Port Hope's Electricity Future

Wind & Solar or New Nuclear?

Ontario Clean Air Alliance Research | June 3, 2025

ONTARIO CLEAN AIR ALLIANCE

Acknowledgments

Ontario Clean Air Alliance Research gratefully acknowledges the generous financial support it has received for this project from:

Clean Economy Fund

Echo Foundation

Externalitator Foundation

Green Sanderson Family Foundation

Taylor Irwin Family Foundation at the Toronto Foundation

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Overview

In 2024, the Government of Ontario said it wanted to involve the local community and Indigenous peoples in a discussion of future electricity generation options for the site of a never-completed oil-fired power plant in Port Hope, on the shores of Lake Ontario.

The proposed plant would be the largest nuclear station in the world

Then in 2025 Energy Minister Stephen Lecce announced his strong preference to build a massive nuclear generating station in Port Hope. The proposed 10,000 megawatt plant would be the largest nuclear station in the world -- one-and-a-half times larger than the Bruce Nuclear Station and nearly three times larger than the Darlington Nuclear Generating Station.

By attempting to short circuit a careful consideration of alternatives, Minister Lecce is rushing to lock Ontario into a costly and problematic technology that cannot address growing power needs or reduce climate damaging emissions before 2045.

Nuclear technology is problematic for many reasons, including its high costs. This report includes a careful real-world comparison of technology costs by the Energy Futures Group that finds that new nuclear electricity costs 1.7 to 2.7 times the cost of Great Lakes offshore wind power, 3.7 to 8.6 times the cost of onshore wind power, and 3.9 to 5.7 times the cost of solar power. That is assuming that everything goes according to plan, which has never been the case with new build nuclear projects in Ontario or in much of the rest of the world.

This report includes a careful real-world comparison of technology costs

It is also highly likely, given a lack of available alternative nuclear technologies, that a new plant would rely on enriched uranium. Canada does not currently have the capacity to produce enriched uranium and faces major barriers to creating such capacity – from enormous costs to international nuclear non-proliferation agreements. That means a new nuclear plant would be dependent on fuel imports from the United States (as we are unlikely to sign an agreement with Russia, the world's biggest supplier of enriched uranium). It is hard to fathom why we would want to be subject to erratic and/or hostile decision making by the current or future U.S. administrations and vulnerable to having our fuel supplies cut off to a plant that would be responsible for an enormous share of our electricity supply.

A new nuclear plant would be dependent on enriched uranium fuel imports from the United States

Nuclear technology is problematic for many reasons, including its high costs

In contrast to risky and slow to deploy nuclear power, a large solar farm could be built in a matter of months. Similarly, offshore wind power, that connects to the provincial grid at the Port Hope site, would be a much quicker and lower cost way to meet the province's growing demand for power than building a giant nuclear plant from scratch.

Last year 92.5% of the world's new electricity supply was renewable, mostly solar and wind

This report does what the Government of Ontario has not done: It looks at the alternatives to building a massive nuclear plant and outlines the costs and security risks of increasing our province's dependence on a technology that, despite industry hype, remains in decline worldwide.

In 1996 nuclear power supplied the world with 17.5% of its electricity. By 2023 its market share had fallen to 9.1%. In contrast, last year 92.5% of the world's new electricity capacity was renewable, mostly solar and wind.

In the 1970s, Ontario Power Generation's predecessor, Ontario Hydro, started construction of what was meant to be a large oil-fired power plant in Port Hope. The oil crises of the 1970s led to that project being abandoned, with only the shell of the plant completed. In many ways, it appears that Ontario is headed down the same path again – racing down a dead end while the world moves to a renewable electricity future. We need to learn the lessons of the past and broaden our horizons to consider the multiple better ways that we can simultaneously meet our energy needs, lower our electricity bills and protect our climate.

This report looks at the alternatives to building a massive nuclear plant

Introduction

In November 2024 the Government announced that it had asked Ontario Power Generation (OPG) to begin discussions with Indigenous, community and municipal leaders to assess community support for all types of new energy generation at its Wesleyville site in Port Hope on the shore of Lake Ontario.[1]

In December 2024 the Municipality of Port Hope passed a resolution supporting "continued dialogue and engagement with Ontario Power Generation (OPG), the Ministry of Energy and Electrification, and local stakeholders to explore the development of clean energy generation projects at the Wesleyville site".[2]

In January 2025 the Government of Ontario announced that it has asked OPG to investigate the potential to build up to 10,000 megawatts (MW) of new nuclear generation at Wesleyville.[3]

A 10,000 MW nuclear station would be the largest nuclear station in the world. It would be 1.6 times larger than the Bruce Nuclear Station and 2.8 times larger than the Darlington Nuclear Generating Station.

This report will compare the costs and benefits of using the Wesleyville site for nuclear, wind and solar generation.

In December 2024 the Municipality of Port Hope passed a resolution supporting continued dialogue and engagement exploring "the development of clean energy generation projects at the Wesleyville site"

Annual Electricity Generation Potential

Nuclear

No electricity generation technology operates 24/7 for all 52 weeks of the year since all technologies need to go offline for maintenance and repairs. Therefore, the annual electricity generation of a 10,000 MW nuclear station will depend on its average annual capacity utilization rate.

According to the International Atomic Energy Agency, the Pickering and Darlington Nuclear Stations have had lifetime average annual capacity utilization rates of 71.4% and 78.6% respectively, as of December 31, 2023.[4]

Assuming capacity utilization rates of 71.4 and 78.6% respectively, a 10,000 MW new nuclear station would produce 62.5 to 68.9 terawatt-hours (TWh) of electricity per year. This would be equivalent to up to half of Ontario's total electricity consumption in 2024 (139 TWh).

Wind Power

The Wesleyville site is next door to Hydro One's high-voltage 500 kV transmission network – Ontario's electricity superhighway. As a result, it is an ideal location to connect Lake Ontario offshore wind farms to Hydro One's transmission grid.

According to Ontario's Independent Electricity System Operator (IESO), Great Lakes offshore wind farms would have average annual capacity utilization rates of 50%.[5] Therefore 14,270 to 15,730 MW of Great Lakes offshore wind power could produce the same amount of electricity (62.5 to 68.9 TWh) per year as a 10,000 MW nuclear station.

The total lakebed footprint of 15,730 MW of wind power would be 0.3146 square km.[6] The total area of the Canadian section of Lake Ontario is 10,000 square km.[7]

A report prepared by Helimax Energy Inc. for the Ontario Power Authority, identified 64 sites in the Canadian sections of the Great Lakes that could host a total of 34,500 MW of offshore wind power. According to Helimax, there are also additional sites in the Great Lakes that can be feasibly developed.[8]

Wesleyville is an **ideal location** to connect Lake Ontario offshore wind farms to Hydro One's transmission grid

Solar Power

The total area of the Wesleyville site is 1,333 acres[9], but according to the Municipality of Port Hope, slightly more than 50% of the site consists of environmentally sensitive lands that should not be developed. Specifically, according to the Town only 634 acres are suitable for development.[10]

According to a report prepared by McDiarmid Climate Consulting, the 634 acres could support 83 MW of solar generation capacity, which could produce 106,000 (megawatt-hours) MWh of electricity per year – enough electricity to supply 11,770 homes.[11]

The total available area of the Wesleyville site for utility-scale solar could produce enough electricity to supply

11,770 homes

Cost

According to the IESO's *2024 Annual Planning Outlook*, the cost of electricity from a new nuclear reactor is about 2.3 times the cost of new utility-scale solar and approximately 3.3 times the cost of onshore wind power.[12]

The IESO's cost estimates for new nuclear are problematic for three reasons.

1. Its capital cost estimates per kW for new nuclear are approximately 40 to 50% lower than the actual costs of the Vogtle nuclear reactors which came into service in Georgia, U.S.A. in 2023 and 2024.[13]

2. It assumes that new nuclear reactors will operate for 60 years without a major refurbishment despite the fact that Ontario Power Generation started a $12.8 billion refurbishment of the Darlington Nuclear Station only 26 years after its first reactor went into service.[14]

3. It assumes that new nuclear reactors will have average annual capacity utilization rates of 93%[15] despite the fact that the average annual capacity utilization rate of the Darlington Nuclear Station between 1990 and 2023 was 78.6%.[16]

As a consequence, we asked the Energy Futures Group to calculate the costs of Ontario's nuclear, wind and solar options using more realistic assumptions.

According to the Energy Futures Group report, new nuclear electricity costs 1.7 to 2.7 times the cost of Great Lakes offshore wind power; 3.7 to 8.6 times the cost of onshore wind power; and 3.9 to 5.7 times the cost of solar power. See Table 1.[17]

Table 1 | Cost per kWh (2024 US$)

	Cents per kWh
Utility-Scale Solar	4.1
Onshore Wind	2.7 – 4.3
Great Lakes Offshore Wind	8.6 – 9.3
Nuclear	20.6 – 22.6
Nuclear SMR First of a Kind	21.1 – 23.2
Nuclear SMR Nth of a Kind	15.9 – 17.4

These cost estimates do not include the cost of decommissioning nuclear reactors and storing their wastes for one million years or more.

The wind and solar costs per kilowatt-hour (kWh) were calculated using data from the IESO's Pathways to Decarbonization report.

The "Nuclear" costs per kWh were calculated using the actual capital cost of the Vogtle nuclear reactors which came into service in Georgia, U.S. in 2023 and 2024 and the historic annual capacity utilization rate of the Darlington Nuclear Station (78.6%).

The "Nuclear SMR First of a Kind" costs per kWh were calculated using the Tennessee Valley Authority's (TVA) estimates of their cost of building their first small modular reactor (SMR) and the historic annual capacity utilization rate of the Darlington Nuclear Station.

The "Nuclear SMR Nth of a Kind" costs per kWh were calculated using TVA's estimates of their costs of building their 2nd, 3rd and 4th small modular reactors and the historic annual capacity utilization rate of Darlington.

The nuclear costs per kWh were calculated under three cost amortization scenarios, i.e., 30, 50 and 60 years.

According to the Energy Future Group's analysis, by investing in Great Lakes offshore wind power instead of 10,000 MW of new nuclear, Ontario can reduce its electricity generation costs by $4.5 to 10.1 billion dollars (2024 US$)[18] per year or $6.2 to $13.8 billion (2024 CDN$) per year.[19]

By investing in solar power instead of 10,000 MW of new nuclear, Ontario can reduce its electricity generation costs by $8.1 to $13.2 billion (2024 US$) per year or $11.1 to $18.1 billion (2024 CDN$) per year.

By investing in onshore wind power instead of 10,000 MW of new nuclear, Ontario can reduce its electricity generation costs by $8.0 to $14.1 billion (2024 US$) per year or $11 to $19.3 billion (2024 CDN$) per year.

New nuclear electricity costs
1.7 to 2.7
times the cost of Great Lakes offshore wind power;
3.7 to 8.6
the cost of onshore wind power; and
3.9 to 5.7
times the cost of solar power

Cost Overruns

Every new nuclear power project in Ontario's history has gone over budget.

For example, the Darlington Nuclear Station was the last new nuclear power plant to be built in Ontario. Its actual cost was 4.5 times higher than its forecast cost.[20]

And it is not just Ontario that has experienced large nuclear cost overruns. According to Bent Flyvbjerg, author of *How Big Things Get Done*, on a global basis the average cost overrun for a nuclear power project is 120%. On the other hand, according to Flyvbjerg, the average cost overruns for solar and wind projects are 1% and 13% respectively.[21]

Timing

According to Lazard, the construction times for new renewable electricity technologies are nine months to three years. See Table 2 below.

Table 2 | Construction Times for Solar and Wind[22]

Residential Rooftop Solar PV	9 months
Utility-Scale Solar PV	12 months
Onshore wind	12 months
Offshore wind	36 months

According to OPG, if it decides that it wishes to build nuclear reactors in Port Hope, it will submit an application to the Canadian Nuclear Safety Commission (CNSC) in the early 2030s for a licence to construct.[23] If the application is approved, it will then take 8 to 15 years to build the reactors according to the Independent Electricity System Operator.[24]

Speed is of the essence for two reasons: First, we must reduce our American gas imports as soon as possible to protect our energy security. (See the "Energy Security" section below.) Second, according to the United Nations, the world must reduce its greenhouse gas pollution by 43% by 2030 to limit temperature rise to 1.5 degrees Celsius.[25]

Nuclear is the slowest and costliest way to reduce GHG emissions. We cannot afford to wait until 2045 or beyond for Port Hope nuclear reactors to produce electricity.

Every new nuclear power project in Ontario's history has gone over budget

Energy Security

American Gas

Ontario's dependence on American gas for electricity generation has increased significantly since 2017. Between 2017 and 2024, gas-fired power rose from 4% to 15.7% of our electricity supply.[26] Moreover, according to Ontario's Independent Electricity System Operator's *2025 Annual Planning Outlook*, gas will be responsible for 25% of our electricity supply in 2030.[27]

Our rising dependence on gas-fired electricity generation is an energy security risk since more than 70% of Ontario's gas is imported from the U.S.[28]

More than 70% of Ontario's gas is imported from the U.S

Enriched Uranium

Ontario's CANDU nuclear reactors consume natural uranium which is mined and processed in Canada. But according to the Globe and Mail, the CANDU reactors are widely regarded as obsolete:

"The last one built in Canada was Darlington Unit 4, completed in 1993. Since then a number of new designs have been drawn up, but none were licenced or built."[29]

As a result, Ontario Power Generation is planning to build four new 300 MW GE-Hitachi reactors at the Darlington site, which would require enriched uranium imports from the U.S. since Canada does not have the capability or legal permission to enrich uranium in Canada. Enriched uranium imports could be curtailed by the President of the U.S. with a stroke of a pen.[30]

Ontario needs to reduce its imports of American gas and avoid the need to import enriched uranium from the U.S. to protect our energy security and political independence.

Back-Up Power & Energy Storage

As noted earlier, no electricity generating technology operates 24/7 for all 52 weeks of the year. For example, the Darlington Nuclear Station has been out-of-service on average for more than 1 hour out of every 5 between 1990 and 2023. Therefore, all supply options must be combined with back-up power or energy storage.

Historically, Ontario has used fossil generation (e.g., coal and gas) to provide back-up power. The good news is that we now have many storage options that can provide back-up power for variable wind and solar electricity.

Lithium-Ion Batteries

Lithium-ion batteries can be used to store surplus wind and solar energy and provide it back to the grid when demand is high and/or when solar and wind generation is low. Last year the Government of Ontario completed the largest battery storage procurement in Canada's history and obtained 1,784 MW of storage from ten lithium battery projects ranging in size from 9 to 390 MW.[31]

According to Lazard, one of the world's preeminent financial advisory and asset management firms, the cost of new nuclear is 1.35 times the cost of solar plus lithium battery storage and 2 times the cost of wind plus lithium battery storage.[32]

According to the International Energy Agency, the cost of lithium-ion batteries has fallen by 90% since 2010 and are forecast to fall by an additional 40% by 2030.[33]

Hydro Quebec's Reservoirs

According to a Massachusetts Institute of Technology report, the lowest-cost storage option for Ontario's electricity system is Quebec's hydro-electric reservoirs.[34] For example, when our wind power production is above average, our surplus wind energy can be exported to Quebec to keep the lights on in Montreal, and Hydro Quebec can store more water in its reservoirs. Conversely, when our wind power production is below average, Hydro Quebec can use the extra water in its reservoirs to produce electricity for export back to Ontario. In short, by integrating our wind generation with Hydro Quebec's reservoirs, we can convert intermittent wind energy into a firm 24/7 source of electricity supply for Ontario.

The total storage capacity of Hydro Quebec's reservoirs (176 terawatt-hours[35]) is 1.3 times greater than Ontario's total annual electricity consumption in 2024 (139 terawatt-hours).

The Independent Electricity System Operator has identified how we can increase our access to Hydro Quebec's reservoirs by 7,500 MW by upgrading our transmission links with Quebec at Chats Falls (2,000 MW), Ottawa (2,000 MW), Beauharnois (2,000 MW) and Cornwall (1,500 MW). All these upgrades can use existing Hydro One transmission corridors.[36]

The cost of lithium-ion batteries has fallen by 90% since 2010 and are forecast to fall by an additional 40% by 2030

EV Batteries

Our electric vehicles' (EVs) batteries have the potential to become a low-cost storage option for wind and solar energy since their batteries have already been paid for by the EV owners. When combined with bi-directional chargers, EV batteries can store surplus power when renewable generation is high and return power to the grid when renewable generation is below average or demand is high.

EV batteries are a viable storage option for electricity grids since on average cars are parked for 95% of the hours of the year.[37]

In the U.K., Octopus Energy provides free EV charging to EV owners who agree to provide power back to the grid during peak demand hours.[38]

In 2030 the total capacity of our EVs' batteries will be more than double the capacity of our gas plants.[39]

Compressed Air

Electricity can be used to store compressed air in underground caverns. When the compressed air is released, it can drive turbines to generate electricity to send back to the grid.

Canada's Hydrostor has been a leader in compressed air storage solutions and developed a pilot project in Goderich, Ontario. It is now developing projects in Australia and California.[40]

Bedrock Energy Corp. is proposing to build a 500 MW compressed air storage facility in Bluewater, Ontario.[41]

Iron-Air Batteries

Iron-air batteries use iron and air to store electricity for long durations—up to 100 hours. Form Energy is building a large iron-air battery in Lincoln, Maine.[42]

Expanding the East-West Electricity Grid

When wind and/or solar generation is high in Ontario, it may be low in Manitoba, Quebec, Labrador or Nova Scotia and vice versa. By expanding the east-west grid we can enable inter-provincial electricity trade to significantly increase and reduce the variability in the provinces' supply of wind and solar energy. Thereby reducing the need for storage and/or back-up generation.[43]

When combined with bi-directional chargers, EV batteries can store
surplus power

Migratory Birds & Bats

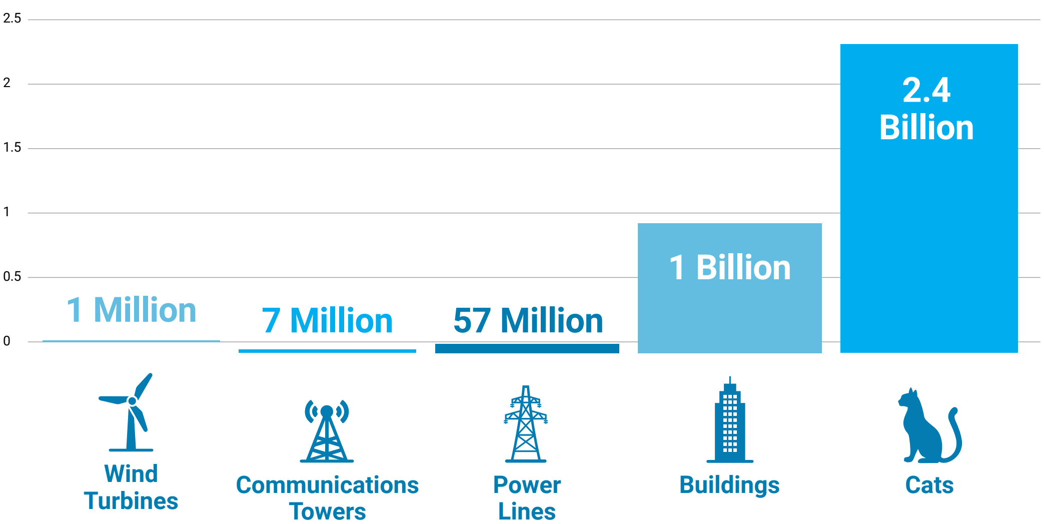
According to the National Audubon Society, "two-thirds of bird species in North America will face extinction unless we tackle climate change."[44] As a result, Audubon supports environmentally appropriate offshore wind projects to help decarbonize the economy and stabilize the climate:

> "Audubon supports the responsible siting and operation of offshore wind and emphasizes that this development must be done in a way that both minimizes harm to birds and provides a path toward a more climate-stable future."[45]

According to Professor Christina Davy, Associate Professor of Biology at Carleton University, bats are the species that are most vulnerable to Great Lakes wind turbines. Nevertheless, she says that: "We can run wind energy in bat-friendly ways."[46]

Specifically, Professor Davy says that Great Lakes wind turbines can produce bat-friendly power if they are turned off from dusk to dawn during the migratory bat seasons (late April & May and mid-July to the end of September) whenever wind speeds are less than seven metres per second, since bats fly more when wind speeds are low.[47]

Figure 1 | Annual Bird Deaths in U.S.*



* Mark Jacobson, *No Miracles Needed: How Today's Technology Can Save Our Climate and Clear Our Air*, (2023), page 258.

Audubon supports environmentally appropriate offshore wind projects

Storage of Nuclear Wastes

According to the Nuclear Waste Management Organization (NWMO), which is owned by Canada's nuclear power companies, radioactive nuclear wastes must be fully isolated from people and the environment for one million years or more.[48]

Ontario Power Generation (OPG) is proposing three sequential methods for the storage of its nuclear reactors' wastes: a) wet storage; b) dry storage; and c) off-site storage in a deep geological repository (DGR).

OPG is failing to put
safety first

Wet Storage

Freshly discharged spent nuclear fuel is so hot that it must be put in wet storage pools to cool down.[49] If the storage pool loses water due to a terrorist attack or other disruption (e.g., earthquake) the nuclear fuel rods could catch fire and release radiation to the atmosphere.[50]

According to the U.S. Nuclear Regulatory Commission, a fire in a densely packed U.S. spent-fuel pool could release 100 times as much radiation into the air as was released by the Fukushima accident. This could require the evacuation of millions of people and cause 20,000 cancers.[51]

Fortunately, the adverse consequences of a pool fire can be dramatically reduced by transferring the spent fuel rods to dry storage when they have cooled enough to do so.[52] According to GE-Hitachi, the spent fuel rods, from OPG's proposed new nuclear reactors at Darlington, could be transferred to dry storage after they have been in a wet storage pool for 2.5 years.[53] Nevertheless, OPG is proposing to keep them in wet storage for 7 to 8 years.[54]

In addition, more than 50% of the spent fuel rods at the Pickering Nuclear Station have been in wet storage for more than 10 years.[55] OPG is failing to put safety first.

Dry Storage

According to the U.S. National Research Council, dry storage is safer than wet storage for two reasons:

1. It is a passive system that relies on natural air circulation for cooling; and

2. It divides the inventory of the spent fuel among a large number of discrete, robust containers. These factors make it more difficult to attack a large amount of spent fuel at one time and reduce the consequences of such attacks.[56]

Currently, the dry storage containers at the Pickering, Darlington and Bruce Nuclear Stations are housed in conventional warehouse buildings on the edge of Lakes Ontario and Huron.

In Germany, six nuclear stations have on-site, above-ground, attack-resistant reinforced concrete vaults for the storage of their nuclear wastes. The concrete walls and roofs of these vaults are approximately 1.2 and 1.3 metres thick respectively.[57]

The International Joint Commission's Great Lakes Water Quality Board is calling for OPG's interim on-site storage facilities to be "hardened" to protect them from terrorist attacks, and located away from shorelines to prevent them from being compromised by flooding and erosion.[58]

According to a report prepared for OPG, the total capital cost of building above-ground, attack-resistant, reinforced concrete vaults at the Bruce, Pickering and Darlington Nuclear Stations would be $236 million (2002$) per station.[59] Nevertheless, OPG has chosen not to do so.

Deep Geological Repository

In the long-term, OPG is hoping that its nuclear wastes can be transferred off-site to a permanent storage facility, on First Nations' traditional territories, where they would be placed in caverns 500 to 1,000 metres below ground.

There is no deep geological repository (DGR) facility for high-level nuclear fuel wastes currently operating anywhere in the world despite decades of effort on the part of the nuclear industry to establish such a facility. In Canada, after almost 50 years of trying to solve the long-term radioactive waste problem, there is still no site accepted by a "host" community and there is no completed design for the DGR itself. In addition, the used-fuel transfer facility is still in the conceptual stage, as is the transportation system for getting waste from nuclear stations to the DGR.

As a consequence, the high-level nuclear wastes at OPG's nuclear stations may remain on-site far into the future.

According to the NWMO, if a radioactive release occurs in a DGR "it may be difficult for a future generation to detect the breach in a timely way and take corrective action."[60]

Currently, dry storage containers are housed in conventional warehouse buildings on the edge of Lakes Ontario and Huron

Conclusions & Recommendations

1

It does not make sense to build a 10,000 MW nuclear station in Port Hope since Great Lakes offshore wind power, solar power and onshore wind power are cleaner, safer, and lower cost options to keep our lights on.

Specifically, by investing in Great Lakes offshore wind power instead of a 10,000 MW new nuclear station, Ontario can reduce its electricity generation costs by $6.2 to $13.8 billion (2024 CDN$) per year.

By investing in solar power instead of 10,000 MW of new nuclear, Ontario can reduce its electricity generation costs by $11.1 to $18.1 billion (2024 CDN$) per year.

By investing in onshore wind power instead of 10,000 MW of new nuclear, Ontario can reduce its electricity generation costs by $11 to $19.3 billion (2024 CDN$) per year.

2

Wind and solar energy are also the quickest ways to reduce Ontario's electricity-related greenhouse gas emissions and to reduce our dependence on American energy imports (e.g., fossil gas, nuclear technology, enriched uranium). We cannot wait 20 years or more for new electricity supply.

3

A utility-scale solar facility should be built on the OPG's Port Hope lands that are suitable for electricity generation (approximately 630 acres).

4

To ensure that Ontario can meet its future electricity needs at the lowest possible cost, the Government of Ontario should rescind its moratorium on Great Lakes offshore wind power.

By investing in wind and solar power Ontario can reduce its electricity generation costs by billions of dollars per year compared to the nuclear option

5	Great Lakes offshore wind power projects should be permitted on a project-by-project basis – subject to environmental assessment reviews that demonstrate that their potential adverse impacts have been minimized, and that ongoing monitoring of impacts on birds and bats is in place. Specifically, to protect bats, Great Lakes offshore wind turbines should be turned off from dusk to dawn during the migratory bat seasons (late April & May and mid-July to the end of September) whenever wind speeds are less than 7 metres per second, since bats fly more when wind speeds are low.
6	OPG's Port Hope site should be used to connect Great Lakes offshore wind power to Hydro One's high-voltage 500 kV transmission network.
7	Intermittent solar and wind energy must be combined with energy storage to provide Ontario with 24/7 reliable power. Last year Ontario completed the largest battery storage procurement in Canada's history and obtained 1,784 megawatts (MW) of stationary battery storage. But Ontario is failing to pursue two of its lowest cost storage options, namely, our EVs' batteries and Quebec's giant hydro-electric reservoirs. It is time for Ontario to pay EV owners to provide power back to the grid when it is needed. And it is time to expand our east-west electricity grid to increase our ability to use Quebec's hydro-electric reservoirs to act like a giant battery for our solar and wind power.

Great Lakes wind power

projects should be permitted on a project-by-project basis

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