A Renewables Powerhouse

New research finds that wind and solar power with battery storage is set to produce cheaper electricity than natural gas in Alberta and Ontario

CLEAN ENERGY CANADA

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Clean Energy Canada is a program at the Morris J. Wosk Centre for Dialogue at Simon Fraser University in Vancouver, British Columbia, located on the unceded traditional territories of the Musqueam, Squamish, and Tsleil-Waututh peoples.

MORRIS J. WOSK
CENTRE FOR DIALOGUE

The smart solution

In 2023, a few things are impossible to ignore. One is climate change: from floods to heatwaves, it's clear the climate clock is ticking. Then there's energy: whether it's $2 gas or higher home heating bills, powering our lives has gotten pricier.[1,2]

These two realities—climate change and volatile energy prices—have a common denominator in fossil fuels. They also share a common solution. In Alberta and Ontario, wind can now produce electricity at significantly lower costs than natural-gas-fired power—with even more reductions on the horizon.

Even without carbon pricing, wind power is set to be 40% cheaper than gas-fired-power in both provinces by 2030. Solar power, meanwhile, is already cheaper than natural gas power in Alberta and is on track to be 16% less expensive by the end of the decade. What's more, wind and solar costs are expected to decline by as much as 40% by 2035, compared to relatively flat costs for new gas deployments, according to new research from Clean Energy Canada based on work commissioned from Dunsky Energy + Climate Advisors. The analysis is among the first to examine the location-specific costs of building new clean power in these two provinces. The study also explores the costs of using battery storage to complement this wind and solar power, finding that, **even with storage included, wind and solar is still highly cost-competitive with natural gas.**

These results are important for a few reasons. For starters, Alberta and Ontario are both in the midst of transforming their power grids. Alberta is phasing out polluting coal power, while Ontario has plans to decommission aging nuclear plants. Currently, both provinces are planning for natural-gas-fired power to play a leading role in filling this gap.

The federal government has committed to new regulations that would require Canada's grid to have net-zero emissions by 2035. This policy is a fundamental pillar of Canada's plan to meet its Paris Agreement climate targets. And in a world that's increasingly valuing low-carbon products, it will be key to maintaining and growing Canadian industry's low-carbon competitive advantage.

But because power plants typically operate for decades, the choices made today will have substantial ramifications for 2035 and beyond. Building new natural-gas-fired power plants means locking in emissions—and costs—for many years to come. There is also the risk that fossil fuel infrastructure is retired before the end of its economic lifetime and becomes a stranded asset—a liability taxpayers would likely pay for.

The implications of these electricity choices are compounded by another important factor: electrification. A lot more of the energy we consume is going to come via a plug, from our home heating systems to the cars we drive. In fact, achieving net zero by 2050 will require Canada to roughly double its electricity capacity to meet demand.[3]

Both Alberta and Ontario's grid operators are investigating pathways to a net-zero power grid, but many of the forecasts have been made using data that is out of date or from other countries.[4,5] The province-specific data in this report can thus help utilities make more informed choices.

Nowhere is this point made more clearly than in Europe, where electricity bills increased 70% year-on-year after Russia's invasion of Ukraine fuelled a rise in the price of natural gas.[6] But as bad as the situation was, renewables prevented it from being a whole lot worse. Record solar generation on the continent this summer helped the EU avoid $42 billion (€29 billion) in imported natural gas costs.[7] Accordingly, Germany has plans to double its wind and almost quadruple its solar capacity by 2030, while the EU has upped its clean power targets.[8]

Canadians clearly see the benefits too. Two thirds of respondents think a clean energy system would be more affordable and secure than a fossil fuel system, according to a recent Clean Energy Canada poll.[9] Similarly, businesses are increasingly prioritizing a reliable supply of clean electricity in their investment decisions.[10]

The benefits are many, and the reasons are critical. With better data in hand, electricity decision makers can chart a brighter course for Canada.

One of the great advantages of electrification is the potential to free Canadians from the cost burdens of yoyo-ing fossil fuel prices. An EV driver needn't worry about the cost of gasoline, while a homeowner with a heat pump on a clean grid can turn up the thermostat without fear of price shocks beyond their control.

A clean energy system is not inevitable. Governments and power authorities must act to make it a reality. That means:

1. **Investing in wind and solar** along with building a stronger and more flexible grid.
2. **Providing the policy certainty** needed to incentivize the necessary investments, including finalizing the promised federal Clean Electricity Regulations.
3. **Removing barriers to adoption** by supporting the use of evolving energy storage solutions and other technologies alongside wind and solar power.
4. **Using up-to-date information** and investing in more research on the role of renewables.

The path to clean, affordable power

Now more than ever, energy security—that is, a country's ability to control the supply and price of the energy it consumes—is a key issue for nations around the world. And with economists anticipating more volatility in the price of oil and gas in the years ahead, this issue is here to stay.[11,12]

In response, many jurisdictions are turning to renewables, especially wind and solar power, to shore up energy supply. Unlike fossil fuels—whose price is impacted by global geopolitics, even in oil and gas producing nations like Canada—renewable electricity prices are set by local market conditions. Practically, that means fewer fluctuations on household energy bills and a much greater degree of domestic control over the price of energy. In fact, numerous studies have also shown that a higher reliance on wind and solar on Canadian grids can contribute to reduced consumer costs. [13–15]

On the whole, Canadians are expected to spend less of their incomes on energy in a net-zero future thanks largely to fuel savings and improvements in energy efficiency.[16,17]

While some energy-saving upgrades come with an upfront cost, government-backed purchase incentives can help make these money-saving upgrades more accessible to low-income Canadians.

What's more, wind and solar can produce power without emissions. In a world that is recording new climate catastrophes on a near-weekly basis, that's an undeniable value add.

Thanks mostly to our reliance on hydro and nuclear, Canada's grid is already comparatively clean, with 84% of its electricity produced from non-emitting sources in 2020.[18] But to tackle climate change at the pace required, Canada's relatively clean electricity system will need to get even cleaner. And as we plug more cars, heating systems, and industries into the grid, its capacity will have to at least double by 2050.[3,19]

Wind and solar must play a big part. **Studies have pointed to the fact that, in a net-zero world, wind and solar capacity would likely make up between 34% and 72% of installed electricity capacity in Canada by 2050, up from 10% in 2020.**[20]

As Canada—along with many countries around the world—charts its course to net zero, the federal government has committed to a target of achieving a net-zero electricity grid by 2035.[21] Given that power plants typically operate for decades, decisions made today will have major implications for our ability to hit these key milestones.

Photo: BluEarth Renewables

Important decisions need good data

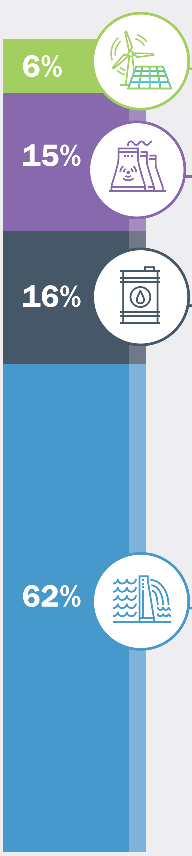
Important choices lie ahead, particularly in Alberta and Ontario where decision makers are currently implementing policies that look to increase the role of natural-gas-fired power.

For the authorities in these jurisdictions to select the best options—both for themselves and for the Canadian households that ultimately pay the bill—they need the best possible information. To date, that has been lacking. Most publicly available studies used to forecast new wind or solar costs are either out of date or use data from other countries.[22] **A recent long-term outlook from Alberta's energy regulator used renewable cost estimates prepared in 2018, which forecast prices out to 2025 for wind and solar that were more than double the cost at which the electricity was actually being purchased in 2021.**[22,23]

The issue is especially relevant in Canada, where electricity systems are largely in the hands of provinces—each with differing perspectives on electricity and different geographies that favour certain types of generation. Province-specific data is therefore critical to help fill some of these data gaps. This report presents one of the only public cost forecasts specific to Alberta and Ontario for new wind and solar power with batteries as well as natural gas.

The goal of this analysis is to provide governments, utilities, researchers, and other stakeholders with insight into the cost-competitiveness of renewable power and battery storage technology in these two provinces, while also offering a transparent, reproducible approach that can be applied to other provinces and territories in the future.

ELECTRICITY GENERATION IN CANADA
(2021)



Renewables (excluding hydro)
- Responsible for over 6% of electricity production in Canada and includes wind and solar
- Globally, wind and solar are expected to see the larges growth of any other electricity source over the coming decades

Nuclear
- Responsible for 15% of electricity production in Canada
- Canada currently has six nuclear power stations. Five are in Ontario and one is in New Brunswick

Fossil fuels
- Responsible for 16% of electricity production in Canada
- Predominantly natural gas and coal

Hydroelectricity
- Responsible for over 60% of electricity production in Canada
- A number of provinces including B.C., Quebec, Newfoundland, and Manitoba use hydro to generate over 90% of their electricity

Sources: Statistics Canada, Table 25-10-0020-01 - Electric power, annual generation by class of producer

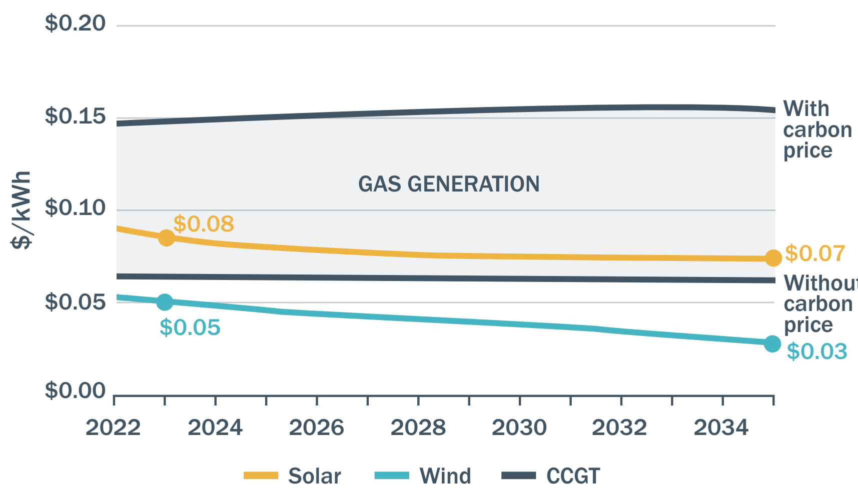
Statistics Canada, Table 25-10-0019-01 - Electricity from fuels, annual generation by electric utility thermal plants

KEY FINDINGS

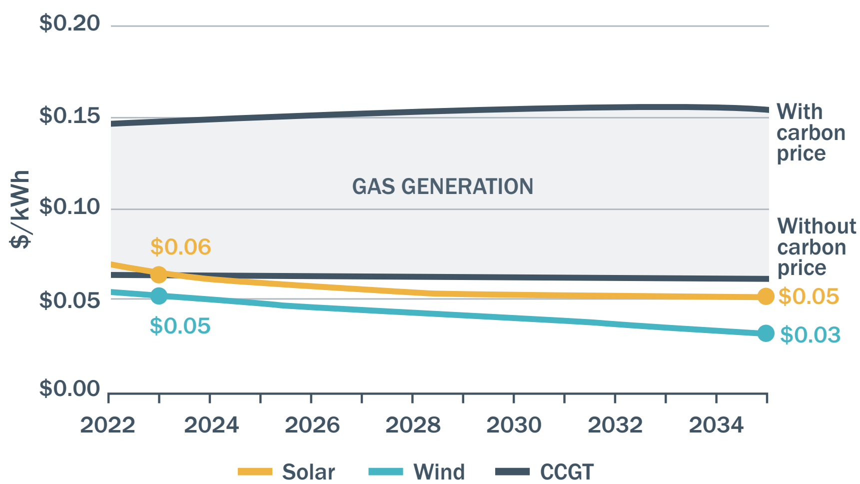
1 Electricity from wind and solar is already cost-competitive with natural gas generation in Ontario and Alberta.

When the current carbon price is also included, both wind and solar are significantly cheaper than natural gas. What's more, costs are expected to decline by a further 40% by 2035, compared to relatively flat costs for new gas deployments. That said, it's important to note that lower costs alone are only part of the consideration.[24] Wind and solar are variable resources, meaning they provide most power to the grid when the sun shines or the wind blows, which may reduce their value relative to other electricity sources. However, as costs continue to fall, there are a number of ways to complement wind and solar, one of which is energy storage.[25]

Ontario levelized cost of energy



Alberta levelized cost of energy



Combined cycle gas turbine (CCGT): Gas-fired-power plants that use gas and steam turbines together. They are often used for baseload power generation.

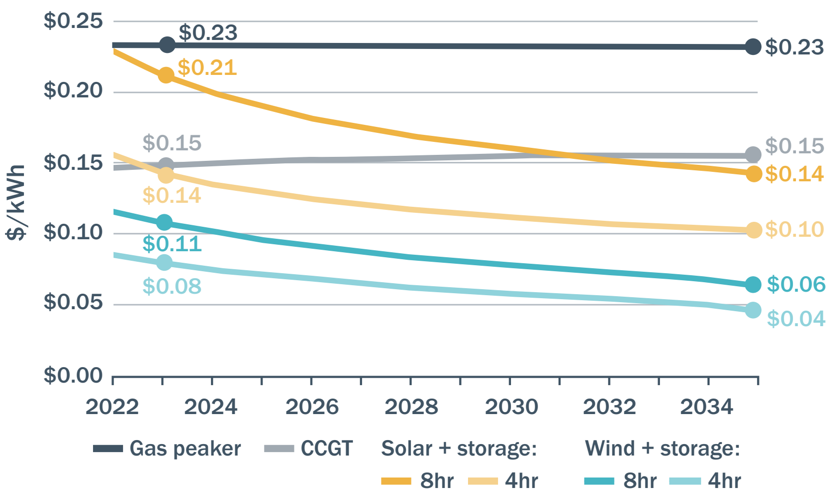
ABOUT THE **LEVELIZED COST OF ENERGY**

The main output of this analysis was a forecast for the costs of constructing and operating renewable resources, with the calculation of a Levelized Cost of Energy (LCOE) used to measure the average cost per unit of electricity generation from a facility over its lifetime. At a high level, it considers the investment required to build the plant, its projected operational and maintenance costs, and the amount of electricity it will produce. Within LCOE calculations, there are many additional and often jurisdiction-specific variables, including the costs of capital, labour, and financing. LCOE data can be used to track and forecast the cost changes of technologies over time.

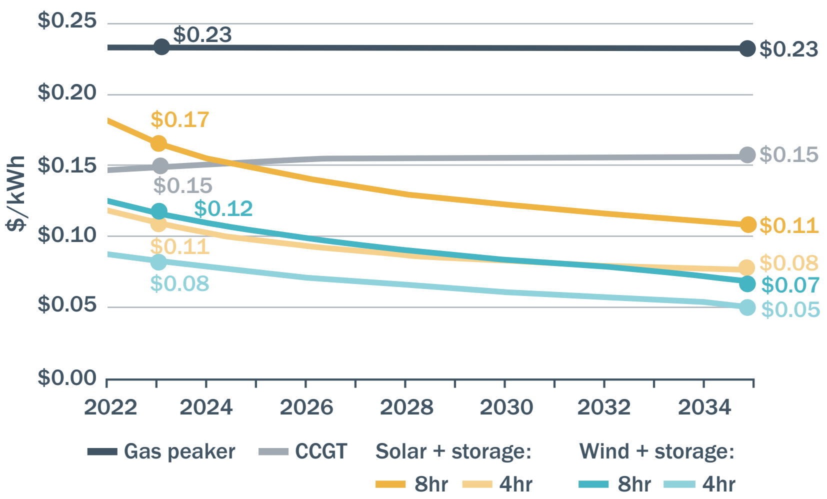
2 When paired with energy storage, wind and solar can offer dispatchable grid power at more competitive costs than gas peakers.

With energy storage added, variable renewables have more flexibility to target output during high-cost periods in the electricity market, irrespective of whether the sun is shining or the wind is blowing. By deploying batteries on their own or alongside wind and solar, surplus power can be stored and redeployed during periods of higher demand. Including four- or eight-hour storage means wind and solar power can be used to supply hour-to-hour and day-to-day energy peaks, making the electricity more valuable to utilities. While additional storage solutions will be needed to manage seasonal capacity gaps, four- or eight-hour storage is a very cost-competitive way to address daily load management needs and contribute to the reliability of the system overall. Battery technologies stand to see significant declines in cost, as innovation in battery chemistries increases their effectiveness and we reach economies of scale.[26]

Ontario LCOE of renewables + storage (with carbon price)



Alberta LCOE of renewables + storage (with carbon price)



Gas peaker / Single cycle gas turbine (SCGT): Gas-fired-power plants that generally run only during periods of peak demand. They are not used for baseload power generation.

WHAT ARE THE **LIMITATIONS OF LCOE?**

On its own, LCOE does not give a full assessment of the economic competitiveness of a technology, as it does not necessarily correspond with the market price that electricity is purchased at. This is because it does not include other key elements such as the full integration costs of a given project to the broader grid or the fact that dispatchable electricity (electricity that is available on demand) will have a higher value than power available more variably. On-demand electricity can be delivered in a number of ways, including from large hydro, natural-gas-fired plants, stored renewable electricity, distributed energy resources (like smart grid investments, EV batteries, or roof-top solar), and nuclear power.

CLEAN ELECTRICITY IS **CANADA'S ECONOMIC ADVANTAGE**

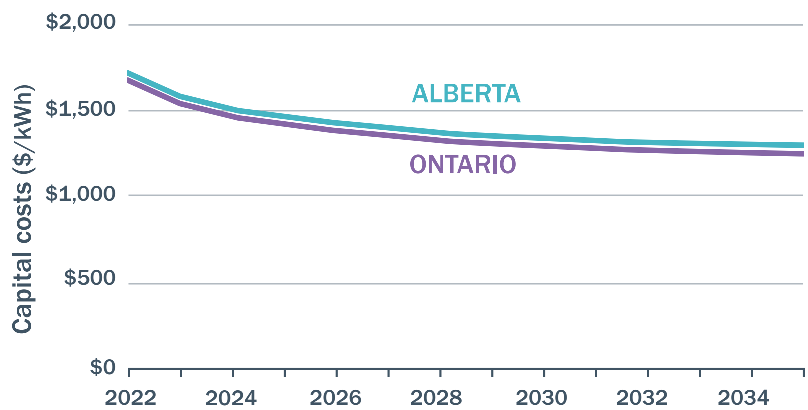
A clean electricity grid is an economic advantage for Canada, as our largest trade partners increasingly look to forge trade relationships that favour low-carbon exports and imports. Europe has plans for carbon tariffs, for example, while it has been reported that the U.K. will propose a carbon border tax on imported steel to level the playing field against competitors with lower environmental standards.[34,35] By powering our industries with clean power and putting a price on carbon, Canada can deliver the premium low-carbon goods more and more countries and companies are looking to buy.

3 While trends are broadly aligned across jurisdictions, regional factors impact deployment costs, both between the U.S. and Canada as well as between provinces.

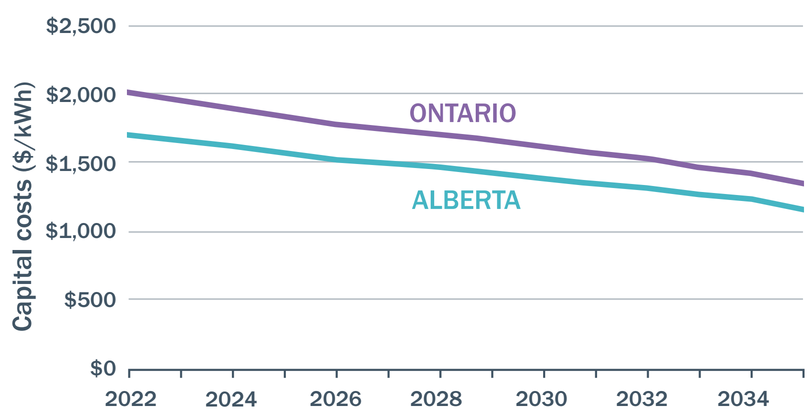
Regional variation in costs is predominantly driven by varying resource potential, physical geography of a project location, differing installation costs (in particular labour costs and taxes), and other project-specific factors like interconnection costs. Equipment costs are relatively unchanged for solar among jurisdictions, with slightly more notable differences for wind.

The graphs below show how these regional capital costs can differ when looking at different technologies, technologies. Different jurisdictions may need to consider unique approaches to addressing the specific cost drivers that affect the costs of deploying renewables.

Solar capital cost forecasts



Wind capital cost forecasts

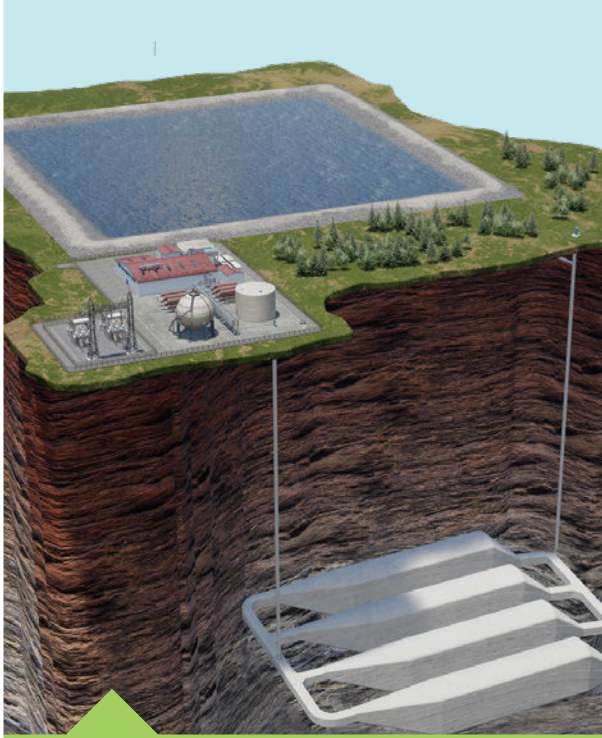


STORAGE **SOLUTIONS**

Battery storage is projected to be the fastest-growing source of flexibility for electricity grids around the world, according to the International Energy Agency.[26]

But while four- and increasingly eight-hour battery storage is a cost-effective option for balancing daily variations in power supply, other technologies will be required to support longer-term storage needs, further increasing the value of wind and solar. Technologies currently in use include pumped-storage hydropower and compressed air storage. Toronto-based **Hydrostor** is a leader in the latter. Its technology uses underground caverns to store compressed air that can be released to turn a turbine. The air is pumped down at a time when wind or solar generation is high, then released during periods of high demand or lower generation. The company already has a number of projects in the works, including two in California and a demonstration project in Ontario.[27–30] There are also other technologies on the horizon that could provide solutions in the future as well, including green hydrogen.[31,32]

Additionally, building interties (essentially power lines with large transmission capacity) between jurisdictions with different resource profiles is another critical pathway to maximize the role of variable renewables in Canada. One example is between B.C. and Alberta. B.C. has plenty of dispatchable hydropower, while Alberta has strong wind and solar potential. By creating a better connection between the two grids, these two power resources could be used in conjunction.[33]



Compressed air storage

Toronto-based **Hydrostor** is a leader in compressed air storage. Its technology uses underground caverns to store compressed air that can be released to turn a turbine.

Photo: Hydrostor

THE HIDDEN COST OF **NATURAL GAS**

Accounting for the price of carbon in fossil-fuel-based energy generation is key to ensuring that natural gas facilities aren't being unfairly favoured. Every tonne of carbon dioxide emitted from a natural gas plant has a cost to society in Canada and elsewhere. **A recent report from the U.S.'s Environmental Protection Agency estimates that a tonne of carbon emitted in 2020 costs the economy between C$160 and C$450.**[36,37] The Canadian government has referenced a range of between $135 and $440 a tonne.[36]

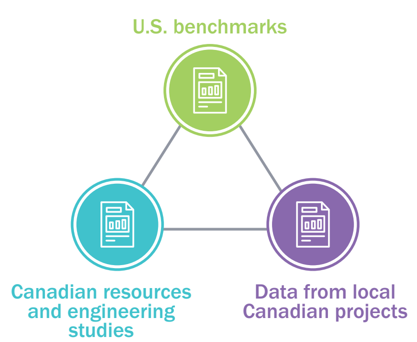
Methodology*

Clean Energy Canada commissioned Dunsky Energy + Climate Advisors to develop and apply a method to translate the existing resource cost forecasts for key renewable electricity resources into rigorous cost estimates for new solar, onshore wind, and four-hour and eight-hour energy storage projects in Alberta and Ontario over the next decade.

For each technology and province, Dunsky evaluated both the capital and operational costs associated with the technologies and developed an annual projection of the levelized cost of energy up to 2035. Dunsky also looked at the costs associated with deploying four- and eight-hour lithium-ion batteries alongside wind and solar, developing cost forecasts based on co-deployment.

* The full workbook with the forecast model and the detailed methodology are available online.

The three key sources of data used to develop cost estimates



Key assumptions

GENERAL ASSUMPTIONS

- Levelized cost of natural gas is **$3.77 per MMBtu.** Fuel cost projections are from the IESO APO 2022.
- Carbon price is assumed to **increase by $15 annually from $50/t in 2022 to $170/t in 2030** and stay constant thereafter.

FINANCIAL ASSUMPTIONS

- Debt interest rate = **6%**
- Discount rate = **3%**
- Debt equity ratio = **70%**

TECHNOLOGY ASSUMPTIONS

Gas generators	Gas peaker / Single cycle gas turbine (SCGT)	Combined cycle gas turbine (CCGT)
Heat rate	9720 Btu/kWh	6360 Btu/kWh
Capacity factor	15%	60%
Carbon emissions	0.447 t per MWh	0.337 t per MWh
Design life	25 years	25 years

Renewable resources	Solar	Wind
Capacity factor	22% (AB), 20% (ON)	35% (AB), 40% (ON)
Design life	Increases from 32 to 42 years	Increases from 30 to 40 years
AC/DC sizing	1.43 to 1.42	–

Energy storage	4 hour	8 hour
System sizing ratio (RE)	60%	60%
Depth of discharge (DOD)	80%	80%

Dunksy collected cost data for recent projects to benchmark against and adjust the forecast. Data was collected from the Government of Alberta's database of major energy projects, Ontario's Independent Electricity System Operator interconnection data, and individual project research.[38] Dunsky also verified costs through interviews with private sector project developers.

The rise of renewables

While 2022 was a tumultuous year for energy writ large, renewables emerged stronger than ever. As supply chain tensions and the Ukraine war squeezed global oil and gas supply, it only reinforced the importance of clean power for both energy affordability and security.

Many countries, particularly in Europe, are doubling down on clean energy expansion in a bid to ditch their dependence on Russian fossil fuels. In particular, the EU increased its 2030 renewable energy target and introduced additional measures to decarbonize its industries.[39]

In fact, for the first time ever, the International Energy Agency forecast a peak or plateau for all fossil fuels under current policies (a scenario that assumes no future policies are introduced to accelerate the energy transition) in the next few years.[26]

But it's not just energy security issues adding buoyancy to renewables' rapid rise. Long before the Ukraine war, renewables were defying growth expectations for one simple reason: cost.

The cost of new solar projects declined globally by 88% between 2010 and 2021, while onshore wind fell by 68%.[40]

Renewables are projected to become the largest source of global electricity generation by early 2025, surpassing coal.[41] Wind and solar are expected to provide 20% of the world's power by 2027, representing 80% of all new renewable electricity generation added between now and then. [41]

GERMANY

In 2000, renewables accounted for 6.3% of electricity generation in Germany. That number climbed to 25% in 2013 before reaching 46% in 2022.[42,43] The country recently passed new legislation requiring renewables to make up at least 80% of electricity production and to be virtually emissions-free by 2035.[44]

CALIFORNIA

California has legislation, first introduced in 2002 and revised several times since then, that requires 33% of electricity sold in the state to come from renewables by 2020, 60% by 2030, and 100% by 2045. The state met its 2020 goal three years early and, in 2021, 35% of in-state electricity generation was renewable, including hydroelectricity.[45,46]

SOUTH AUSTRALIA

The rise of renewables is especially impressive in South Australia. In 2006, the region was wholly reliant on fossil fuels for electricity generation, before completely transforming its grid through good planning and policy.[47] By 2021, wind and solar (both utility-scale and rooftop) supplied 63% of electricity demand in the state, second in the world only to Denmark.[48,49] The Australian Energy Market Operator forecasts this could rise to approximately 85% by 2025, and the state is now aiming to supply 100% of its electricity from renewables by 2030.[48] The early adoption of grid-scale batteries was key to its success.

In 2017, South Australia built what was the the world's largest battery at the time and has built three more since.[49]

How does Canada stack up?

Canada's grid is already 84% non-emitting thanks to abundant hydropower across Canada and significant nuclear power generation in Ontario.[50] This prevalence of non-emitting power has been helped by federal, provincial, and territorial government policy, including both carbon pricing and the phase-out of coal-fired power.[51]

Canada's clean grid is an important economic advantage for the country in the energy transition, with emissions-minded companies preferentially choosing Canada to build manufacturing facilities, in part, due to its low-carbon grid.

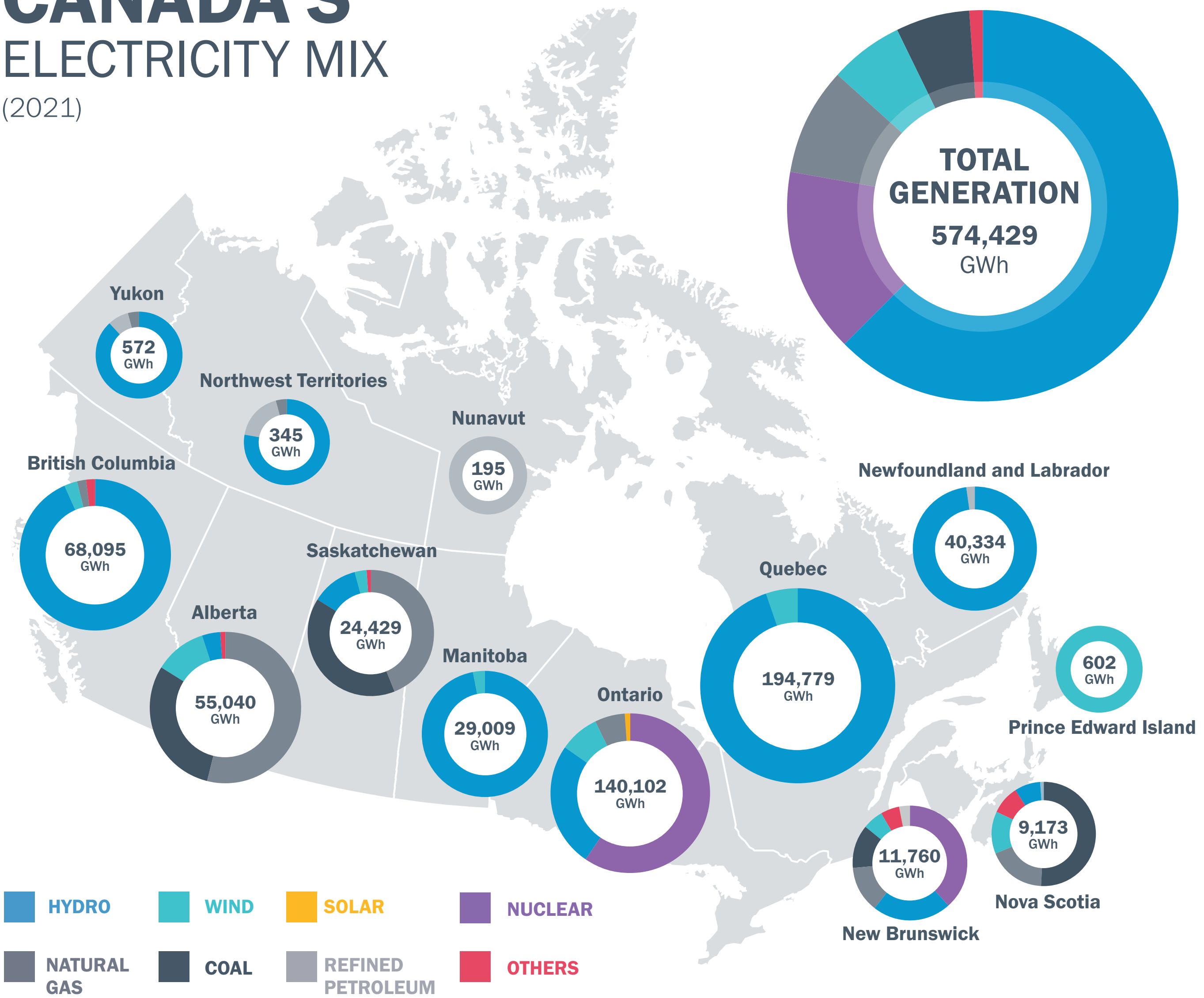
What's more, many of Canada's Indigenous communities are leaders in clean power generation. In 2022, First Nations, Métis, and Inuit entities were partners or beneficiaries of almost 20% of Canada's electricity generating infrastructure, almost all of which produced renewable electricity.[52]

As of 2021, Indigenous communities were the largest clean energy asset owners in Canada, apart from Crown and private utilities.[53]

However, electricity generation is still Canada's sixth-largest source of carbon pollution, accounting for 8.3% of Canada's total emissions in 2020.[54] And if we consider all energy use—not just electricity—Canada still uses fossil fuels for over 76% of its energy needs (largely in transportation, industry, and heating), much of which will need to be electrified.[55]

This national picture hides important provincial disparities in fossil fuel use for electricity generation. The most polluting provinces have seen big electricity emissions reductions in recent years, thanks to the phase out of coal power. But in some cases, particularly in Alberta, the shift has been from coal-fired power to natural-gas-fired power. [50] In fact, the Canadian Energy Regulator anticipates that 8,900 megawatts of new natural gas generating capacity will be added nationally by 2035 under current policies.[50] Alberta alone is planning to add more than 3,500 megawatts by 2024, while Ontario is proposing to add 1,500 megawatts by 2027.[23,56]

CANADA'S
ELECTRICITY MIX
(2021)



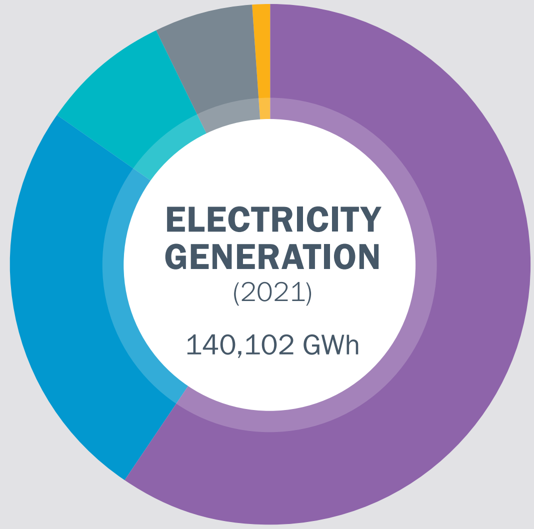
Sources: Statistics Canada, Table 25-10-0020-01 - Electric power, annual generation by class of producer
Statistics Canada, Table 25-10-0019-01 - Electricity from fuels, annual generation by electric utility thermal plants

If we continue adding natural gas to the grid, it will be very difficult to meet our climate targets. And because power plants operate for decades, the decision to build more natural gas generation is passing significant risk on to future generations—both in terms of the emissions produced and the costs to retrofit or retire facilities early.

Furthermore, both utilities and academic studies have called for clear and consistent government policy to attract renewable-related investments.[5,22]

The federal government has committed to reaching a net-zero electricity grid by 2035, through the Clean Electricity Regulations, which will be key to helping Canada transition to a more sustainable and affordable electricity system. A number of major studies suggest that wind and solar will play an essential role in meeting this net-zero goal.[57,58]

ONTARIO



NUCLEAR 59% 82,967 GWh

HYDRO 25% 34,661 GWh

WIND 8% 10,887 GWh

NATURAL GAS 6% 9,100 GWh

SOLAR 1% 1,727 GWh

Current state of the grid

Ontario is one of the biggest electricity generating provinces in Canada, second only to Quebec.[55] Ontario's nuclear plants, which currently supply the biggest share of the province's power, face an uncertain future. Numerous facilities are old enough that refurbishment is required, impacting their electricity output. The Pickering Plant, Ontario's largest power plant by generation, was set to be decommissioned in 2025, although operators are exploring options to extend its life.[59,60]

Current status of renewable deployment

Between 2010 and 2017, Ontario added a net 7,152 megawatts of renewable capacity, primarily in wind and solar. Between 2017 and 2023, however, Ontario is projected to add just 466 megawatts of new renewable capacity.[61] This is a significant slowdown in the pace of development for new renewables in the province.

Ontario's independent electricity operator, the IESO, has previously forecast that electricity-related emissions will increase by 375% by 2030 relative to 2017—and 600% by 2040—largely due to the ramp-up of natural-gas-fired generating facilities to replace aging nuclear facilities.[62–64]

Currently, the IESO is planning to procure an additional 4,000 megawatts of electricity capacity between 2025 and 2027, including 1,500 megawatts of new natural gas assets and 2,500 megawatts of energy storage, including a role for batteries. Ontario's energy minister has directed the IESO to proceed with its procurement plan.[65,66]

Potential role of renewables

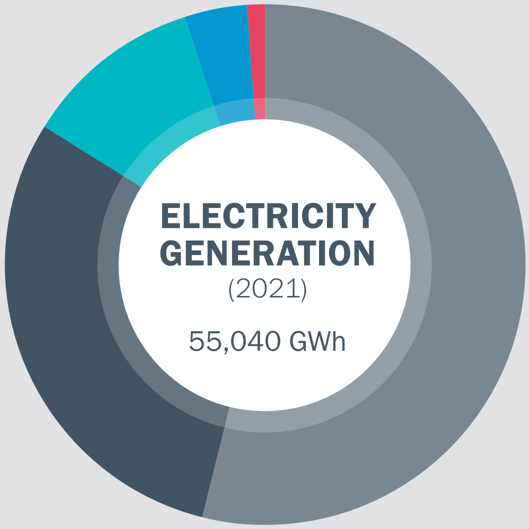
Many in Ontario remember high renewable prices. Fortunately, this is no longer the case as the market has greatly changed. Only a decade ago, Ontario paid prices of $135 per megawatt hour for wind and over $400 per megawatt hour for solar. Today in Alberta, where most private investment in renewable energy is currently occurring, contracts are being signed in the low $30s per megawatt hour for wind and below $50 per megawatt hour for solar.[25]

A recent study by the The Atmospheric Fund looked at three different potential pathways for Ontario to reach net zero by 2035 and found that, in each scenario, wind made up the largest share of new capacity, with both solar and storage playing important supporting roles in achieving a clean, reliable, affordable grid.[14]

The IESO also conducted a recent study on pathways to decarbonization, finding that achieving net-zero emissions economy-wide in 2050 would require Ontario's grid to double, with major contributions from wind and solar.[5] While the analysis did not explore what would be required to meet the federal government's 2035 net-zero grid target, it did find that policy certainty is key and that mandatory emissions goals were necessary in order to enable investment in clean energy infrastructure.

Sources: Statistics Canada, Table 25-10-0020-01 - Electric power, annual generation by class of producer
Statistics Canada, Table 25-10-0019-01 - Electricity from fuels, annual generation by electric utility thermal plants

ALBERTA



NATURAL GAS
54%
29,915 GWh

COAL
30%
16,273 GWh

WIND
11%
6,085 GWh

HYDRO
4%
2,160 GWh

OTHERS
1%
488 GWh

Current state of grid

Alberta is heavily reliant on fossil fuels for its power production but has been undertaking a major shift away from coal, with most coal facilities converted to or replaced with natural gas. This transition has happened with surprising speed, with the province expected to completely phase out coal in 2023—seven years ahead of its 2030 target.[67] Alberta has an open, competitive power market with limited import capacity. [68]

Current status of renewable deployment

Alberta has a legislated target that 30% of its power be produced by renewable electricity by 2030, with interim targets of 15% by 2022, 20% by 2025, and 26% by 2028. To get there, the province plans to add over 1,000 megawatts of renewable electricity through its Renewable Electricity Program.[69] Five years ago, wind power accounted for 9% of Alberta's capacity with almost no solar. Now, the two sources make up 22% of capacity in the province.[70] The Business Renewable Centre reported last year that Alberta's renewable market had seen "unprecedented" growth in 2021, securing over $3.75 billion worth of new wind and solar investments.[71] In 2021, Alberta accounted for 60% of new wind and solar energy installed across Canada.[72]

Potential role of renewables

Alberta has the potential to lead Canada in wind and solar deployment by 2025.[73,74] An Alberta-specific analysis of different resource options found that non-emitting energy portfolios can reduce consumer costs along with climate and health impacts while delivering the same or greater services as gas plants.[75]

Perhaps the greatest challenge facing widespread wind and solar use in Alberta is the province's wintertime electricity need. Alberta faces its highest electricity loads during its coldest months, and increasing its share of renewables will ultimately require long-term energy storage and transmission solutions to meet the needs of Albertans year-round.[76]

Sources: Statistics Canada, Table 25-10-0020-01 - Electric power, annual generation by class of producer
Statistics Canada, Table 25-10-0019-01 - Electricity from fuels, annual generation by electric utility thermal plants

How to maximize renewables in Canada

Provincial and federal governments need to each play their part to maximize the role of renewables. **Specifically, they must:**

1 Prioritize investments over the next decade that advance the deployment of wind and solar and the grid investments they require.

Where the priority over the last decade has been to bring down the costs of these technologies, the priority for the next decade must be the deployment and integration of renewables into reliable electricity systems.[77,78]

RECOMMENDED GOVERNMENT ACTIONS

FEDERAL

- Continue to provide predictable funding opportunities for provinces and utilities to deploy innovative clean technologies that support greater shares of renewables.
- Establish new funding and processes for a renewed dialogue between provinces regarding interprovincial interties.[58,79]

PROVINCIAL

- Develop procurement processes that are structured in a manner that attracts new renewable energy projects, shares the risk with the private sector, and ensures renewables can derive meaningful revenue for all the attributes they provide to the grid.[80]
- Leverage federal dollars and increase provincial investments focused on transmission, distribution, and smart-grid infrastructure to support the expansion of renewables.[5]

FEDERAL & PROVINCIAL

- Invest in new resources to provide capacity to Indigenous communities to develop, benefit from, and operate renewable energy projects.
- Work together to speed up permitting and interconnection timelines for renewables and associated transmission.

2 Send the right signals and create policy certainty.

One of the main challenges governments must address to increase and accelerate the deployment of wind and solar is regulatory uncertainty.[25] Both federal and provincial governments have a role to play in aligning policies to send a clear signal to utilities, regulators, and project developers.

RECOMMENDED GOVERNMENT ACTIONS

FEDERAL

- Implement the Clean Electricity Regulations to help accelerate near-term renewable deployment.[81]
- Reform the treatment of the electricity sector under Canada's Output-Based Pricing System so that generators are exposed to the full carbon price.[3,81]

PROVINCIAL

- Establish climate-aligned energy strategies that integrate all forms of energy while setting clear objectives for the decarbonization of the grid.[22,33,58]
- Put in place short-term targets for wind and solar deployment and longer-term clean electricity targets.[22]
- Provide clear direction to utilities and regulators to balance climate objectives with other planning objectives and prioritize the deployment of variable renewables.[22,33,58,82]

3 Remove barriers to energy storage and deploy the technology alongside renewables where feasible.

For many jurisdictions, increasing the share of electricity that comes from wind and solar will require the deployment of storage solutions to address their variability.[83] At lower levels of deployment, this will be less of a challenge, but as deployment increases, so will the role of energy storage technologies.[25]

RECOMMENDED GOVERNMENT ACTIONS

FEDERAL

- Prioritize funding for the innovation and deployment of both short- and long-term energy storage resources.[25,84,85]

PROVINCIAL

- Address regulatory and legislative barriers that limit the ability of storage technologies to be properly evaluated and compensated in procurement and planning processes.[22]
- Deploy new market instruments that help provide revenue certainty for energy storage projects.

FEDERAL & PROVINCIAL

- Prioritize investments and policies that advance a domestic battery-storage supply chain.

4 Draw on up-to-date information and invest in more research to deploy a greater share of renewables.

Governments need to expand funding into jurisdiction-specific research that explores how we can maximize the role of renewables and energy storage technologies in Canada.

RECOMMENDED GOVERNMENT ACTIONS

FEDERAL & PROVINCIAL

- Governments must advance research that addresses:
  - opportunities for advancing renewables and storage in other provinces;
  - opportunities for advancing additional emerging clean energy technologies and long-duration energy storage;
  - engagement of local industry to capture regional drivers and refine costing assumptions;
  - a more comprehensive look at the capacity contribution of different technologies;
  - and the full value stack of services and benefits renewables and storage can bring to Canadian grids.
- Ensure the transparent publication of energy data that is used to inform long-term planning.

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