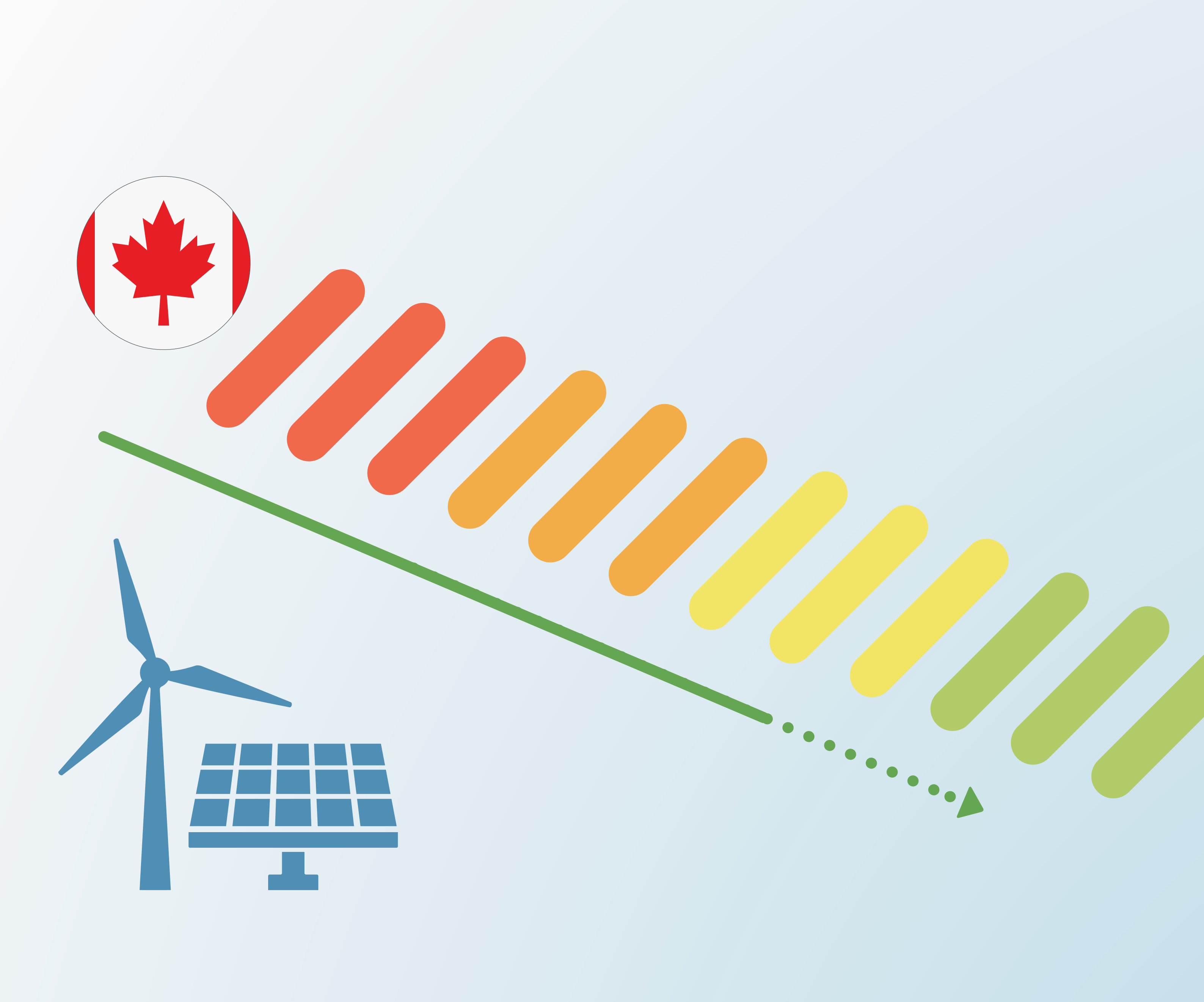


Climate Action Tracker

Wind and Solar benchmarks for a 1.5°C world

CANADA

February 2026

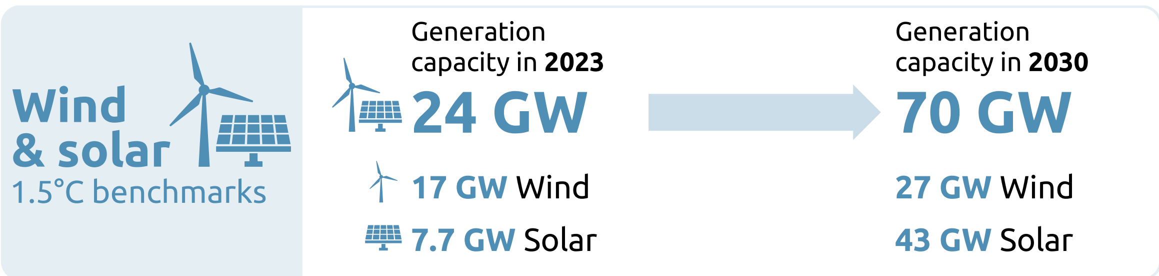
Executive Summary

Context

- Canada's electricity grid is already predominantly clean, with 80% of generation in 2023 coming from clean electricity sources – 57% from hydro, 14% from nuclear, and 9% from wind and solar. Emissions from the electricity system have fallen rapidly, dropping 58% since 2005, largely due to the phase-out of coal and the expansion of renewables.
- However, fossil fuels still provide roughly 20% of total generation – predominantly from fossil gas (15%) which has increased over the last five years.
- Canada has committed to phasing out coal by 2030 and to achieving a net-zero electricity grid by 2050.
- In this report, we examine national studies and global energy system models to assess how much Canada's wind and solar capacity needs to grow to align with the global goal to triple renewables by 2030 and the Paris Agreement's 1.5°C warming limit.

Key findings

- Canada's wind and solar generation needs to grow approximately three times by 2030 to align with 1.5°C. This equates to 142 TWh of wind and solar generation in 2030, up from 48 TWh in 2023.
- Almost 46 GW of new wind and solar would be needed by 2030 (36 GW solar, 10 GW wind). This would require average annual capacity additions of 4.3 GW/yr of solar and 1.5 GW/yr of wind from 2023-2030.
- Canada's wind rollout is broadly aligned with a 1.5°C pathways, with around 29 GW of wind capacity projected by 2030 – slightly exceeding the benchmark of 27GW. However, Canada's solar rollout needs to accelerate significantly, with a projected capacity gap of 29 GW in 2030 between anticipated solar deployment and the 1.5°C-compatible benchmark.



Context

At COP28, governments agreed to triple global renewable capacity by 2030 globally to stay in line with 1.5°C. This report highlights the potential implications of this COP28 decision at the national level, focusing on **Canada**.

Wind and solar deployment is accelerating around the world. However, expected wind and solar capacity deployment under current policies falls short of what is needed for 1.5°C, and is concentrated mainly in a few regions.

Research is needed to understand the pace of wind and solar deployment that aligns with the highest plausible ambition and is compatible with 1.5°C

This project aims at answering the following questions:

- **How much wind and solar generation is needed (TWh) at the national level?**
- **How much wind and solar needs to be built (GW of capacity)?**
- **When does it need to be built by, and how quickly?**

Policy context

Canada's 2030 climate target - or nationally determined contribution (NDC) – commits to reducing greenhouse gas (GHG) emissions by 40-45% below 2005 levels by 2030, including land use, land-use change, and forestry (LULUCF) – equivalent to a 36-44% reduction when LULUCF is excluded. Canada's 2035 NDC commits to reducing GHG emissions by 45-50% below 2005 levels by 2035, including LULUCF – equivalent to a 40-49% reduction when LULUCF is excluded. The country has also committed to reach net zero GHG emissions by 2050.

Canada has also committed to achieve a net-zero electricity grid by 2050 and implemented Clean Electricity Regulations in 2024 to operationalise this goal.

Under current policies and market conditions, the IEA estimates that **solar capacity in Canada will reach 15 GW in 2030**, up from 8 GW of solar in 2023. Meanwhile, **wind capacity is projected to reach 28 GW in 2030**, up from 17GW in 2023.

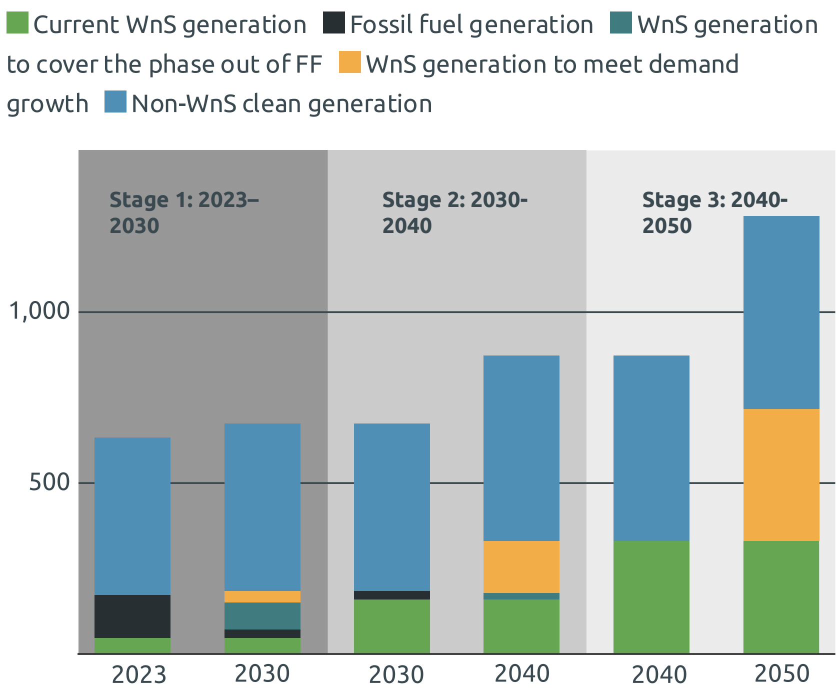
National enabling factors

Key enabling factors for ambitious wind and solar rollout include:

- **Institutional capacity.** A rapid build-out of wind and solar will require the governance and institutional capacity to develop, implement and enforce policy frameworks.
- **Just transition.** A just transition will be needed to take along all stakeholders, particularly those employed by the fossil economy.
- **Grid development.** Substantial increases in both transmission and distribution grid infrastructure will be necessary to integrate large-scale new wind and solar generation into the power system.
- **Fossil fuel phase-out.** Existing fossil fuel infrastructure often will need to be retired earlier than its economic lifetime. Policies need to be developed to achieve the early phase out of fossil fuel plants.
- **System flexibility.** Energy storage (diurnal and seasonal), flexible generation technologies such as hydro and geothermal, and increased demand side flexibility will all be crucial.
- **Market design.** Reform of market designs and regulation adapted to renewable energy-based systems that incentivise and mobilise investments to install renewable energy at the scale needed (e.g., minimise cost of capital, ensure revenue certainty, etc).

Results

Stages of power sector decarbonisation



The stages of the electricity system transition in Canada

WnS = Wind and Solar

Figure 1 – Electricity generation in each stage in TWh

In a 1.5°C pathway, countries must add solar, wind, and other clean technologies to meet rising power demand while replacing phased-out fossil fuels. The evolution of the power capacity mix over successive decades varies across countries.

From now until 2030, Canada would need to add 3 GW of wind and 10 GW of solar capacity to meet growing demand alone. Another 7 GW of wind and 25 GW of solar will be needed to displace the share of fossil fuels in the electricity generation mix.

Power sector transformation and the increasing participation of variable renewable energy (VRE) – mainly wind and solar – in a country's power mix gives rise to a set of technical challenges linked to the integration of VRE sources. Six phases can be distinguished here, from phase 0 (pre-development with negligible amount of VRE shares) to phase E (with over 80% VRE shares). More information about these phases can be found in Annex A.

Meeting the benchmarks for 2030 will put Canada in Phase B, with wind and solar making up 21% of the generation mix. Contribution of VRE varies significantly over time, with periods of very low output and periods of high penetration. This variability increases the need for operational flexibility. Enhanced coordination between system operators, network operators, and distribution system operators becomes critical to maintain system efficiency and security.

Figure 1 and Table 1 both show the stages of the transition to a decarbonised power sector in terms of the volumes of existing wind and solar and what is needed to displace fossil fuels and meet demand increases for the EU. Figure 1 shows the stages in terms of electricity generation, and Table 1 shows it in terms of generation, capacity and share of the electricity mix.

Table 1: Stages of the electricity system transition detailing how much generation capacity of wind and solar will be needed to displace fossil fuels in the system and meet growing electricity demand

	2023		2030		2040		2050
Grid integration phase							
Phase	Phase A		Phase B		Phase C		Phase D
VRES load coverage	**< 15%**		**< 25 %**		**< 40%**		**< 70%**
Share of electricity generation							
Wind & Solar	**7.5 %**		**21 %**		**39 %**		**56 %**
Other renewables	73 %		75 %		61 %		44 %
Fossil Fuels	**20 %**		**3.8 %**		**0 %**		**0 %**
Generation capacity							
To displace fossil fuels		**+33 GW**		**+10 GW**		**+0 GW**	
Wind & Solar	**24 GW**	**+6.7 GW/yr**	**71 GW**	**+8.9 GW/yr**	**160 GW**	**+12 GW/yr**	**280 GW**
To meet demand increase		**+13 GW**		**+83 GW**		**+120 GW**	
Generation							
Total	**630 TWh**	6%	**670 TWh**	30%	**870 TWh**	49%	**1300 TWh**
Wind & Solar	48 TWh		140 TWh		340 TWh		710 TWh
Generation Capacity of VRE (variable renewable energy)							
To displace fossil fuels			7.4 GW		1.2 GW		0 GW
Wind capacity	**17 GW**		**27 GW**		**38 GW**		**91 GW**
To meet demand increase			3 GW		9.8 GW		53 GW
To displace fossil fuels			25 GW		8.9 GW		0 GW
Solar capacity	**7.7 GW**		**43 GW**		**130 GW**		**190 GW**
To meet demand increase			10 GW		74 GW		65 GW

Note: Numbers are rounded to two significant figures, which may contribute to minor differences in totals. The calculations assume that wind, solar, and other renewables contribute equally and proportionally to displacing fossil fuels and meeting demand growth.

Future electricity demand

Electricity demand is taken from the Intitut de l'énergie Trottier study exploring net zero pathways for Canada. We take demand from the main net-zero scenario, which achieves net zero greenhouse gas emissions by 2050 and a 40% reduction in emissions by 2030, relative to 2005 levels.

In this scenario, total electricity generation in Canada doubles by 2050 relative to 2023 levels, reaching 1281 TWh. This increase is driven by widespread electrification in all sectors of the Canadian economy. This growth in electricity generation accelerates over time, especially in the last decade leading up to the net zero target, as electrification extends into more sectors, reflecting the scale of transformation required to achieve Canada's 2050 goal.

However, there is a significant range in the studies in terms of the expected electricity generation in 2050 ranging from 889 TWh to 1521 TWh. This would affect the necessary growth of wind and solar significantly. Our demand estimate is closer to the higher end of that estimated by country-level studies.

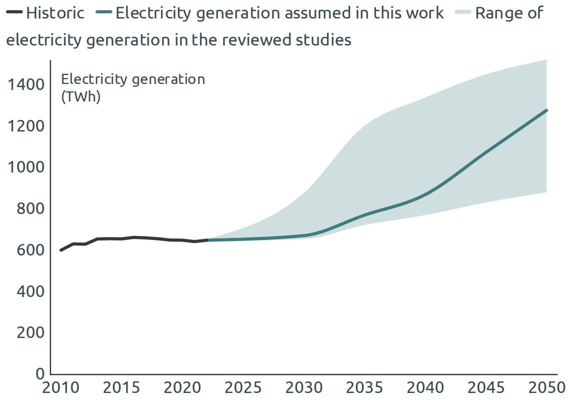


Figure 2 – Total electricity generation in TWh

Electricity generation doubles in Canada between 2023 and 2050

The solid line shows the electricity generation projection used to develop the benchmarks

Pace of fossil fuel phase-out needed

The rate of fossil fuel phase-out is set by the overlap between country- level studies, downscaled 1.5°C compatible global pathways and the global milestones of the IEA's Net Zero roadmap, in which Canada achieves a clean power system by 2035.

To align with 1.5°C, fossil fuels must exit the Canadian power sector before 2035. Coal must be phased out even earlier – by 2030.

Fossil fuel generation falls by 79% to 81% between 2023 and 2030.

To align with 1.5°C, fossil fuels must exit the power sector in Canada by 2035, even as electricity demand grows rapidly.

Canada would need to achieve clean electricity by 2035

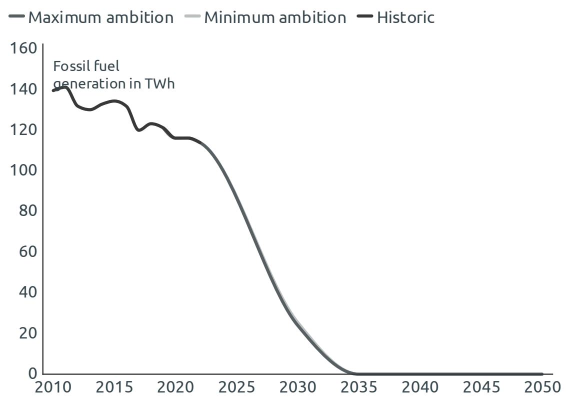


Figure 3 – Fossil fuel generation in TWh

Coal and gas phase-out in Canada

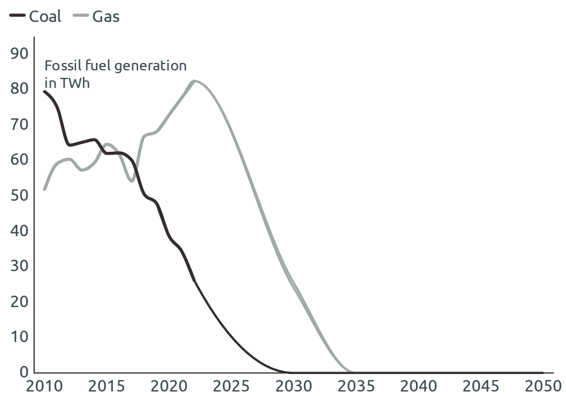


Figure 4 – Fossil fuel generation by fuel type in TWh

The role of other clean electricity generation

While wind and solar will be the workhorse of the energy transition, other clean electricity generation may play a role. We estimate the role of non-wind and solar clean electricity generation* (largely hydro, biomass, nuclear and geothermal) from country-level studies.

In our modelling, we assume that generation from clean technologies other than wind and solar in Canada remain relatively stable this decade, at around 507 TWh in 2030, and increases to 567 TWh by 2050. However, to meet growing electricity demand, wind and solar are expected to expand rapidly and by 2050, are projected to surpass hydro as the main source of electricity generation in the country.

Total wind and solar generation needed to align with 1.5°C

The wind and solar rollout is then calculated by combining projected electricity demand growth, the fossil phase-out necessary to align with 1.5°C, and the assumed generation from other clean technologies.

To align with 1.5°C, **wind and solar generation in Canada would need to reach 142 TWh by 2030**. Generation in 2023 was 48 TWh. This is therefore a more than threefold growth in wind and solar.

Wind and solar provides 24% of overall electricity generation in 2030, and 56% of overall generation in 2050. A grid with high penetration of wind and solar would require substantial rollout of batteries and energy storage, support from dispatchable generation such as hydro and geothermal, flexible demand and grid extension to ensure reliability of the system.

To align with 1.5°C, wind and solar generation would need to grow rapidly in Canada

Wind and solar generation needs to grow more than three times by 2030 relative to 2023 in Canada

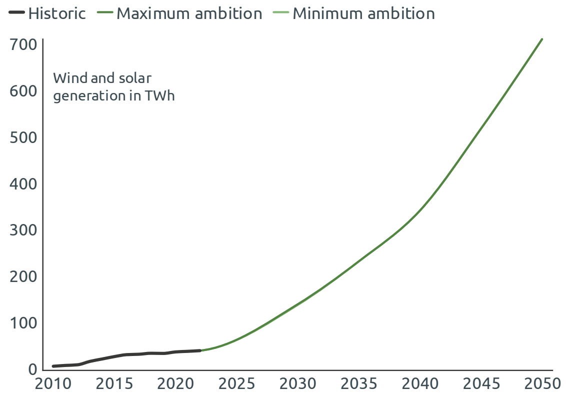


Figure 5 – Wind and solar electricity generation in TWh

Wind and solar need to provide over 50% of electricity generation in Canada by 2050

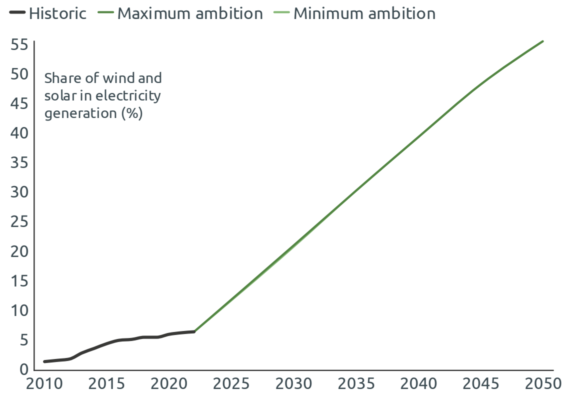


Figure 6 – Wind and solar electricity generation share (%)

* We do not consider CCS in the power sector, as we do not consider CCS a viable source of large-scale emissions reductions in the power sector.

Possible splits between wind and solar

The relative share of wind and solar deployment will vary depending on how various factors develop in the future. We explore one key uncertainty, the relative cost of solar and wind electricity generation (see methods). When accounting for this uncertainty, we see a range of possible future generation mixes between wind and solar.

We highlight the median of the range as our **central benchmark**, but do not suggest that this is the only possible breakdown into wind vs. solar. The model includes a simplified representation of the power grid and does not fully capture transmission constraints, spatial effects, curtailment, or detailed integration costs. These factors could influence the relative balance between wind and solar in practice.

In this scenario, **Canada would need to reach 70 GW of wind and solar by 2030 to align with the 1.5°C temperature limit**. By 2050, total wind and solar capacity would need to reach to over 280 GW. Wind plays a larger role than solar, providing on average 1.4 times as much generation as solar in the electricity mix by 2050. However, solar drives the majority of near-term growth through the 2020s and early 2030s, expanding rapidly, while wind growth accelerates later in the 2040s.

Importantly, these are cost-optimised modelled pathways that give a useful indication of the pace and scale of wind and solar deployment needed for 1.5°C, but they cannot fully the capture real-world context, where industry development, supply chains, workforce, and infrastructure will require stable and sustained development.

Canada needs to reach over 70 GW of wind and solar by 2030 to align with 1.5°C

Solar capacity in Canada would reach 43 GW by 2030 in a 1.5°C-aligned scenario

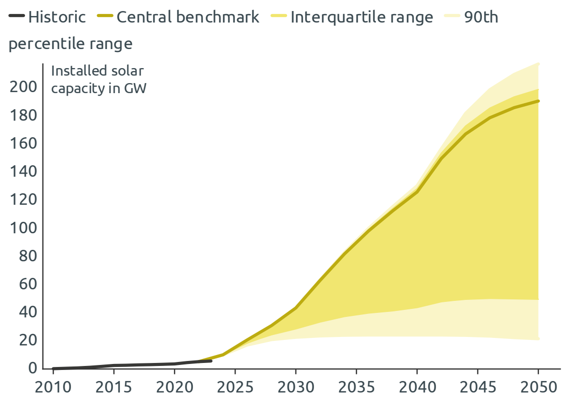


Figure 7 – 1.5°C compatible capacity benchmarks for solar in GW

Wind capacity in Canada would reach 27 GW by 2030 in a 1.5°C-aligned scenario

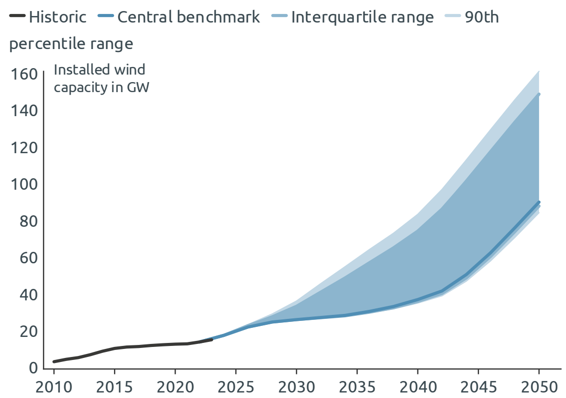


Figure 8 – 1.5°C compatible capacity benchmarks for wind in GW

The following table shows the wind and solar deployment needed to align with the central 1.5°C compatible benchmark produced. 2023 is historical data. All benchmark data from 2030 onwards is reported to two significant figures.

Table 2: Wind and solar electricity generation and capacity (2023–2050)

Scenario	Variable	Unit	2023	2030	2035	2040	2050
Central 1.5°Cbenchmark	Solar generation	TWh	11	70	150	210	300
Central 1.5°Cbenchmark	Wind generation	TWh	42	72	87	130	420
Central 1.5°Cbenchmark	Solar capacity	GW	8	43	90	130	190
Central 1.5°Cbenchmark	Wind capacity	GW	17	27	30	38	91

Table 3: Benchmarks translated into CAT format

Variable	Ambition	Unit	2030	2035	2040	2045	2050
Share of coal	Minimum	%	0	0	0	0	0
	Maximum	%	0	0	0	0	0
Share of gas	Minimum	%	2	1	0	0	0
	Maximum	%	0	0	0	0	0
Share of renewables	Minimum	%	95	97	98	98	98
	Maximum	%	97	98	98	98	98
Share of wind and solar	Minimum	%	29	42	52	60	64
	Maximum	%	31	43	52	60	64

Comparison to current rollout and country target

Under current policies and market conditions, deployment of solar PV in Canada would not align with 1.5°C. There would be a capacity gap of **28 GW of solar PV** in 2030 between current rollout and the 1.5°C compatible benchmark highlighted here. However, wind deployment is aligned with a 1.5°C pathway, with around 28 GW of capacity projected under current policies and market conditions, slightly exceeding our benchmark of 27 GW.

According to IEA estimates, both solar and wind deployment are projected to exceed national 2030 targets under current policies and market conditions. These national targets are drawn from Ember's Global Renewable Target Tracker and based on the federal government's 2030 Emission Reduction Plan published in 2022. However, while the wind target is largely aligned with the 1.5°C benchmark, the solar target falls well short. To close this gap, Canada's **solar capacity target for 2030 would need to increase fivefold to be consistent with a 1.5°C pathway**.

In short, while Canada is on course to meet or exceed both its national target and the 1.5°C compatible benchmark for wind, further action will be required to drive solar deployment at the pace and scale required for 1.5°C.

There is strong support from businesses for high ambition from the government to transition the electricity system to be powered by renewables, with 96% of executives in Canada polled in the Global Business Poll in favour of transitioning to an electricity system powered by renewables.

Canada's wind rollout is broadly aligned with 1.5°C, but solar rollout needs to accelerate

In Canada, current rollout of solar lags behind 1.5°C-aligned levels

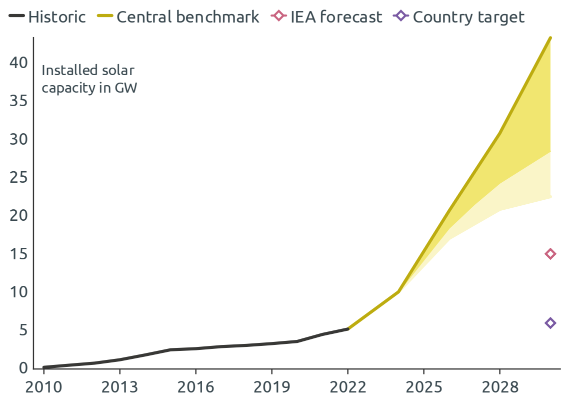


Figure 9 – Installed solar capacity in 2030 compared to targets and current policy projections in GW

In Canada, current rollout of wind is aligned with 1.5°C-aligned levels

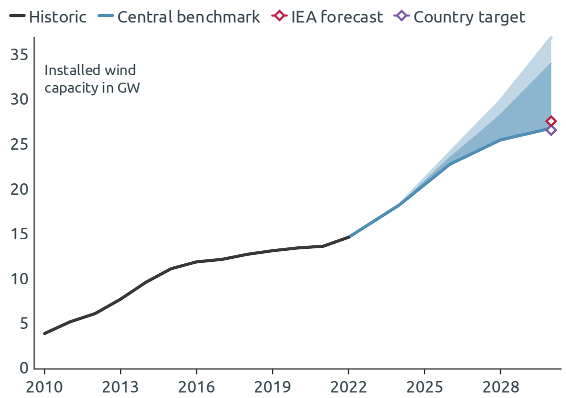


Figure 10 – Installed wind capacity in 2030 compared to targets and current policy projections in GW

Note: The target data was last pulled from Ember in January 2025. The current policies data was last pulled from the IEA in February 2026.

Wind and solar capacity additions in Canada need to accelerate to align with 1.5°C

Canada would need to add on average 4.3 GW/yr of solar capacity until 2030, and 7.6 GW/yr over 2030–2050, compared to 0.51 GW/yr from 2020–2023

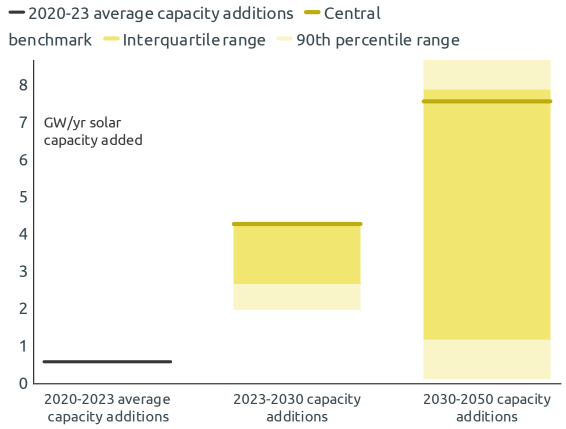


Figure 11 – Solar capacity additions per year in GW/y

Canada would need to add on average 1.5 GW/yr of wind capacity until 2030, and 3.6 GW/yr over 2030–2050, compared to 0.66 GW/yr from 2020–2023

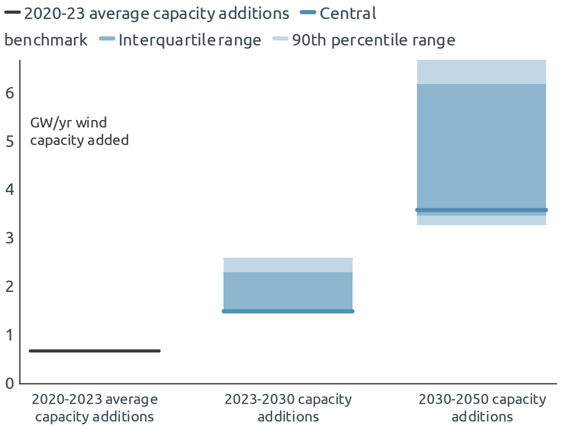


Figure 12 – Wind capacity additions per year in GW/y

Comparison with other studies

We compare the wind and solar generation seen in our analysis to that in the literature review of country-level studies. We highlight the results of modelling from the Intitut de l'énergie Trottier study, exploring net zero pathways for Canada, where we particularly highlight the results from the *Net-zero scenario (NZ50)*.

Our analysis of wind and solar generation is generally consistent with the range of results found in national studies. However, there are considerable variations in the projections for 2050, particularly for solar, due to differences in the underlying assumptions across studies. For solar, our results tend to align with the higher end of the generation estimates reported in these studies, while our wind generation estimates are closer to the lower end.

Compared to the Trottier study, our projections for both wind and solar are higher, though this can be attributed in part to the Trottier study's increasing reliance on other non-emitting sources of generation out to 2050, especially nuclear power. Despite these differences, both national studies and our own modelling agree that wind is expected to provide more generation than solar in both 2030 and 2050.

Our benchmarks are broadly aligned with the literature

Electricity generation from solar: comparison with literature in Canada

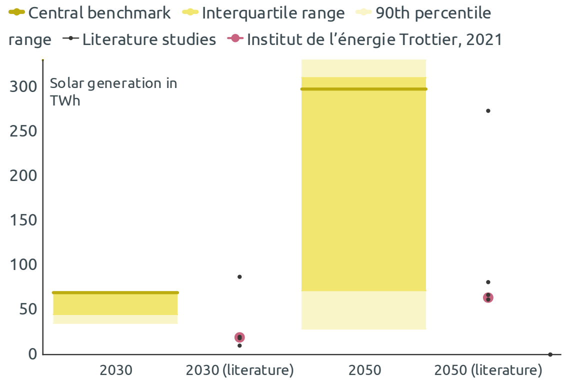


Figure 13 – Solar electricity generation in TWh

Electricity generation from wind: comparison with literature in Canada

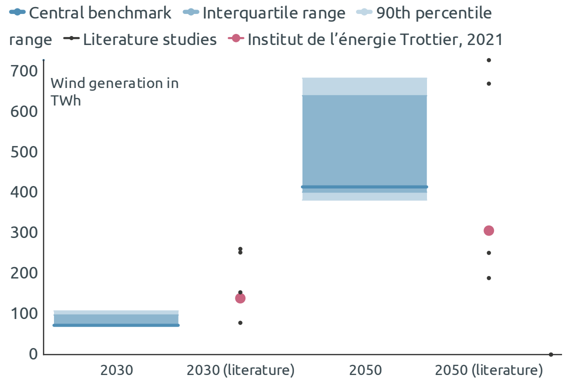


Figure 14 – Wind electricity generation in TWh

In Canada, our benchmarks generally suggest that wind will provide more generation than solar

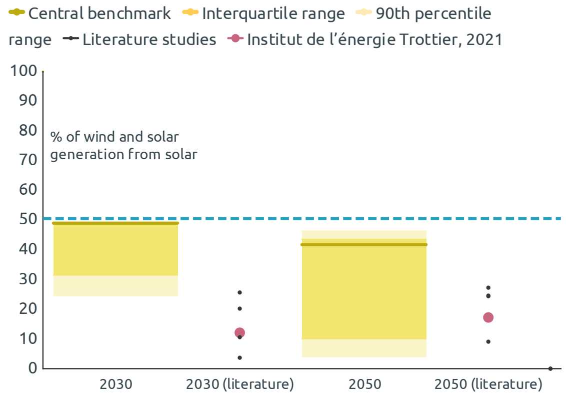


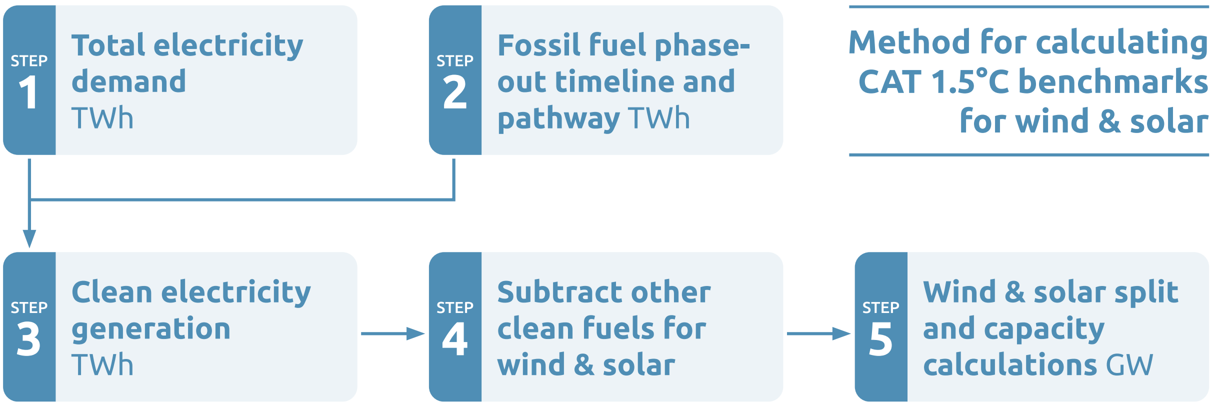
Figure 15 – Generation split between wind and solar (%)

Share of wind and solar generation that comes from solar: comparison with literature in Canada

The area above the blue dashed line represents a power system in which solar provides more electricity generation than wind

Methodology

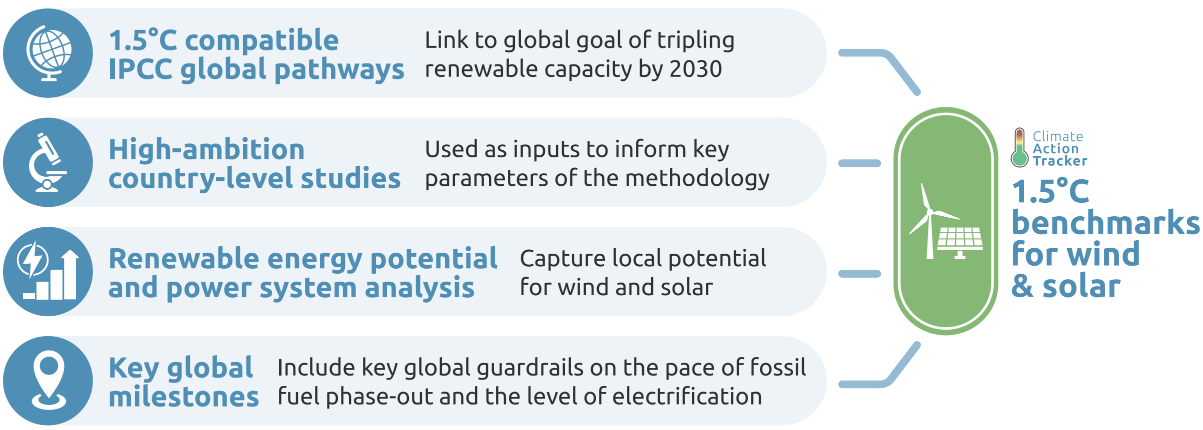
Summary of our method



Our method takes a series of steps to calculate the wind and solar generation needed for 1.5°C, and the resulting capacity deployment. The key methodological steps are highlighted below.

1. We project future electricity demand in the country.
2. We calculate the pace of fossil fuel phase-out needed to align with 1.5°C.
3. Bringing these trajectories together defines the level of clean electricity generation required to meet electricity demand growth while phasing out fossil fuels in the power sector.
4. We project non-wind and solar clean electricity generation based on country-level literature. This allows us to identify the wind and solar generation necessary to align with 1.5°C.
5. Having produced this wind and solar generation trajectory, we feed it into a simplified electricity system model (PyPSA), which calculates for a given set of cost assumptions around wind and solar, a split into wind versus solar and the associated capacity requirements.

Overlap of different elements



Our method focuses on the overlap between different elements. By looking at the range of fossil fuel phase-out which is outlined in both high ambition country-level studies and downscaled 1.5°Ccompatible global pathways, and is informed by key global milestones, we identify benchmarks which are both consistent with a global least cost pathway to limiting warming to 1.5°C but are also aligned with national–level modelling.

Combining multiple different analytical elements can help identify the most robust path to achieving a zero-carbon energy system.

For more details see the Methods Annex.

List of scenarios selected

Table 4: Country level studies for Canada

Study	Publication	Scenario selected
Canadian Climate Institute, 2021	Canada's Net Zero Future: Finding our way in the global transition	Range across scenarios
Canada Energy Regulator, 2021	Canada's Energy Future 2021: Energy Supply and Demand Projections to 2050	• Evolving policies scenario • Net Zero Electricity (NZE) Base Scenario
David Suzuki Foundation, 2022	Shifting Power: Zero-Emissions Electricity Across Canada by 2035	Zero Plus scenario
Electric Power Research Institute, 2021	Canadian National Electrification Assessment: Electrification Opportunities for Canada's Energy Future	Net Zero scenario
Institut de l'énergie Trottier, 2024	Pathways for a net-zero Canada	Net-zero scenario (NZ50)
Teske, S.; Rispler, J.; Niklas, S. et al., 2023	Net-zero 1.5°C sectorial pathways for G20 countries: energy and emissions data to inform science-based decarbonization targets	

Annex A

Phases of grid integration

The grid integration phase is adapted from a de Vivero et al. report detailing a qualitative assessment framework for power system transformation and an IEA report on integrating solar and wind. We use the share of VRE sources in electricity generation to classify countries into a phase. More information about the characteristics and key challenges of each phase can be found in the report.

Phase 0 (less than 5% annual VRE share): we assign this phase when wind and solar make up 0-5% of a country's electricity generation mix. Installed VRE capacity is limited, and the impact on power system operation is negligible. Integration does not require significant operational or structural changes.

Phase A (between 5% and 15% annual VRE share): we assign this phase when wind and solar make up 5-15% of a country's electricity generation mix. Conventional power system operation remains largely sufficient for day-to-day system management. However, system planning must anticipate higher future VRE shares. This includes improving forecasting tools, integrating forecasting into dispatch decisions and moving toward shorter scheduling intervals and more real-time system operation.

Phase B (between 15% and 25% of annual VRE share): we assign this phase when wind and solar make up 15-25% of a country's electricity generation mix. The contribution of VRE varies significantly over time, with periods of very low output and periods of high penetration. This variability increases the need for operational flexibility. Enhanced coordination between system operators, network operators, and distribution system operators becomes critical to maintain system efficiency and security.

Phase C (between 25% and 40% of annual VRE share): we assign this phase when wind and solar make up 25-45% of a country's electricity generation mix. Periods in which VRE dominates system behaviour become increasingly frequent. A key operational challenge is maintaining system stability during sudden disruptions in supply or demand. Curtailment of VRE may become necessary to preserve system security. Without structural adjustments, integration constraints of VRE into the system may slow further increases in renewable energy shares despite additional installed capacity.

Phase D (between 40% and 70% of annual VRE share): we assign this phase when wind and solar make up 45-80% of a country's electricity generation mix. Periods in which VRE availability exceeds demand occur more frequently than in earlier phases. Ensuring system stability while continuing to increase renewable penetration requires additional measures, such as expanded demand response, stronger interconnections and large-scale energy storage. Market design and regulatory frameworks become increasingly important to enable these solutions. Although particularly critical in this phase, many of these measures should begin in earlier phases (B and C) to provide long-term investment signals and facilitate a smoother system transformation.

Phase E (more than 70% share of annual VRE share): we assign this phase when wind and solar make up 80-100% of a country's electricity generation mix. The power system reaches very high VRE penetration. The primary challenge becomes ensuring adequacy during extended periods of low wind and solar availability. Addressing this requires long-duration energy storage, sector coupling allowing for export and import of power between economic sectors in the same country and extensive electricity trade both within regions and between countries.

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Authors names are listed with country lead first, then alphabetically.

The Consortium

The Climate Action Tracker (CAT) is an independent scientific analysis produced by three research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

climateactiontracker.org

Climate Analytics is a non-profit institute leading research on climate science and policy in relation to the 1.5°Climit in the Paris Agreement. It has offices in Germany, the United States, Togo, Australia, Nepal and Trinidad and Tobago.

climateanalytics.org

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