



Report 2023

Canada

Black wind turbine blades in use in Haeckel Hill wind farm. Source: Eagle Hill Energy Limited Partnership, GBP Creative Media.

Authors Keelia Lafreniere and Ryan Kilpatrick, Natural Resources Canada (NRCan).

An advance in deployment driven by new facilities in Alberta, added 1,671 MW out of the 1,720 MW of new capacity across the country, which gave Canada an increase in new installed capacity above the 1,006 MW installed in 2022.

A seven-month moratorium on approvals of new projects in the province overshadowed this growth. Investor uncertainty is likely to affect growth in Alberta beginning in 2025. Longer-term wind power procurements for new builds were announced in Nova Scotia, Quebec, and Saskatchewan in 2023 in newly released provincial Strategic Plans. Preliminary groundwork for procurements took place in Ontario,

Manitoba, New Brunswick, and British Columbia without official procurement announcements, though they are expected in the near future [1].

Highlight(s)

- More than 1.7 GW of new utility-scale wind was added in 2023, of which, the province of

Table 1. Key National Statistics 2023: Canada

Total (net) installed wind power capacity	17.03 GW
Total offshore capacity	0 GW
New wind power capacity installed	1.72 GW
Decommissioned capacity (in 2023)	1.6 GW
Total electrical energy output from wind	39.66 TWh
Wind-generated electricity as percent of national electricity demand	6.4%
Average national capacity factor	29.7%
Target	
National wind energy R&D budget	CAD \$5,022,000

Alberta accounted for 97% [1].

- The federal government announced a 15% investment tax credit and a 30% manufacturing tax credit for clean electricity.
- New wind power procurement schemes were announced in Nova Scotia, Quebec, and Saskatchewan, and new planning targets were announced in Ontario, Manitoba, New Brunswick and British Columbia.

Market Development

Targets and Policy

- In 2023, the Federal government announced a 15% Clean Electricity federal investment tax credit legislation for eligible investments in technologies required for generating and storing clean electricity and its transmission between provinces and territories [2].
- The federal government also announced a 30% Clean Technology manufacturing tax credit to help cover the costs of new machinery and equipment used

to manufacture or process clean technologies and extract, process, or recycle critical minerals [3].

- The Nova Scotia Clean Power plan includes a target of 1,000 MW of fixed-price power purchase agreements by 2030, with procurements occurring in 2023, 2025, and 2027 [4].
- Hydro Quebec released its 2035 Action Plan, which comprises a planned tripling of wind power capacity to roughly 8,000 MW by 2035 and a provincial net-zero mandate [5].
- In Saskatchewan, SaskPower has committed to procuring 3,000 MW of wind and solar by 2035. Of this, 400 MW of wind has been procured to date. [6]
- Ontario announced a procurement of 5,000 MW of non-emitting energy-producing resources over the next four to six years (2023 to 2027-2029) [7].
- New Brunswick's energy strategy, released in December 2023 and titled "Our Path Forward to 2035", includes the develop-

ment of 1,400 MW of new wind power, with biannual procurements expected to start in 2027 [8].

- Manitoba Hydro completed an integrated resource plan that intends to increase total capacity from 6,600 MW to 16,000 MW, and wind will play a role in achieving this goal [9].

Progress and Operational Details

- There has been a significant and steady increase in the average size of wind turbines installed in Canada due to continual advancements in technology. The accelerated growth in the average kW per turbine (Figure 1), rotor diameter, and hub height (Figure 2), indicates turbines have become more powerful and efficient in recent years.

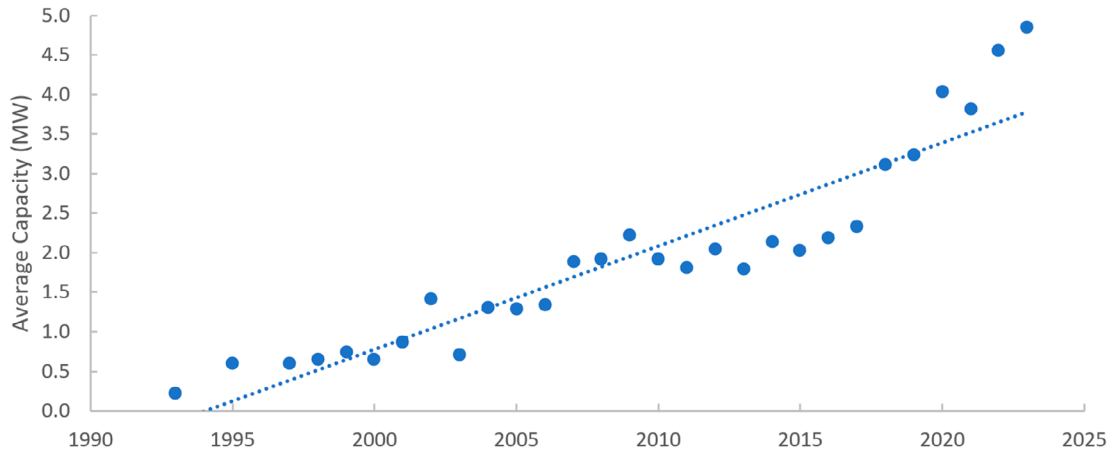


Figure 1: Average rated capacity per turbine in Canada over time [1]. Source: Canadian Renewable Energy Association.

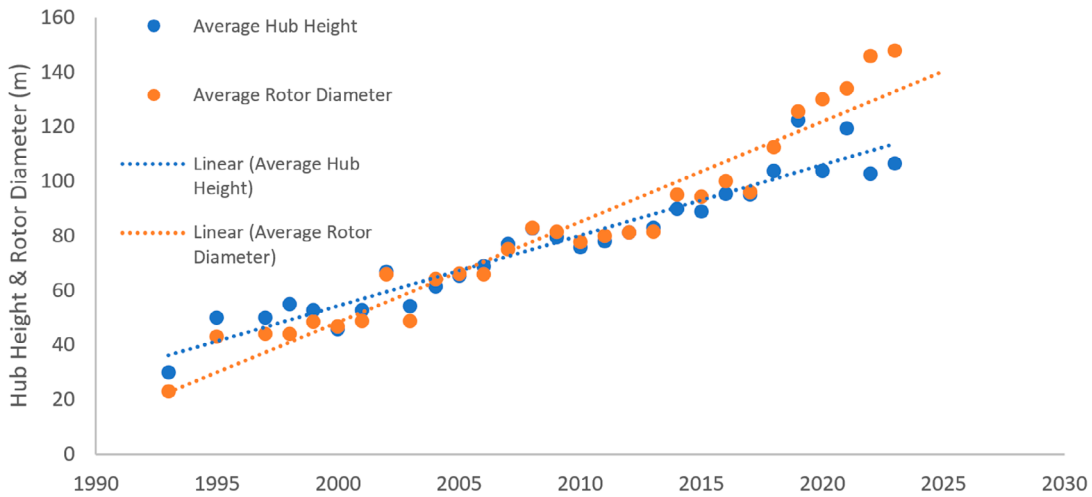


Figure 2: Average turbine hub height and rotor diameter in Canada (in m) over time [1]. Source: Canadian Renewable Energy Association.

- The 4 MW Haeckel Hill-Thay T'aw Wind Energy Project, connected to the Yukon energy grid in Fall 2023, marked a historic accomplishment as the first 100% Indigenous-owned wind energy project in northern Canada. It is also the first wind energy project to be repowered in Canada [10].
 - The Jenner Wind Power Project by Potentia Renewables was the largest wind project installed in Canada in 2023, with 303 MW of capacity across all three phases of the project. Sharp Hills wind farm by EDP Renewables was a close second, with 297 MW installed [1].

 - The largest turbines installed in 2023 were ENERCON E-160 EP5 E3, which feature a 114m hub height and 160m rotor diameter with a rated power of 5.56 MW. These turbines were installed at the Jenner Wind Power Project [1].
- Regarding offshore wind, there are ongoing activities regarding planning:
- In the interest of providing a clear pathway between offshore wind generation and relevant markets for regulators, policy-makers and other stakeholders, Net Zero Atlantic produced a work plan that “analyses paths to market, maps the resource potential, and enables effective grid integration in an Atlantic Canadian context” [18].
- Matters Affecting Growth and Work to Remove Barriers**
- There are nationwide issues around public acceptance of wind energy [1]. This may lead to future limitations in local sup-



Photo 1: Jenner Wind Projects. Credit: ENERCON Canada Inc.

port and barriers to siting.

- There is now significant congestion on certain parts of the Alberta grid. Various operators are seeing an unprecedented number and severity of curtailments of wind projects in 2023. The number of constrained GWh has increased from 151 across the last seven quarters to 188 in Q4 of 2023 alone [11].
- There was a seven-month pause on approvals of new wind and solar projects in Alberta, which started in August 2023. Although this pause ended in February 2024, the provincial government is now undertaking several years of consultations for further market changes, including impact on viewscapes, land reclamation security, agricultural land

coexistence and public land use access. Significant regulatory reform is also on the horizon for transmission regulation, which compounds existing uncertainty for wind development in the province [12].

- Some provincial governments have started to stage multiple rounds of procurements of renewable energy as a means of evolving beyond the “boom/bust” cycles that have traditionally been common in the industry. For example, Ontario’s IESO is planning a “cadenced schedule of procurements to include both medium-term commitments for existing resources and long-term commitments for new builds and upgraded resources.” This approach will allow for regular reassessments of needs as time

progresses and for ongoing technological advances that may reduce associated costs [13].

RD&D Activities

National Research Initiatives and Results

- A preliminary considerations analysis, based on a multi-criteria analysis, was completed by CanmetENERGY-Ottawa to identify areas in Atlantic Canada that would be potential candidates for offshore wind development. Six scenarios were developed and evaluated on multiple inputs [19].
- Nergica released a study investigating the impact of climate

change on wind energy in North America. Wind, icing, and wind energy production in the period of 1981-2010 was compared to the future period of 2031-2060: wind energy production is expected to remain relatively stable over this period [20].

- WEICan produced a report that outlined a path towards reliable operational strategies and rapid repairs for wind turbine rotor over-speed faults using SCADA data, vibration analyses, and field inspections [21].

Test Facilities and Demonstration Projects

- Nergica and WEICan are two chief test facilities for wind in Canada. Nergica owns and operates a research site with two 2 MW wind turbines [22]. WEICan operates a 10 MW Wind R&D Park with a 111.5 kW/223 kWh battery storage system on the northwest tip of Prince Edward

Island [23].

- World Energy GH2 bought Stephenville Port in western Newfoundland in June 2023. This port is slated to serve as a future shipping hub of green hydrogen and ammonia, generated via a minimum of 328 wind turbines built in 2025 on the Port au Port Peninsula and in the Codroy Valley [24, 25].

Collaborative Research

- Nergica received two grants to enhance infrastructure: Applied Research Tools and Instruments (ARTI) to acquire a Battery Energy Storage System and the Canadian Foundation for Innovation (CFI) to expand their Rivière-au-Renard, QC research site. This equipment will be leveraged to support activities under Task 50 (Hybrid Power Plants) [26].

Impact of Wind Energy

Environmental Impact

- In May 2023, the hoary, eastern red and silver-haired bats were listed as endangered in Canada. This can potentially affect the development and operation of wind farms in the future [27].
- Environment and Climate Change Canada and Natural Resources Canada published a study regarding the estimated theoretical financial impact of turbine curtailment for bat mortality mitigation purposes in partnership. The study indicated that curtailment to curb bat mortality would cost the equivalent of roughly 0.42% of annual earnings [28].

Economic Benefits and Industry Development

- As of 2022, just over 110,600 individuals were employed in



Photo 2: Inuvik Hight Point Wind Project located in Inuvik, Northwest Territories. Credit: ENERCON Canada Inc.

the electricity sector across a wide range of occupations. Although it is difficult to pinpoint how many work in the wind sector specifically, the number of online job postings for wind turbine technicians grew by 579% between 2017 and 2022, indicating a significant increase in demand in recent years [29].

- Regional Assessments for Offshore Wind Development are underway in two provinces: Newfoundland and Labrador, and Nova Scotia. The Regional Assessments commenced in the spring of 2022 and will continue into 2024. The Assessments will “help inform future project-specific federal impact assessments and decisions for offshore wind projects in these areas” [14, 15].
- Nova Scotia plans to offer 5 GW of offshore wind energy leases by 2030, with the first call for bids opening in 2025. In May 2023, the Government of Nova Scotia released the Module 1 draft of the Nova Scotia Offshore Wind Roadmap. This Module outlined the work required to establish the legislative and regulatory framework for offshore wind in the area, including mention of the significant potential for green hydrogen generation through offshore wind-powered hydrolysis [16]. The Clean Hydrogen Investment Tax Credit, worth up to 40% of capital costs for hydrogen projects producing hydrogen with a carbon intensity of 0.75 kg CO₂/kg H₂ or less, will be available from 2023-2034 [16, 17].

Next Steps

Five wind projects are currently under construction, comprising 199 wind turbines and 1,114 MW of wind capacity expected to be operational by the end of 2024 [1].

References

- [1] Canadian Renewable Energy Association (CanREA) (2024). Work generated under contract to NRCan. Download from: <https://renewablesassociation.ca/>
- [2] Environment and Climate Change Canada (2023). Minister Guilbeault highlights the big five new Clean Investment Tax Credits in Budget 2023 to support sustainable made-in-Canada clean economy. Download from: <https://www.canada.ca/en/environment-climate-change/news/2023/04/minister-guilbeault-highlights-the-big-five-new-clean-investment-tax-credits-in-budget-2023-to-support-sustainable-made-in-canada-clean-economy.html>
- [3] Department of Finance Canada (2023). Fall Economic Statement 2023: Chapter 3 Building an Economy That Works for All Canadians. Download from: <https://www.budget.canada.ca/fes-eea/2023/report-rapport/chap3-en.html#a1>
- [4] Nova Scotia's 2030 Clean Power Plan (2023) Nova Scotia Department of Natural Resources and Renewables. Download from: <https://beta.novascotia.ca/sites/default/files/documents/1-3582/nova-scotia-clean-power-plan-presentation-en.pdf>
- [5] Hydro Québec (2023) Towards a Decarbonized and Prosperous Québec Action Plan 2035. Download from: <https://www.hydroquebec.com/about/publications-reports/action-plan-2035.html>
- [6] SaskPower (2024) Future Supply Plan - 2030 and Beyond. Download from: <https://www.saskpower.com/Our-Power-Future/Creating-A-Cleaner-Power-Future/Future-Supply-Planning/Future-Supply-Plan-2030-and-Beyond>
- [7] Independent Electricity System Operator (2023) Evaluating Procurement Options for Supply Adequacy. Download from: <https://www.ieso.ca/-/media/Files/IESO/Document-Library/resource-eligibility/Evaluating-Procurement-Options-For-Supply-Adequacy.pdf>
- [8] Province of New Brunswick (2023) Powering our Economy and the World with Clean Energy Our Path Forward to 2035. Download from: <https://www2.gnb.ca/content/dam/gnb/Corporate/Promo/energy-energie/GNB-CleanEnergy.pdf>
- [9] Manitoba Hydro (2023) Our 2023 Integrated Resource Plan. Download from: <https://www.hydro.mb.ca/corporate/planning/>
- [10] Chu Niikwän Development Corporation (2024) Hill Energy Limited Partnership. Download from: <https://www.chuniikwan.ca/ea-gle-hill-energy>
- [10] Chu Niikwän Development Corporation (2024) Hill Energy Limited Partnership. Download from: <https://www.chuniikwan.ca/ea-gle-hill-energy>
- [11] Market Surveillance Administrator (2024) Quarterly Report for Q4 2023. Download from: <https://www.albertamsa.ca/assets/Documents/Quarterly-Report-for-Q4-2023.pdf>
- [12] Government of Alberta (2023) Alberta's Renewables Inquiry and the Related Pause. Download from: <https://www.alberta.ca/system/files/au-faq-albertas-renewables-inquiry-and-the-related-pause.pdf>

- [13] Independent Electricity Electricity Operator (2023) Resource Acquisition and Contracts. Download from: <https://www.ieso.ca/Sector-Participants/Resource-Acquisition-and-Contracts/Resource-Eligibility>
- [14] Impact Assessment Agency of Canada (2024) Regional Assessment of Offshore Wind Development in Newfoundland and Labrador. Download from: <https://iaac-aeic.gc.ca/050/evaluations/proj/84343?culture=en-CA>
- [15] Impact Assessment Agency of Canada (2024) Regional Assessment of Offshore Wind Development in Nova Scotia. Download from: <https://iaac-aeic.gc.ca/050/evaluations/proj/83514?culture=en-CA>
- [16] Government of Nova Scotia (2023) Nova Scotia Offshore Wind Roadmap. Download from: <https://novascotia.ca/off-shore-wind/>
- [17] Department of Finance Canada (2023) Consultation on Clean Hydrogen Investment Tax Credit. Download from: <https://www.canada.ca/en/department-finance/programs/consultations/2022/consultation-on-the-investment-tax-credit-for-clean-hydrogen.html>
- [18] John Dalton (2023) Creating a Workplan for Offshore Wind Pathways to Market Studies. Department of Finance Canada (2023) Consultation on Clean Hydrogen Investment Tax Credit. Download from: <https://www.canada.ca/en/department-finance/programs/consultations/2022/consultation-on-the-investment-tax-credit-for-clean-hydrogen.html>
- [19] Ryan J. Kilpatrick et al. (2024) Preliminary Considerations Analysis of Offshore Wind Energy in Atlantic Canada. Download from: <https://doi.org/10.4095/331855>
- [20] Nigel Swytink-Binnema et al. (2023) Pan-Canadian study - Impact of climate change on wind power potential in North America. Download from: <https://nergica.com/en/pan-canadian-study-impact-of-climate-change-on-wind-power-potential-in-north-america/>
- [21] Majid Morshedizadeh et al. (2023) A case study of wind turbine rotor over-speed fault diagnosis using combination of SCADA data, vibration analyses and field inspection. Download from: <https://www.sciencedirect.com/science/article/pii/S1350630723000109>
- [22] Nergica (2024) Wind Power Energy in the Air. Download from: <https://nergica.com/en/wind-power/>
- [23] Wind Energy Institute of Canada (2024). Download from <https://www.weican.ca/our-facilities/>
- [24] CBC News (2023) World Energy GH2 buys Stephenville port to clear the way for producing and shipping hydrogen. Download from: <https://www.cbc.ca/news/canada/newfoundland-labrador/world-energy-gh2-stephenville-port-1.6862116>
- [25] CBC News (2024). Proposed wind project in western Newfoundland gets \$128M federal development loan. Download from: <https://www.cbc.ca/news/canada/newfoundland-labrador/world-energy-federal-loan-1.7128018>
- [26] Nergica (2023) Optimization and Integration of Solar PV in Cold Climates. Download from: <https://nergica.com/en/achievement/optimization-and-integration-of-solar-pv-in-cold-climates>
- [27] Government of Canada (2023) Hoary Bat (*Lasiurus cinereus*) Eastern Red Bat (*Lasiurus borealis*) Silver-haired Bat (*Lasionycteris noctivagans*): COSEWIC assessment and status report 2023. Download from: <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/hoary-bat-eastern-red-bat-silver-haired-bat-2023.html>
- [28] Bethany G. Thurber et al. Economic Impacts of Curtailing Wind Turbine Operations for the Protection of Bat Populations in Ontario. Download from: <https://www.mdpi.com/2674-032X/3/3/17>
- [29] Electricity Human Resources Canada (2024) Electricity in Demand: Labour Market Insights. Download from: <https://ehrc.ca/wp-content/uploads/2024/05/Electricity-in-Demand-Labour-Market-Insights.pdf>