Ontario can phase out nuclear and avoid increased carbon emissions

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New research shows Ontario doesn’t really need nuclear energy, and its absence would not have an impact on emissions in the province’s energy sector. Credit: Ferdinand Stohr/Unsplash

As wind and solar energy have become cheaper, they've become a more prominent and important way to generate clean electricity in most parts of the world.

The Ontario government, on the other hand, is canceling renewable

energy projects at a reported cost of at least $230 million while reinforcing the province's reliance on nuclear power via expensive reactor refurbishment plans.

As researchers who have examined the economics of electricity generation in Ontario and elsewhere, we argue that this decision is wasteful and ill-advised, and the unnecessary cost differential will rise further in the future.

One concern about renewables has been the intermittency of these energy sources. But studies have shown it's feasible to have an all-renewable electric grid.

These feasibility studies, however, are always location specific. In that spirit, we have carried out detailed modeling and found that it's possible to meet Ontario's electricity demands throughout the year with just a combination of renewables, including hydropower, and storing electricity in batteries.

We also found that dealing with the intermittency of wind and solar energy by adding batteries would be more economical than refurbishing nuclear plants in the foreseeable future, well before the current refurbishment projects are completed.

That's because of the expected decline in the cost of batteries used to store the electricity during the hours when the wind is blowing or the sun is shining in order to supply electricity during the periods when they aren't. The cost of different kinds of battery technologies, such as lithium-ion or flow batteries, have come down rapidly in recent years.

Modelling

To explore the relative economics of nuclear and renewable energy, we

constructed a very simple model that optimized the total cost of meeting the electricity demand in Ontario for each hour of the year.

We used what's known in physics as a toy model. It's not intended to be sufficiently accurate to reproduce reality in detail, but to capture the basic and important elements of the system being studied. Our model is not meant to actually calculate the cost of supplying electricity, but only to compare the relative costs of different options, with the condition that no fossil fuels be used.

Using a software program called pypsa, we started with an example that modeled a fully renewable electricity system for European countries, and then modified it significantly. Our target was Ontario's hourly electricity demand in 2017, taken from the province's Independent Electricity System Operator, known as the IESO.

We met this demand in two ways —batteries and refurbished nuclear plants. Both cases incorporated solar energy, wind energy and hydro power from existing dams. The base costs of solar and wind were taken from a November 2018 report by the Wall Street advisory firm Lazard; the prices have since declined.

For simplicity, we assumed that the variable costs of all these technologies were zero. This actually favours the nuclear scenarios because it ignores the cost of uranium fuel and radioactive waste disposal.

The availability factors for every hour of the year for the theoretical solar and wind generators were also based on data from the IESO on actual production of solar and wind energy in Ontario in 2017.

The maximum power available from large hydropower dams during any hour of the year was assumed to be less than 85 percent of the installed

capacity within Ontario of 9,065 megawatts; this is a conservative assumption since the province could easily import more hydropower from neighboring Québec.

We ran a large number of scenarios with multiple cost and other assumptions and derived fairly robust results.

Essential results

In all scenarios, the bulk of the demand was met by solar and wind power, with a lower fraction met by hydropower. Even in the scenarios with no batteries, less than 20 percent of the electricity demand was met by nuclear power.

Second, it would be cheaper to reduce this even further. Because of safety and other operational reasons, it's a bad idea to change the outputs of nuclear plants quickly. Traditionally, reactor outputs have been held steady.

But if, for argument's sake, we allow the outputs of nuclear reactors to go up and down as fast as needed by the grid, then our model predicts that nuclear power plants would be used even less. If nuclear power plants outputs are held steady, then they would supply more electricity, but the cost to consumers would also be higher.

Finally, and perhaps most consequentially, if the costs of batteries decline from current levels to those projected for 2025, then the cost of supplying electricity using a combination of renewables and battery storage would become cheaper than doing the same using nuclear power.

The cost of meeting the electricity needs for the province could be further reduced if the availability of hydropower is increased.

Our choice of 2025 for the projection year, incidentally, is guided by the fact that the current use of modern renewables in Ontario is low, and there will be no need for batteries to store electricity until there is a dramatic increase in the wind or solar power projects constructed. The levels of renewables that will require storage are unlikely to be reached before 2025.

In summary, our results show that for reasonable assumptions about future battery costs and the current price tag for solar and wind power, scenarios involving nuclear power are more than 20 percent higher than the cheapest scenario involving only batteries, solar, wind and the current hydropower capacity.

If an extra 2,000 megawatts of hydropower capacity were to be available, scenarios involving nuclear power would be over 30 percent more expensive.

That means, simply put, that nuclear power isn't needed to meet Ontario's electricity needs. And the absence of nuclear power won't have any impact on emissions in Ontario's energy sector.

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