Stable policy and Ontario's energy future

Submission to the Environmental Registry of Ontario (ERO)

December 13, 2024
ERO number 019-9285

Clean Prosperity is pleased to present this submission to the Environmental Registry of Ontario (ERO) in response to ERO number 019-9285: Integrated Energy Resource Plan Consultation.

Clean Prosperity is a Canadian climate policy organization that develops and advocates for practical climate policy solutions to reduce Canada's emissions and grow the economy. Learn more at CleanProsperity.ca.

Introduction

Ontario's integrated energy resource plan is a long-term vision for the province's energy economy and will outline a strategy for energy use across the economy while ensuring that the overall system remains clean, reliable, and affordable. For the past several years, Clean Prosperity has engaged Navius Research to better understand the dynamics informing Ontario's energy future under various policy scenarios. This brief outlines our findings at a high level and offers considerations for planning.

Using Navius's integrated gTech-IESD model, we modelled what Canada and Ontario's energy systems would look like between now and 2050 under a set of energy and climate policies and plans that we see as politically stable.[1] In the Ontario context, this notably includes the announced procurement of 6000 MW of new nuclear generation capacity by 2040, 5000 MW of fuel-saving renewables (i.e. solar and wind), and a landmark procurement of 2917 MW of grid storage.

[1] We include the provincial and federal climate policies that are currently in place, except for the Clean Fuel Regulations and the federal fuel charge. We exclude the Clean Electricity Regulations, but include industrial carbon pricing. The results represent one possible set of outcomes of the macroeconomic dynamics and technological choices. In the model, electricity production responds to the demand signal such that electricity demand is necessarily met with adequate supply, the total costs of the electricity system are minimized and system revenues are maximized.

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This modelling offers directional guidance on how the Ontario economy may decarbonize, with implications for key sectors of strategic interest, such as clean electricity and electric vehicles.

We make the following recommendations to Ontario policymakers

1. **Prioritize electrification across the entire Ontario economy.** Electrification will be a key driver of energy affordability and decarbonization, but electrification is also not inevitable. Our results suggest that electrification of light-duty vehicles will accelerate under current policies, including the federal zero-emissions vehicle (ZEV) sales mandate and ZEV subsidies, and Ontario's cleaner transportation fuel regulation. However, we see little electrification for other sectors such as medium- and heavy-duty vehicles, rail, and space heating for buildings. More policy support is needed to accelerate electrification in these sectors.

2. **Prioritize fleet-based approaches to building nuclear reactors.** Our modelling shows that planned energy procurements in Ontario — particularly the 6000 MW of new nuclear reactors — will increase the levelized cost of electricity (LCOE) in Ontario by 2-3% per year between 2025 and 2040. Ontarians will only realize the affordability benefit of electrification if we procure electricity at a reasonable price. Ontario has proposed 6000 MW of new nuclear capacity at the Bruce and Darlington stations, and is exploring the possibility of greenfield nuclear development in Port Hope, Haldimand County, and St. Clair. To realize Ontario's nuclear ambitions, driving down the costs of new reactor construction is critical to affordability over the long term.

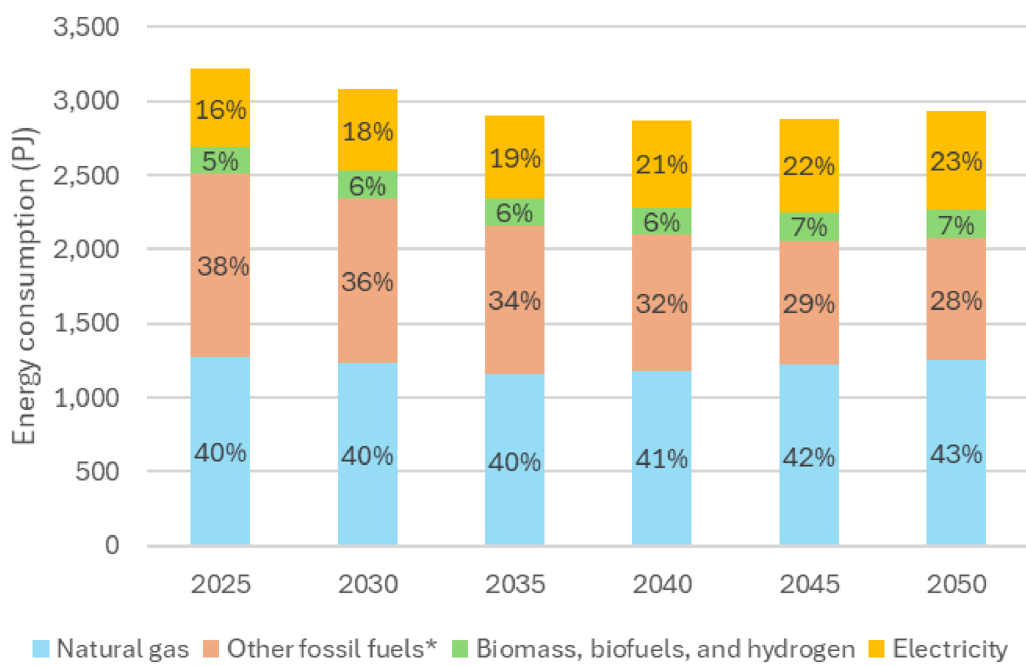
3. **Develop a whole-of-system approach to cost-effectively meet peak demand**. Our estimates indicate a significant increase in peak demand under current policies, particularly for residential consumers. One key reform to help meet this increase in demand and manage peak demand is increased investment in local electricity distribution grids. Rather than rely on taxpayers, homebuyers, or higher rates to finance long-term growth, Clean Prosperity suggests cities turn to non-municipal investment partners to help finance the build-out of electricity distribution. Broader expertise and capital from beyond traditional municipal utilities can help enable approaches to reducing peak electricity demand, such as distributed energy resources.

Analysis

Electrification will drive efficiency gains

Even with significantly higher levels of electricity use, total energy consumption in Ontario is projected to fall by around 9% while emissions fall by about 20% between 2025 and 2050 (see Figure 1). This is largely due to the continued phaseout of coal use across the economy and efficiency gains from electrification in the transportation sector (relative to internal combustion gasoline vehicles). Our modelling suggests approximately 185 terawatt-hours of annual generation by 2050.[2]

Figure 1: Projected total energy consumption in Ontario under stable policies

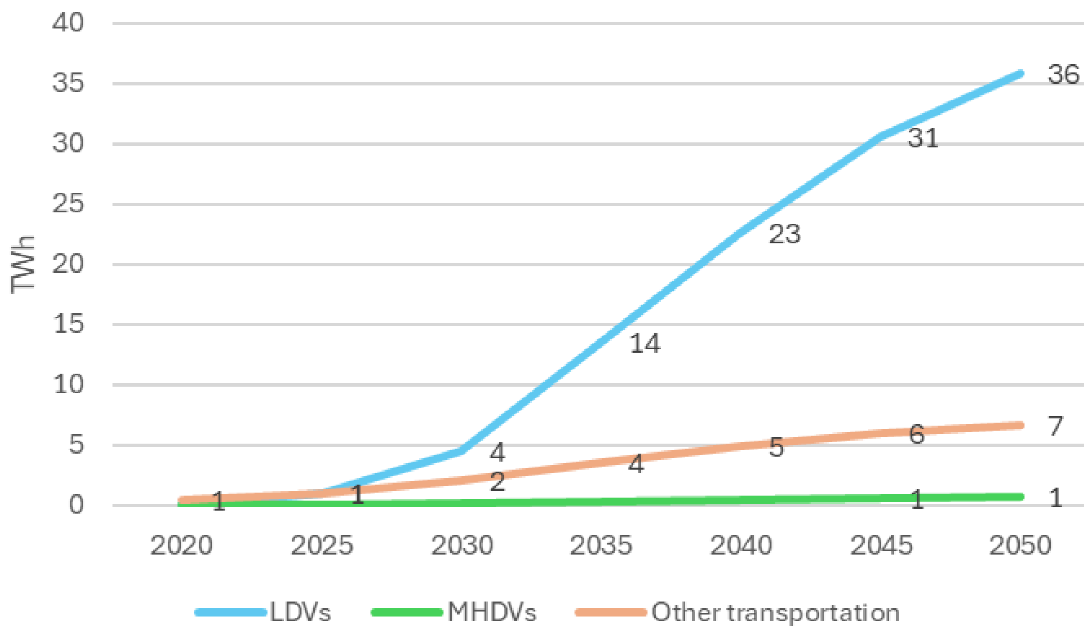


*Other fossil fuels include primarily refined petroleum, as well as natural gas liquids such as propane, and coal and coke.

[2] This value represents the end-use electricity consumption. To ensure reliable supply, additional electricity is needed to account for losses at transmission lines, transformers, storage discharge, etc. For comparison, total electricity demand was 137.6 TWh in 2022 (IESO, 2024).

Despite this decline in total energy consumption, electricity consumption is set to increase markedly. Total electricity consumption is projected to increase by close to 27% over the next 25 years, reaching approximately 185 TWh[3] by 2050. Electricity demand from light-duty vehicles (LDVs) will be a significant driver, making up nearly 20% of all electricity demand by 2050 (see Figure 2).

Figure 2: Annual electricity consumption (TWh) in transportation in Ontario



Further action needed to electrify and modernize the transportation sector

Our modelling suggests that the current politically stable policies will contribute to significant shifts in the market for light-duty vehicles (LDVs). By 2050 we expect 72% of LDVs will be electric, reducing emissions by 82% relative to 2025.

[3] This value represents the end-use electricity consumption. To ensure reliable supply, additional electricity is needed to account for losses at transmission lines, transformers, storage discharge, etc.

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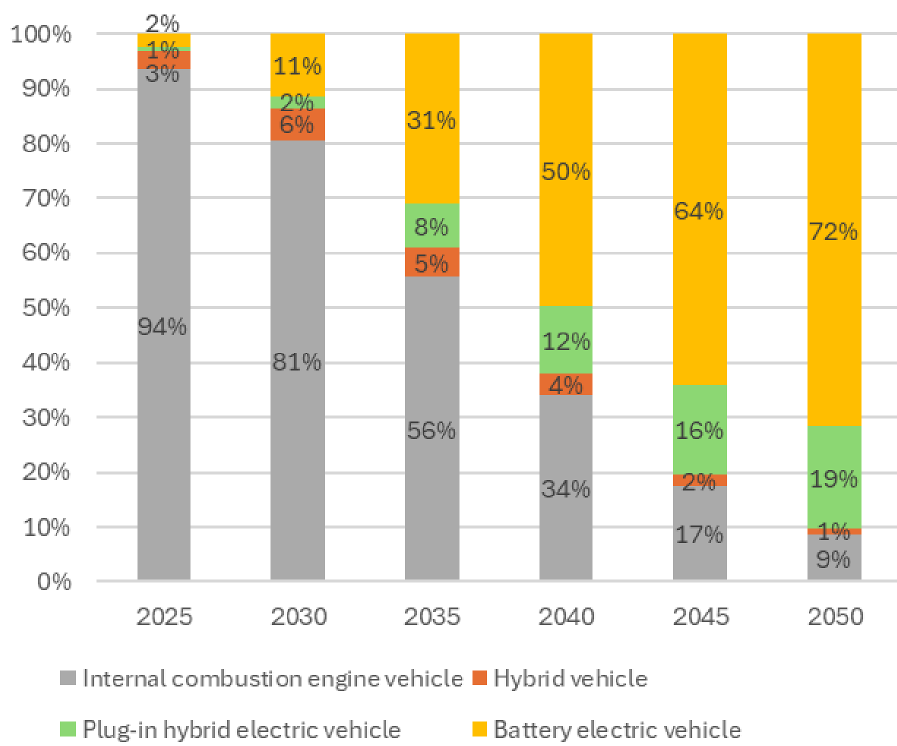
We identify a significant policy gap for medium- and heavy-duty vehicles (MHDVs). The share of hybrid and battery-electric MHDVs only grows to about 2% and 3%, respectively, by 2050. Furthermore, under the current stable policy scenario we see little to no decarbonization in other transportation subsectors including rail and aviation.

Broad EV adoption carries massive implications for resource planning. However, there are significant opportunities to further electrify and decarbonize the transportation sector, especially beyond light-duty vehicles, that are not covered by politically stable policies.

Figure 3: Market share of light-duty vehicles in Ontario under stable policies



Based on these results, we expect limited growth in the uptake of natural gas and hydrogen fuel cell vehicles, with 82% of MHDV market share continuing to be retained by internal combustion engine vehicles through 2050 without additional policy.

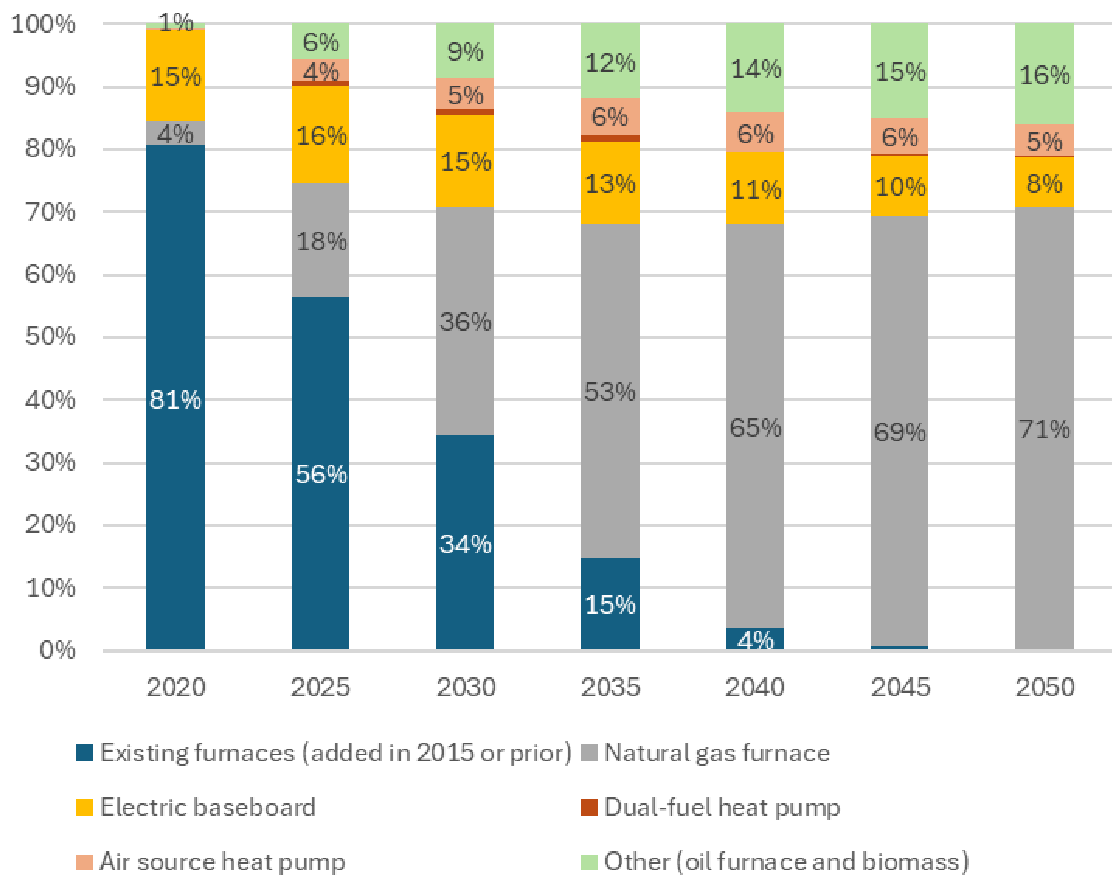
Current policies have little impact on emissions from buildings

Emissions in the building sector remain flat through 2050, with a 10% increase in total energy consumption. By 2050, natural gas would still make up over 60% of total fuel consumption in buildings, mainly for space heating.

Current policies are not incentivizing electrification in the buildings sector. Limited growth (or decline) in electricity demand from space heating will mean that under current policy Ontario will continue to see peak electricity demand in the summer months.

Heat pumps are the most technologically ready and widely available option to electrify space heating, but our modelling shows limited uptake (including dual-fuel heat pumps and ground source heat pumps) of these and other electricity-based forms of heating (i.e. baseboard) in Ontario. In 2050, heat pumps are set to account for only 5% of the space heating technology stock in residential buildings and 2% in commercial buildings (Figure 4). Despite the available incentives for heat pumps, aging furnaces are replaced primarily with new natural gas furnaces in our model. We do see significant adoption of hydrogen-ready natural gas furnaces (25% of total residential and 21% of total commercial stock in 2050). However, hydrogen consumption in the sector remains negligible, meaning that these furnaces act purely as natural gas furnaces in our simulation.

Figure 4: Space heating fuel use in Ontario under stable policies



Current policies leave little wiggle room if electricity demand grows faster than expected

By 2050, our simulated electricity generation in Ontario reaches 197 TWh to meet the growing demand in the province. However, we consider this to be a low-end estimate. We emphasize that this includes limited electrification of medium- and heavy-duty vehicles, rail, aviation, and buildings. Moreover, these model results do not account for the development of increasingly energy-intensive technologies such as data centres, carbon dioxide removal facilities, and other potential technologies that have yet to be invented or scaled but could be by 2050.[4] Clean Prosperity will be partnering with Navius Research to conduct new modelling in 2025 that will explore these higher-demand scenarios.

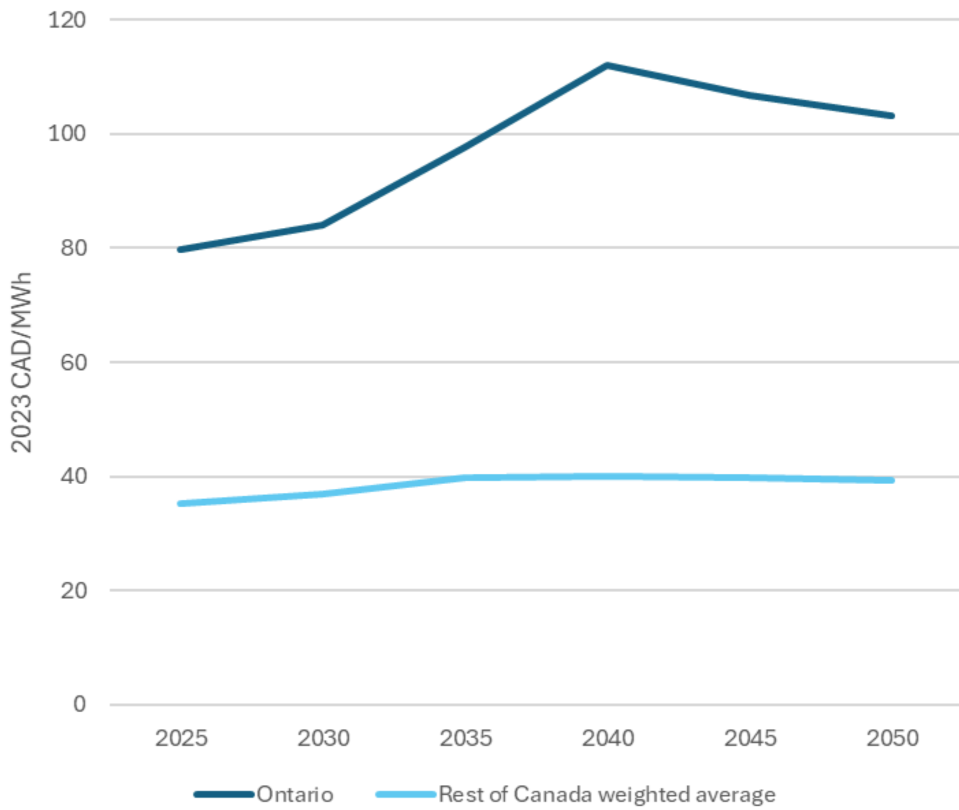
Our simulation shows that under current policies and modest demand assumptions, effectively all of the generated electricity is going to meet Ontario's simulated demand.

Our modelling shows that the planned energy procurements in Ontario — particularly the new nuclear reactors — will increase the levelized cost of electricity (LCOE) generation in Ontario by 2-3% per year between 2025 and 2040. The LCOE in the rest of Canada varies significantly by region, but a weighted average shows that Ontario's electricity costs will be two to three times higher than the rest of the country (Figure 5).

We can draw a few conclusions from these results. First is that subsidy programs, such as the Ontario Electricity Rebate and Comprehensive Electricity Plan, will continue to be important for Ontario to maintain affordability in the short-run. Second, nuclear power is a relatively high-cost option for electricity generation. Driving down the cost of building new nuclear facilities by 2040 will be crucial to managing electricity costs over time. Frank et al. (2024) argue that executing the first small modular reactor (SMR) in North America would offer a critical piece of evidence that the nuclear sector is capable of delivering first-of-kind advanced reactors on time and on budget. This would reduce the risk of cost overruns and higher-than-necessary electricity prices over the long run.

[4] IESO estimates annual demand of 14 TWh/year or 1,600 MW for data centres in Ontario from 2038 to 2050. Data centres are not included in our current simulation.

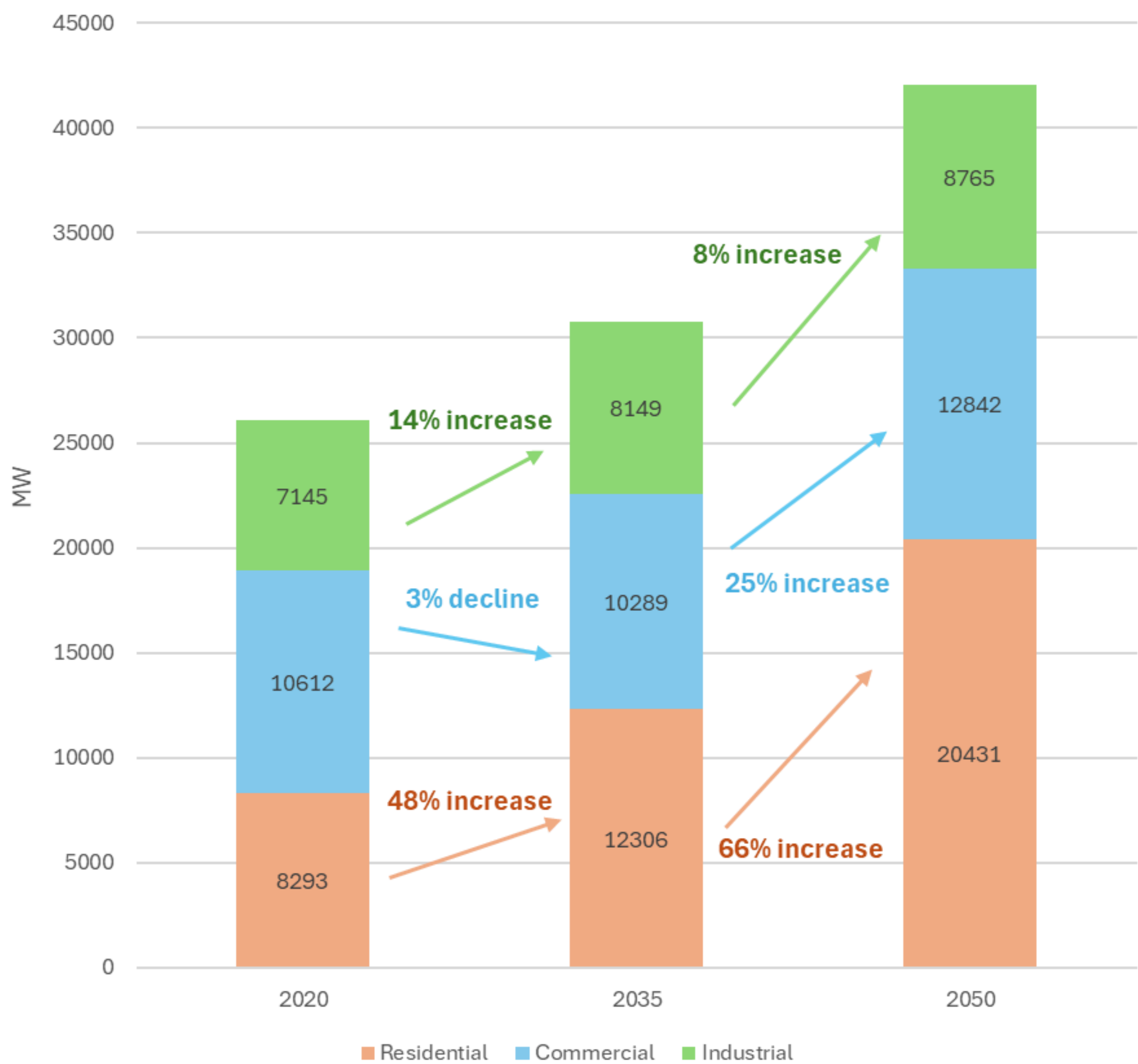
Figure 5: Electricity generation costs in Ontario under stable policies



Creative solutions needed to address the challenge of peak load

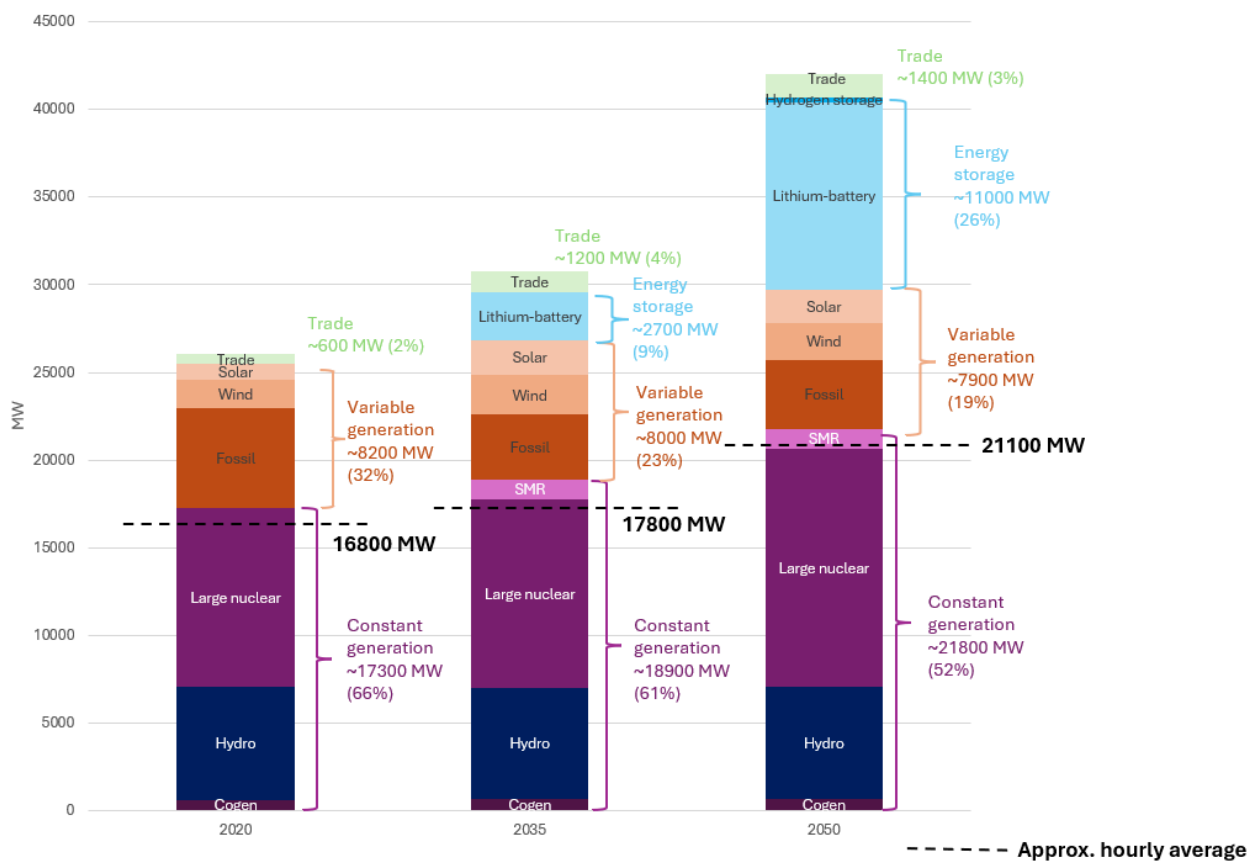
We simulated 25 of the highest hourly peak loads in a given year, broken down by three aggregate sectors (residential, commercial, and industrial) and the electricity sources deployed to meet the peak demand. Peak hours consistently occur in the summer months (July, August, and September), with residential load taking up an increasing share (Figure 6). This will put pressure on local electricity distribution companies to meet the increase in peak demand across the province. Dachis (2024) finds that Ontario local electricity distribution companies will face a considerable gap to finance the growth needed for Ontario to achieve net-zero emissions. The estimate of residential peak demand growth in Figure 6 is comparable to the estimates of overall peak growth used in Dachis (2024). This suggests that even in potential future demand outlooks without widespread heat pump adoption, local distribution companies will likely face demand peaks that will require them to find new sources of investment.

Figure 6: Peak load demand by sector in the average of top 25 peak hours in 2020, 2035, 2050



We observed that the peak load increases from 26 GW in 2020 to 42 GW by 2050, a 60% surge. The increase in peak load is much steeper than the rise in total generation in TWh (which increases by approximately 28% between 2020 and 2050) and the approximated hourly average load in the simulated years. These findings suggest room for demand-side load management strategies to help improve the future load factor[5] in Ontario to both lower electricity costs and increase grid reliability.

Figure 7: Peak load supply by source in the average of top 25 peak hours in 2020, 2035, 2050[6]



[5] The load factor is defined as the ratio between the average demand and the maximum demand for a given period. A higher load factor implies lower cost per unit of electricity generated due to lower required maximum generation capacity. ([Cerna et. al., 2023](#))

[6] The approximate hourly average load is based on the total annual generation. Represents the averages of contribution by source for the top 25 peak data points in each given year. In the Ontario context, fossil generation is from natural gas.

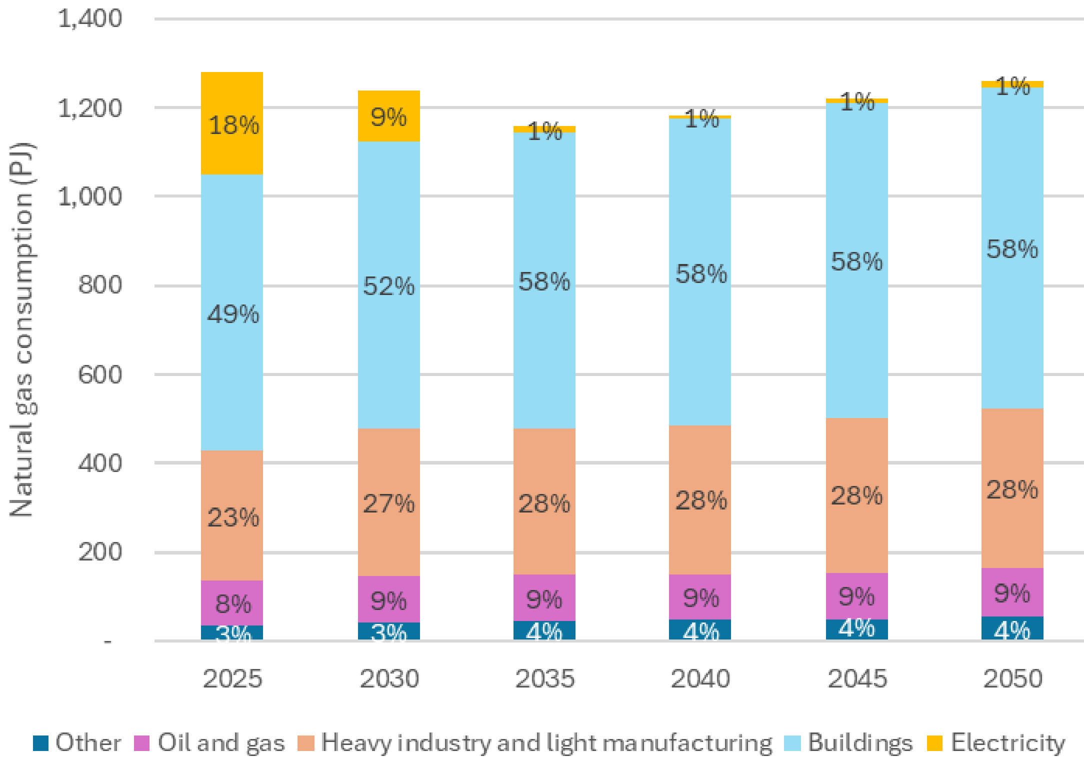
Energy storage emerges as a critical solution, growing from negligible levels in 2020 to supplying nearly 10% of projected peak load during the 25 highest-demand hours by 2035. In 2050 lithium battery storage is projected to provide over a quarter of peak supply (9,000-11,000 MW), with hydrogen-based energy storage systems playing a minor role in filling supply gaps (Figure 7).

Use of natural gas will increase in most sectors by 2050 under current policies

Natural gas currently comprises about 40% of Ontario's energy consumption. In our modelling of currently politically stable policies, natural gas consumption is projected to slightly increase to 43% of energy consumption by 2050.

Natural gas will take on a different role in Ontario's future economy, with the amount used for natural gas electricity generation falling to small amounts beyond 2030. We project that about 58% of natural gas will be used for space and water heating (up from 49% in 2025), and industrial consumption will rise by 22%, accounting for 28% total (Figure 8).

Figure 8: Natural gas consumption by sector in Ontario



This contrasts with the 2023 Ontario Electrification and Energy Transition Panel (EETP) report, which hinted at a declining role for natural gas in buildings due to cost-competitive alternatives. This can change, however, if additional supports for decarbonization are implemented, in line with the key recommendations from the EETP report.

In electricity generation, natural gas plants are increasingly used as dispatchable back-up for managing intermittency and peak load periods. However, limited electrification demand beyond EV growth, combined with an expansion of nuclear power plants, under current policies risks creating stranded assets in the electricity sector. Greater electrification could better utilize these assets as a transitional solution while non-emitting energy sources are developed.

Conclusion

1. **Prioritize electrification across Ontario's entire economy.** Extensive deployment of EVs in Ontario is aligned with the Ontario government's aspirations, but also largely a result of federal policy. Similar ambition on policy is likely needed to encourage deployment of electricity use in buildings, heavy freight, and industry.

2. **Prioritize actions that will drive down the cost of constructing new nuclear reactors.** For Ontarians to realize the full affordability benefits of electricity, the full, system-wide cost of electricity must be as low as possible. As Ontario policymakers explore the possibilities of greenfield nuclear development in Port Hope, Haldimand County, and St. Clair Township, they should optimize around reactor designs that fully leverage technology choices made at the Darlington station (small reactors) and the choices to be made at the Bruce expansion (large reactors).

3. **Develop a whole-of-system approach to cost-effectively meet peak demand.** The forecasts for peak electricity demand in this scenario of large-scale EV rollout will produce considerable peak demand pressures, particularly for residential consumers served by local electricity distribution companies. Their financial and operating model likely requires a significant rethink, ranging from including more non-municipal investment to adopting a distributed energy resource model.

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Appendix A: Modelled energy procurement schedule

Table A1: Nuclear reactor refurbishment schedule

Reactor	Model	Capacity (MWe)	First grid Connection	Scheduled shut-down	Refurbishment scheduled completion	Modelled Year of Return to Service
Bruce 1	CANDU 791	732	1977-01-14		2012	2015
Bruce 2	CANDU 791	732	1976-09-04		2012	2015
Bruce 3	CANDU 750A	750	1977-12-12	2023	2027	2030
Bruce 4	CANDU 750A	750	1978-12-21	2025	2028	2030
Bruce 5	CANDU 750B	822	1984-12-02	2026	2030	2030
Bruce 6	CANDU 750B	822	1984-06-26	2020	2024	2025
Bruce 7	CANDU 750B	822	1986-02-22	2028	2032	2035
Bruce 8	CANDU 750B	795	1987-03-09	2030	2034	2035
Darlington 1	CANDU 850	881	1990-12-19	2023	2026	2030
Darlington 2	CANDU 850	881	1990-01-15	2016	2020	2020
Darlington 3	CANDU 850	881	1992-12-07	2020	2023	2025
Darlington 4	CANDU 850	881	1993-04-17	2023	2027	2030
Pickering 1	CANDU 500A	508	1971-04-04	2025	Decommissioned	n/a
Pickering 4	CANDU 500A	508	1973-05-21	2025	Decommissioned	n/a
Pickering 5	CANDU 500B	516	1982-12-19	2026	2035	2035
Pickering 6	CANDU 500B	516	1983-11-08	2026	2035	2035
Pickering 7	CANDU 500B	516	1984-11-17	2026	2035	2035
Pickering 8	CANDU 500B	516	1986-01-21	2026	2035	2035

(Table A1 continued)

Sources:
Bruce Power, 2020. https://www.brucepower.com/wp-content/uploads/2020/01/Nuclear-Refurb-EN.pdf
Ontario Power Generation, 2024.
https://www.opg.com/power-generation/our-power/nuclear/pickering-nuclear/
World Nuclear Association, 2024.
https://world-nuclear.org/information-library/country-profiles/countries-a-f/canada-nuclear-power

Table A2: Planned new nuclear procurement in Ontario

Utility	Site	Model	MWe gross	Scheduled/ targeted/ estimated for operation	Modelled Year Entering Service
OPG	Darlington	BWRX-300	2x300	2028 (scheduled)	2030
Bruce	Bruce C	CANDU	2x800	2035 (estimated)	2035
Bruce	Bruce C	CANDU	4x800	2040 (estimated)	2040
OPG	Darlington	BWRX-300	2x300	2035-40 (estimated)	2035

Sources:
Ontario Power Generation, 2023.
https://www.opg.com/projects-services/projects/nuclear/smr/darlington-smr/#:~:text=When%20will%20the%20SMRs%20start,by%20the%20end%20of%202029.
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https://www2.gnb.ca/content/dam/gnb/Corporate/Promo/energy-energie/GNB-CleanEnergy.pdf
Bruce Power, 2024. https://www.brucepower.com/the-bruce-c-project/

Table A3: Planned energy storage procurement schedule

Type	MW of capacity	Year reflected in model
Lithium ion	868.47	2025
Lithium ion	2048.43	2030
Sources: Ontario Newsroom, May 9, 2024. https://news.ontario.ca/en/release/1004567/ontario-completes-largest-battery-storage-procurement-in-canada-to-meet-growing-electricity-demand Independent Electricity System Operator, 2024. https://www.ieso.ca/en/Sector-Participants/Resource-Acquisition-and-Contracts/Long-Term-RFP-and-Expedited-Process Independent Electricity System Operator, 2023. https://ieso.ca/en/Sector-Participants/Resource-Acquisition-and-Contracts/Overview		