ENERGY SERIES: Part 1

# Powering Up on Nuclear

## Summary

This report is the first part of a two-part series examining key trends and emerging technologies in the energy sector. Part 1 focuses on nuclear energy, while Part 2 will provide insights into the hydro and wind energy mix.

- Nuclear energy is increasingly recognized as vital for climate change mitigation and rising energy demand, with countries and financial institutions committing to significantly expanding global nuclear capacity in the coming decades.
- Green bond issuance for nuclear are on the rise, being used to finance plant upgrades and extend lifespans.
- Nuclear power's reliable energy source is fitting with the rapid growth of AI and data centres.
- Ontario, Canada's leader in nuclear energy, is committed to expanding nuclear capacity and grid infrastructure upgrades to meet rising electricity demand.
- Small modular reactors (SMRs) are gaining interest. Their expected reliability and long lifespan make them a critical part of the future energy mix.
- Nuclear's reliable baseload power makes it a valuable complement to intermittent energy sources.

## The Emerging Global Nuclear Renaissance

Nuclear energy is gaining momentum as a key solution to combat climate change and address growing energy demand. At COP29, six additional countries joined the pledge to triple global nuclear capacity by 2050. Earlier in 2024, fourteen global financial institutions expressed support for this expansion. The International Atomic Energy Agency projects nuclear capacity could grow to 2.5 times its current level by 2050, not far off the goal established at COP28.

Nuclear power is the second-largest source of low-carbon electricity, producing no greenhouse gas emissions during operation. Its appeal has grown due to geopolitical tensions and energy security concerns. The European Commission recently approved nine SMRs, aiming for deployment by the early 2030s to reduce reliance on Russian energy.

Nuclear is also an extremely reliable source for generating baseload power, complementing intermittent sources like wind and solar power. The U.S. Energy Information Administration reports nuclear has the highest capacity factor of any energy source, operating 90% of the time—nearly three times that of wind power.

## Nuclear Capacity Set to Expand Substantially

Nuclear energy is operational in 32 countries, according to the International Energy Agency. Its global electricity output remains lower than wind energy. Given the broadening commitment of countries and the vast number of plants under construction, the pace of growth in nuclear capacity is poised to accelerate over time. The World Nuclear Association (WNA) provides these key facts:

- In 2023, nuclear electricity generation increased by 2.2%.
- 64 reactors are under construction in 15 countries, including seven larger plants in China.
- Over 20 countries, including Singapore, Thailand, and Malaysia, are either planning to build their first nuclear plants or have shown strong interest in doing so.

Furthermore, Japan reintroduced nuclear energy as part of its climate bond transition framework in 2023, 12 years after the Fukushima Daiichi accident. In December 2024, the Japanese government released its new energy policy, targeting a 20% nuclear share by 2040 in the entire energy mix, up from 9% today.

In the U.S., the Nuclear Regulatory Commission's (NRC) approved NuScale Power's SMR design in 2023. However, full commercialization remains costly and distant, with deployment expected beyond 2030. In December 2024, the NRC also approved Westinghouse's different nuclear technology for instrumentation and control systems.

## Ontario: Canada's Nuclear Stronghold to Get Bigger

Nuclear produces about 15% of Canada's electricity, according to the Canadian Nuclear Safety Commission. Ontario leads the country with 18 nuclear units operating in three plants. Nuclear energy accounts for nearly half of the electricity in the province.

The federal and Ontario governments have included nuclear in their respective Updated Green Bond Framework, reinforcing their commitment to the sector. Canada's largest province is preparing to add nuclear as base load power. The Independent Electricity System Operator (IESO) forecasts a 75% rise in electricity demand by 2050. The industrial sector will be the main driver, especially the expansion of electric vehicle production and its supply chain, which accounts for more than half of the projected rise in energy needs.

## Data Centres: A Major Driver of Future Energy Demand

Data centres constitute the second-largest contributor to Ontario's projected increase in energy demand by IESO. According to a report from the Canada Energy Regulator, the growth of data centres could put a strain on the country's power grid. The report highlights the need for solutions to manage the larger power loads. Data centres require consistent, reliable energy, making nuclear power an ideal solution due to its high energy density and steady supply.

Canada ranks fifth globally in the number of data centres, with 336 facilities, according to Mordor Intelligence. Ontario has the most data centres (105), followed by Quebec (57) and British Columbia (35). The Canadian data center market is expected to grow at a rate of 9% annually until 2029. In the U.S., Constellation Energy predicts data centres will boost electricity demand from 2.5% annually in 2022 to 7.5% by 2030.

## Essential to Add Transmission and Distribution Networks

Meeting the increasing energy demand will require more than just expanding existing power plants. Investments in grid infrastructure, by improving the efficiency of current sites and adding new capacity, will be essential. Transmission and distribution networks will be key to achieving Ontario's energy plan goals. Hydro One will play a crucial role in adapting and expanding the transmission and distribution lines.

## Recent Green Bond Issuance to Extend Life of Existing Plants in Ontario

In November 2024, the Ontario government announced the completion of the refurbishment of Unit 1 at the Darlington site, five months ahead of schedule. The refurbishment will provide 875 MW of power for the next 30 years, enough to supply energy to 875,000 homes.

This completion was the last step in Ontario Power Generation's (OPG) major initiative, which began in 2022. As part of this effort, OPG issued a $300 million, 10-year green bond to finance the Darlington refurbishment. The deal was highly successful, being oversubscribed six times. OPG is the largest corporate green bond issuer in the country, with total issuance reaching $4.6 billion since 2018. OPG's original Green Bond Framework, released in 2022, which included nuclear energy was replaced in mid-2024 with a new Sustainable Finance Framework. The latter received a medium green rating from CICERO, a second-party opinions firm.

Highlighted in the 2024 Ontario budget, the OPG plans to refurbish units 5-8 at the Pickering station with the provincial government's support. For the time being, the federal Canadian Nuclear Safety Commission approved a short extension of the Pickering station until the end of 2026. Units 1 and 4 were close in late 2024.

Meanwhile, Bruce Power has issued a total of $1.7 billion in green bonds through three offerings. The company made history in 2021 by being the first to issue a nuclear green bond, which was also oversubscribed six times.

In the spring of 2023, Bruce Power issued a $600 million, 7-year green bond. The company has six refurbishment projects planned, some of which are already underway, to extend energy supply beyond 2060. CICERO awarded Bruce Power's updated Green Financing Framework a medium green rating in late 2023.

Since January 2023, Hydro One has issued $4.7 billion in Sustainable Financing Instruments. The company plans to keep issuing green bonds to support its strategic investments in transportation and distribution infrastructure.

## Nuclear Green Bond Issuance to Improve Existing Plants Globally

Nuclear green bonds are gaining momentum worldwide, demonstrating a broadening successful shift towards sustainable energy financing. The following entities have been tapping the bond market to refurbish and extend the lifespan of existing nuclear power plants:

- In November 2023, Électricité de France (EDF), which owns eight power stations, issued its first €1 billion green bond with a 3.5-year term. The deal was oversubscribed by 3.4 times. Despite political fragility, the French government is considering giving a zero-interest loan to EDF to finance six new nuclear projects using existing pressurized water reactor technology.
- Teollisuuden Voima Oyj (TVO) in Finland issued a €600 million, 7-year green bond in May 2024. Proceeds will be used to finance the development and life extension of its existing boiling water reactors.
- In March 2024, Constellation Energy Generation became the first U.S. company to issue a nuclear green bond. The company raised US$900 million through a 30-year bond to fund upgrades and extend the life of its 14 nuclear power plants.

The average age of nuclear plants is 43 years old in the U.S., 42 in Canada, and 38 years in Europe. Extending the lifetime of operational reactors lowers the cumulative cost of production per kilowatt relative to previous expectations.

## The Next Frontier in Green Bond Financing: SMRs

There is also a noticeable shift in the purpose of nuclear bond issuance. Companies are preparing to build SMRs, the next generation of nuclear power plants. Advocates of SMRs cite simplicity, safety, and flexibility to build units at specific locations. Another advantage of SMRs is their shorter construction time. While large nuclear reactors can take eight years or more to build, SMRs can be completed in just one to three years.

SMRs can be built on sites previously used for coal plants or other nuclear facilities. In the U.S., the Department of Energy has identified over 300 such sites. Similarly, OPG owns sites in Lambton and Port Hope that could potentially be converted for SMR use. This offers a clear advantage over wind farms, which require large land areas for installation.

## SMRs: Imperative for the Future of Clean Energy

SMRs are in the early stages of development, not as mature relative to the larger-scale deployment of solar and wind energy observed globally. As SMRs progress toward broader commercialization, they are also becoming targets to growing critics.

SMRs have a smaller capacity than large nuclear reactors, with output typically ranging from 300 MW to 500 MW per unit. Some experts say their cost of construction and production per unit of energy is more expensive relative to large nuclear reactors benefiting from economies of scale.

A recent project at the Vogtle plant in Georgia has notably raised concerns about the cost-effectiveness of nuclear energy. In early 2024, two small reactors at this plant, producing 1.1K MW, began operations at a total cost of $35 billion—more than double the original estimate. Furthermore, the Institute for Energy Economics and Financial Analysis reports that the cost of SMRs is four times higher than onshore wind or solar power. However, proponents argue that nuclear energy's long lifespan allows total costs to be spread over many years. In addition, new technologies could make nuclear plants safer and more cost-effective in the future.

Another significant cost factor relates to the disposal of radioactive waste and the decommissioning of nuclear plants. The cost of these processes is difficult to predict. In late November, the Nuclear Waste Management Organization selected a site for Canada's nuclear waste repository in Northern Ontario (north of Lake Superior), at a cost of $26 billion. The construction phase is expected to last one full decade before operations can begin in the 2040s. Nuclear waste can remain radioactive for centuries, a criticism often cited by opponents of nuclear energy.

Overall, SMRs may not be as cost-effective as wind, solar or hydro power. But SMRs are still poised to become an important part of a reliable energy mix since a province or country cannot depend solely on intermittent power.

## Canada's First SMR Under Construction Very Soon

OPG's Sustainable Finance Framework incorporates the possibility of dedicating proceeds to new nuclear projects and to create partnerships with Indigenous communities. OPG notably issued $1 billion of bonds last June. Using General Electric-Hitachi's technology, the company plans to build four SMRs. These reactors will generate 300 MW each, providing power to 1.2 million homes, and will have a life expectancy of about 30 years. Construction of the first SMR by OPG is expected to begin in 2025, with operations starting by 2029. This SMR—the first in Canada—will be build next of the existing Darlington site.

In 2022, the Canada Infrastructure Bank committed $970 million to support the pre-construction phase of the SMR project, covering expenses like site preparation and design. At the time, nuclear energy was not part of the federal government's green bond framework. It wasn't until November 2023 that nuclear projects became eligible for funding through green bond issuances.

Canada's updated Green Bond Program has not directly finance new SMRs at this point, but such an outcome appears more likely going forward. This would mark an evolution of sustainable finance. In February 2024, the government raised $4 billion through green bonds, with the offering being oversubscribed by two times. In October 2024, the government reopened the bond to raise an additional $2 billion, also oversubscribed by almost two times. According to the fiscal update of mid-December, more than half of the buyers in 2024 were socially and environmentally responsible investors. The federal government intends to proceed with two smaller green bond issuances before the end of March 2025 with October's re-opening and a separate offering.

## Promising Nuclear Projects in Canada

OPG is leading the way with its SMR project. In 2022, Ontario, Alberta, and Saskatchewan formed a joint strategy to develop SMRs. For the time being, there are several promising other projects, though no major investments have yet been finalized.

New Brunswick offers strong potential for SMRs, particularly with OPG's General Electric-Hitachi SMR technology. Although New Brunswick Power previously explored sodium-cooled SMR technology, progress on those efforts has been limited. The province can now leverage new federal funding for clean energy projects, announced in December. While most of the funding is allocated to wind power, $25 million has been earmarked for New Brunswick Power to advance pre-development work on a 600 MW SMR project. This initiative could help offset the loss of the 450 MW capacity from the Belledune coal plant, slated for closure by 2030. Nuclear power already plays a vital role in the province, with the Point Lepreau station contributing about 40% of New Brunswick's total electricity generation.

OPG is also working with Capital Power in Alberta to explore SMR possibilities. In Saskatchewan, SaskPower has created SaskNuclear, a subsidiary collaborating with OPG to bring the General Electric-Hitachi SMR to the province. Additionally, the Saskatchewan Research Council is studying the use of Westinghouse's eVinci microreactors for remote communities in northern Saskatchewan. In Canada's northern regions, floating mini reactors could offer a solution for First Nations communities.

Global First Power is considering the construction of a 5 MW Micro Modular Reactor (MMR) at Chalk River Laboratories in Ontario. However, one limitation of MMRs is their relatively short lifespan, typically 20 years or less. AtkinsRéalis, a private company, has introduced an advanced version of the Candu reactor, known as the Monark. This new model has a significantly larger capacity, capable of generating 1,000 MW, and is designed for deployment in both Canadian and international markets, offering a more robust and long-term solution compared to MMRs.

## Global Progress for OPG

Building on the global shift toward nuclear energy, OPG is also actively involved in advancing projects outside of Canada. The company is working with Poland and the Czech Republic to deploy SMRs and with SN Nuclearelectrica in Romania to refurbish an existing nuclear plant using CANDU technology. OPG's involvement in these European projects positions it to benefit from the strong market reception for nuclear energy, much like the success experienced by other nuclear green bond issuers over the past year.

## Takeaway

Nuclear energy, bolstered by the extension of existing plants, the rise of SMRs and maturing green bond financing, is playing an increasingly critical role in meeting global energy needs and carbon emissions reduction. Canada is among countries reinforcing efforts with the building of next-generation reactors and existing plants extensions. As energy demand continues to rise, nuclear power's ability to provide steady dependable, low-carbon energy makes it an essential part of the ongoing sustainable global transition.

In Part 2 of our energy series, we will continue our exploration of trends, regional strategies, and emerging technologies shaping the energy landscape, with a focused analysis on the strong bound between hydro and wind power.

# We want to hear from you

## Sales & Trading

**Robert Sforza, CFA**
**Head of Distribution, Money Market & Repo**
SforzaR@vmbl.ca | 514 350 2905

**Etienne Bisaillon, CFA**
**Vice President, Trader**
BisaillonE@vmbl.ca | 514 350 2905

**Kacper Jurga, MS**
**Vice President, Trader**
JurgaK@vmbl.ca | 514 350 2905

**Benoit Martineau, MS**
**Vice President, Trader**
MartineauB@vmbl.ca | 514 350 2907

**Jean-Philippe St-Laurent, CFA**
**Vice President, Sales**
StLaurentJP@vmbl.ca | 514 350 2904

**Laura Chelaru, CFA**
**Vice President, Sales**
ChelaruL@lb-securities.ca | 416 865 5811

## Debt Capital Markets

**Benoit Lalonde, CFA**
**Vice President & Head DCM**
LalondeB@vmbl.ca | 514 350 2904

**Massimo Morabito, CFA, FRM**
**Director, Debt Capital Markets**
MorabitoM@vmbl.ca | 514 350 2904

**Zakaria Hammama**
**Associate, Debt Capital Markets**
HammamaZ@vmbl.ca | 514 350-2904

## LBS Economics

**Sébastien Lavoie**
**Chief Economist**
LavoieS@vmbl.ca | 514 213 4571

**Alexandre Larose**
**Economic Analyst**
LaroseA@vmbl.ca | 514 350-2800

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