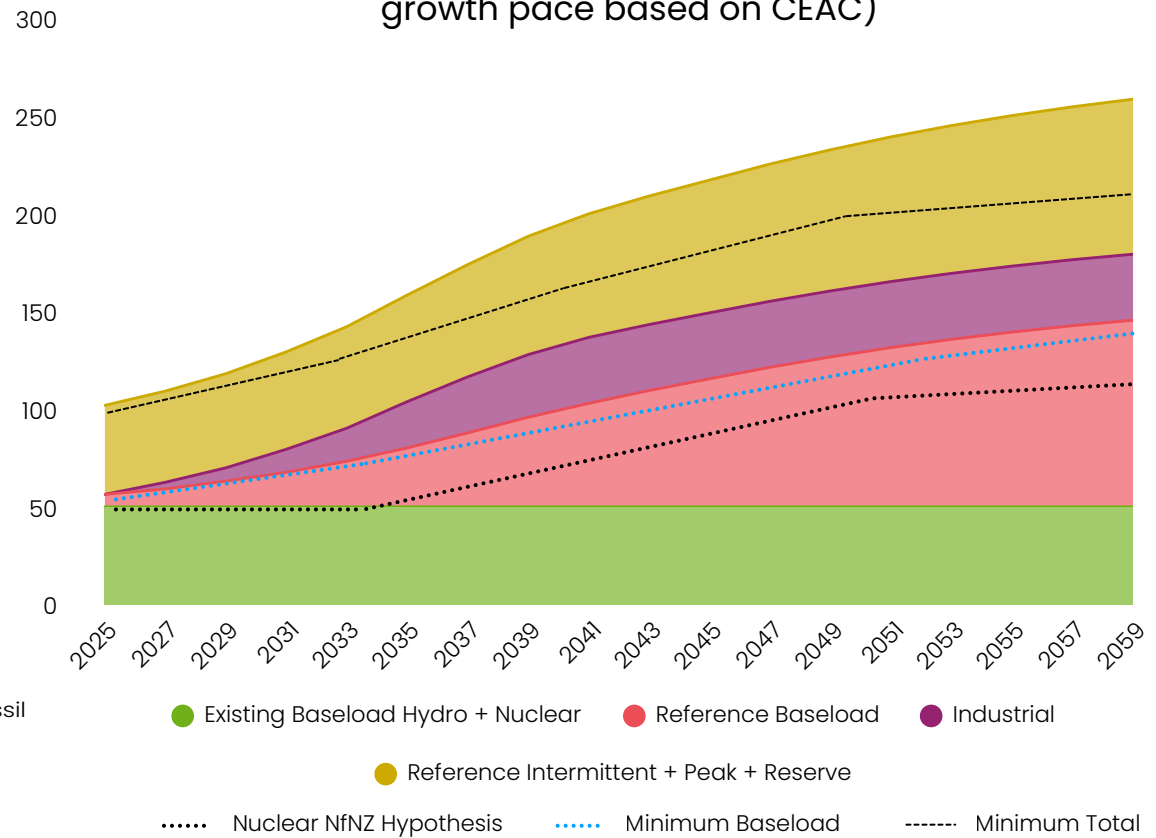
### Existing Capacity - Canada (GW, Derated at Peak, 2021)



● Nuclear ● Hydro ● Other Renewables ● Fossil

### Illustrative Demand and Supply Growth Chart - Canada Total

(GW Capacity, Derated at Peak, Ref Scenario with growth pace based on CEAC)



# Nuclear Deployment Cases



Canada has an opportunity in the coming decades to deploy a substantial amount of nuclear energy, both to supply low-carbon emissions electricity and to power harder-to-decarbonize sectors of industry. It is a challenge to accurately predict what the new nuclear deployment will be years in advance across Canada. However, it is possible to build illustrative cases that reasonably bound the size, indicating what is possible. The purpose of these cases is to initiate informed conversations about potential possibilities. CNA has constructed low, medium and high new build cases, informed by published plans as well as by reasonable aspirational goals and opportunities based on discussions with nuclear utilities.<sup>4</sup> These three possible nuclear new build cases are as follows:

- The **Low Build Case** is based on publicly available information and indications of nuclear build potential currently taking place across the country in Ontario, Saskatchewan, Alberta and New Brunswick. Only these provinces with currently announced intentions to deploy nuclear power are assumed to go forward. The total amount of new nuclear capacity is about 17 GW.
- A **Medium Build Case** reflects potential additions in those same provinces as well as responding to the recognition of greater demand growth and the potential for other provinces, such as Quebec and BC to consider new nuclear which add

limited nuclear generation starting in the early 2040's, reaching a total deployment of new nuclear in the range of 37 GW.

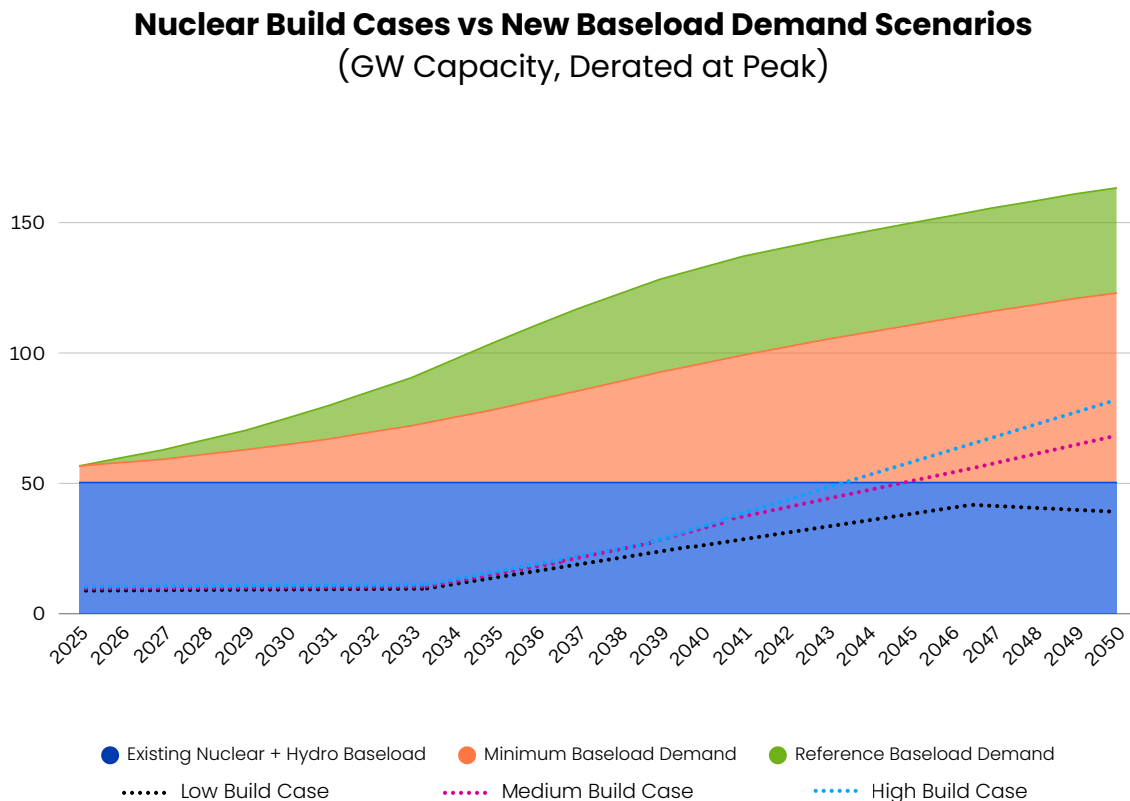
- And the **High Build Case** responds to the magnitude and pace of demand growth across the country and reflects a sector ambition that once the sector builds up a development capacity of about 4 GW/year by 2040, then that same build rate could continue indefinitely should demand interest remain. This could be 51 GW of new nuclear generation by 2050.

Figure 4 illustrates these nuclear build cases in the context of the need for new baseload in the Minimum and Reference Demand Scenarios. Four implications are highlighted:

- The *Medium Build Case* may only address 33% of the identified 2050 demand for new baseload.
  - The *High Build Case* may only address 45% of the identified 2050 demand for new baseload.
  - Other sources of supply will be relied upon to address the remaining 55% to 67% of the identified 2050 demand for new baseload.
  - 50 GW of new baseload supply from other resource types could be required by 2035. These supplies will be needed to operate beyond 2050.
- 



Figure 4: Nuclear Build Cases versus Demand Scenario needs for New Baseload



While these nuclear build cases may appear ambitious, they may only be solving a portion of the overall energy development challenge.

In contemplating the pursuit of these cases, the potential for nuclear in Canada's decarbonization efforts faces practical challenges that must be addressed (such as workforce availability, construction timeframes, and regulatory approvals).

A fleet approach, aligned with multi-governmental priorities and policies, could accelerate deployment if initiated promptly. Early site identification minimizes risk and enables cost optimization, with Ontario already taking steps in this direction. Ongoing initiatives, such as CANDU refurbishments and global projects, are improving cost certainty for large nuclear, while growing competition

among nuclear providers further enhances prospects. SMRs are progressing through international collaborations and investments from sectors like AI data centres, driving scale and cost reductions.

While nuclear deployment has uncertainties, alternatives like carbon capture, hydro and firmed-up renewables face similar challenges. A balanced, risk-informed approach to developing all supply options is essential for the energy transition. In the near term, natural gas-fired generation will remain necessary to meet demand by 2035, with a phaseout unlikely before 2050. Strategies like co-locating nuclear and gas facilities could reduce stranded costs and enhance flexibility during the transition, but further study is needed to refine these approaches.

# Advantages of Nuclear within the Supply Mix

Nuclear is a sensible option due to many attributes. It provides baseload power to the grid, 24/7, 365 days of the year. It has the highest energy capacity factor<sup>5</sup> amongst generation options – typically over 90%.<sup>6</sup> It is energy-dense compared with other energy options, meaning a small amount of fuel can produce a vast amount of energy, making it a highly efficient energy source. It is considered a clean energy source, given it emits essentially no greenhouse gases (GHGs) during operations. It has the smallest land use footprint of all non-emitting energy sources.

Nuclear energy can offer significant economic advantages, being less capital-intensive, more affordable for ratepayers, and providing greater returns on government incentives like Investment Tax Credits (ITCs), as shown in Figure 5.



**Nuclear's life-adjusted capital costs over a 40 to 60-year horizon could be less than half those of firmed-up renewables-based solutions.**



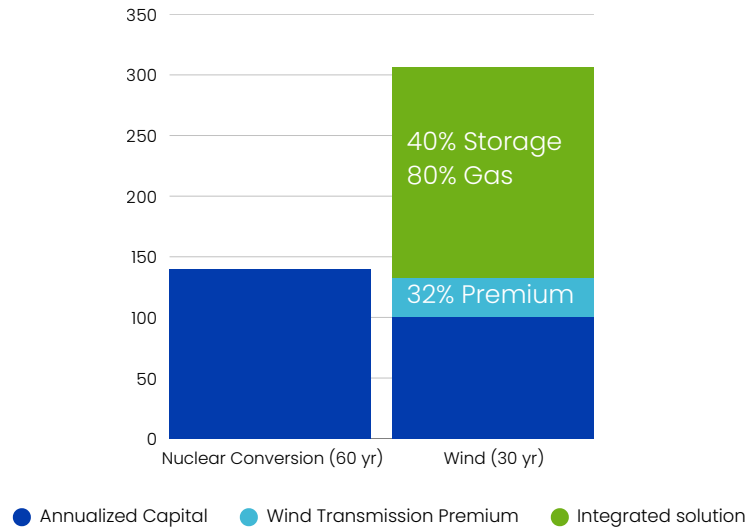
Economic advantages should be compared for the integrated suite of technologies required to meet demand, either baseload, which nuclear can provide directly, or intermediate demand, which requires a portfolio of generation components including storage and backup. The CNA study illustrates how a wind-based solution to meet intermediate demand in Ontario also requires storage capacity equivalent to ~40% of the maximum demand to be served and backup gas-fired generation capacity of ~80% of that demand.

Nuclear's life-adjusted capital costs over a 40 to 60-year horizon could be less than half those of firmed-up renewables-based solutions. Total system costs to ratepayers for nuclear could be up to 60% lower than firmed renewable options. The high domestic content of nuclear projects provides for ITC payback rates that could reach 95% within 20 years compared to 50% for other technologies. This means the cost to the federal government, and hence taxpayers, could be 82% less. These economic advantages are critical to ensuring Canada's energy competitiveness.

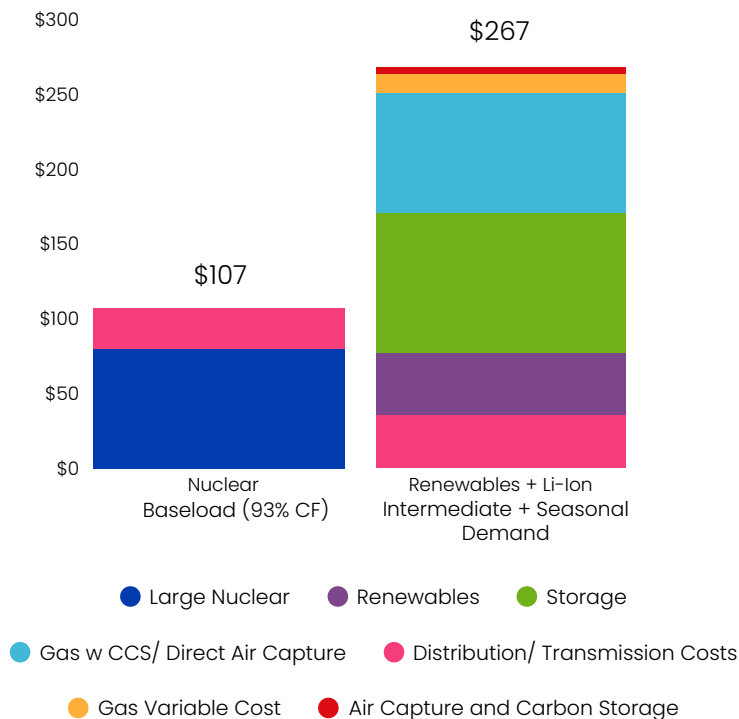
Nuclear energy is economically essential to achieving Canada's energy security, as well as a net-zero economy, and should be prioritized wherever feasible.

Figure 5: Illustrative Economic Advantages of Nuclear

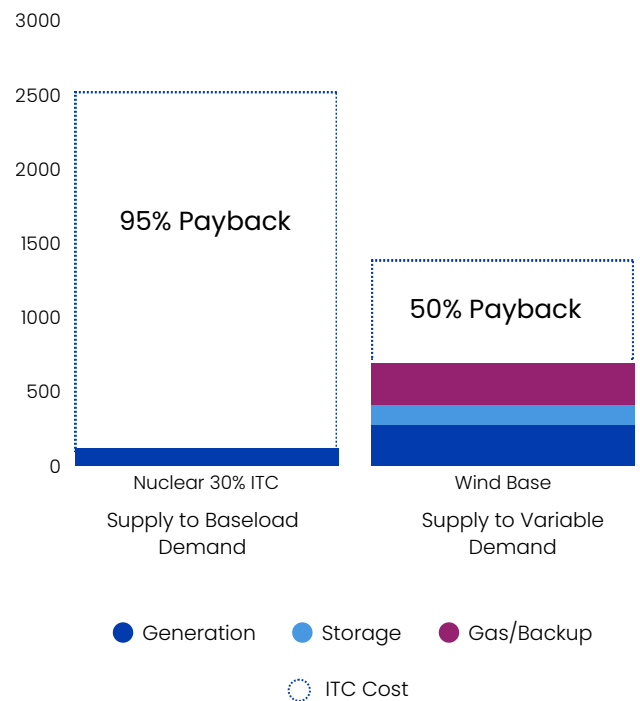
### Life Adjusted Energy Equivalent Annualized Capital Allocation (CAD\$/kW/Year of Operation)



### LCOE of Portfolio Solutions (\$2020/MWh, including Transmission/ Distribution, Ontario example)



### 20 Year Net Federal ITC Cost (\$/kW for equivalent energy)



Source: Resource costing assumptions based on US EIA 2021 Annual Energy Outlook values



# Recommendations

Given the scope of the challenge and the benefits that nuclear energy provides, Canada must take rapid and decisive action to initiate new nuclear deployment in Canada, advance nuclear power plant site development across the country, and accelerate the time to commercial operations of new facilities as much as possible and wherever it makes sense.

A unified consensus among government decision makers about the importance of the potential role of nuclear energy in addressing the future demand is a key factor in determining the extent to which nuclear energy will contribute to Canada's future electricity system. Aligning policymakers on nuclear development imperatives will help clarify the merits of supportive policies.

In order to accelerate the energy transition, several observations are offered:

- The magnitude of demand growth necessitates urgent planning for significant supply infrastructure development across all types
- A comprehensive energy transition plan must focus on providing a reliable near-term supply while building a longer-term, secure and clean energy future

- Energy supply mix decisions, including nuclear, should prioritize net cost benefits for ratepayers and taxpayers while exploring innovative business models to optimize economic outcomes and manage risks.
- Canada, particularly its provinces, can accelerate nuclear development by setting clear goals and providing reliable commitments.

Accelerating nuclear development could position Canada as a first mover, leveraging clean, firm electricity for export opportunities. Achieving this requires collaboration and support across all levels of government in Canada.



**Canada must take rapid and decisive action to initiate new nuclear deployment in Canada.**



# Endnotes

- [ 1 ] The CNA also considered the Strategic Policy Economics (Strapolec) 2021 report on Electrification Pathways for Ontario, which informed a Council for Clean and Reliable Energy (CCRE) 2022 Commentary on “Toward a National Energy Vision – Case Study: Electricity System Implications for Ontario and Quebec”, and the CNA’s 2024 Nuclear for Net Zero project.
- [ 2 ] Statistics Canada. 2024. Electric power, electric utilities and industry, annual supply and disposition. <https://www150.statcan.gc.ca/t1/tbl/en/tv.action?pid=2510002101>
- [ 3 ] Note that annual energy demand is measured in terawatt hours (TWh), and generation supply capacity to meet that demand is measured in gigawatts (GW), which is the amount of energy that can be produced at any given hour by a generating plant – effectively the size of the plant. In this report, the demand for new supply capacity is used to capture the intent of both, highlighting what needs to be built.
- [ 4 ] The full report is available by request to the CNA.
- [ 5 ] Energy capacity factor is the ratio of actual energy produced by a power plant over a period to the maximum possible energy it could have produced if running at full capacity continuously during the same period.
- [ 6 ] U.S. Energy Information Administration.  
[https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_b](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)

# About the CNA

The Canadian Nuclear Association (CNA) is a non-profit organization that represents over 100 members from the nuclear industry across Canada. Our members include owners and operators of nuclear power plants, reactor designers, advanced technology companies, uranium suppliers, construction and engineering firms, consulting companies, manufacturers, producers of radiopharmaceuticals and medical isotopes, universities and research laboratories, labour unions, and various service companies.

The CNA actively engages with municipal, provincial, and federal governments on policies that impact the nuclear sector. We strive to raise awareness and understanding of the benefits that nuclear technology provides to the environment, economy, and daily lives of Canadians.

## Get in touch

[communications@cna.ca](mailto:communications@cna.ca)



