IMPACT ON THE ELECTRICITY SYSTEM

QUESTION 7

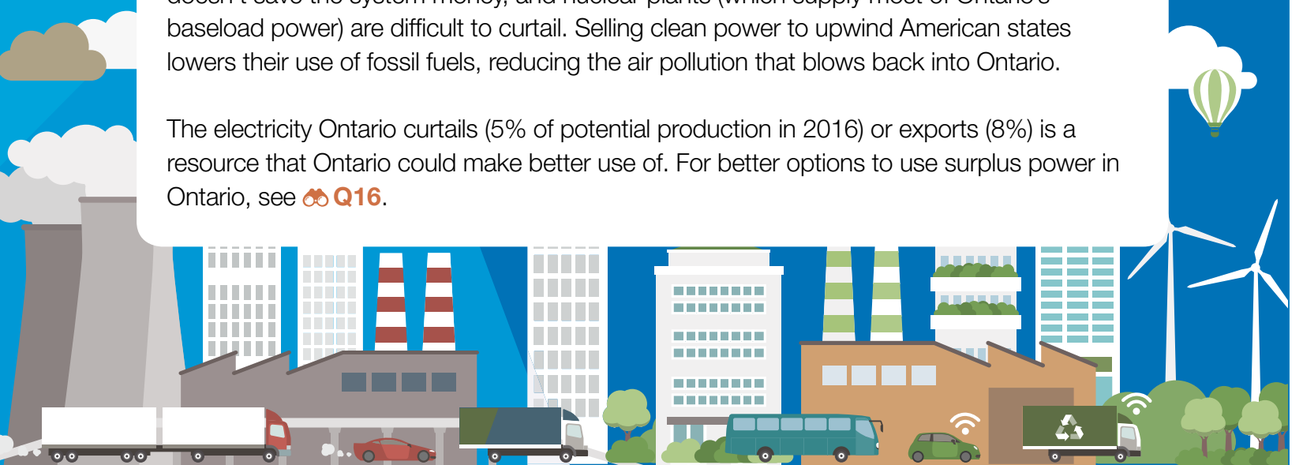
Why does Ontario export and curtail so much electricity?

At times of low demand, Ontario has surplus low-carbon electricity that cannot currently stored, and must be used or lost. The province saves money by selling part of the surplus.

Ontario's nuclear plants usually produce electricity 24 hours a day, because they cost about the same to operate whether they are producing power or not. And for many of our renewable resources, if electricity is not generated when the wind, sun, or water is available, that potential power is lost forever. Most of the time, these "baseload" resources such as nuclear and hydro are used productively to make low-emission electricity for Ontarians. However, Ontario power demand has huge swings, and some industries that used to require round-the-clock electricity no longer do. At times of peak demand, the province may have barely enough power. At times of low demand, Ontario has surplus electricity.

To get these resources built, Ontario accepted legal obligations to pay for the surplus electricity, even when it's not needed. What should the province do with the surplus power? Because current electrical storage capacity is limited, there have been only two choices: sell what we can to neighbouring jurisdictions at the market price, or "curtail" production (waste the power that could have been produced). It makes financial sense to sell power where possible, as long as exports recover more than their marginal costs. Curtailment doesn't save the system money, and nuclear plants (which supply most of Ontario's baseload power) are difficult to curtail. Selling clean power to upwind American states lowers their use of fossil fuels, reducing the air pollution that blows back into Ontario.

The electricity Ontario curtails (5% of potential production in 2016) or exports (8%) is a resource that Ontario could make better use of. For better options to use surplus power in Ontario, see Q16.



Contents

The details…

Q7

Surplus occurs when electricity production from baseload facilities is greater than the province's demand.

Introduction

Q2 of this report discusses the "top down" central approach that the province has taken since 2004 to plan Ontario's electricity system. To ensure that we have enough power for peak needs, this process has committed Ontario to paying for more power than we need when demand is low. In this chapter, the ECO analyzes how much surplus (unwanted) electricity the province is paying for and what it does with it.

What is surplus baseload generation?

- **Baseload generation** is the amount of electricity available at any given time from resources where the electricity production must be used or lost – primarily nuclear, hydro (in excess of dam storage capacity), and intermittent renewables such as wind and solar.[1]
- **Surplus baseload generation** (SBG) occurs when electricity production from baseload facilities is greater than the province's demand.[2] The excess electricity must be exported or curtailed (wasted).

The amount of surplus baseload generation has increased in recent years, and is tracked by the Independent Electricity System Operator (IESO). Figure 7.1 shows conceptually how the amount of surplus baseload generation in the province varies depending on the time of day and year, by comparing a mild spring week (when there is a large surplus) and a hot summer week (when there is very little surplus).

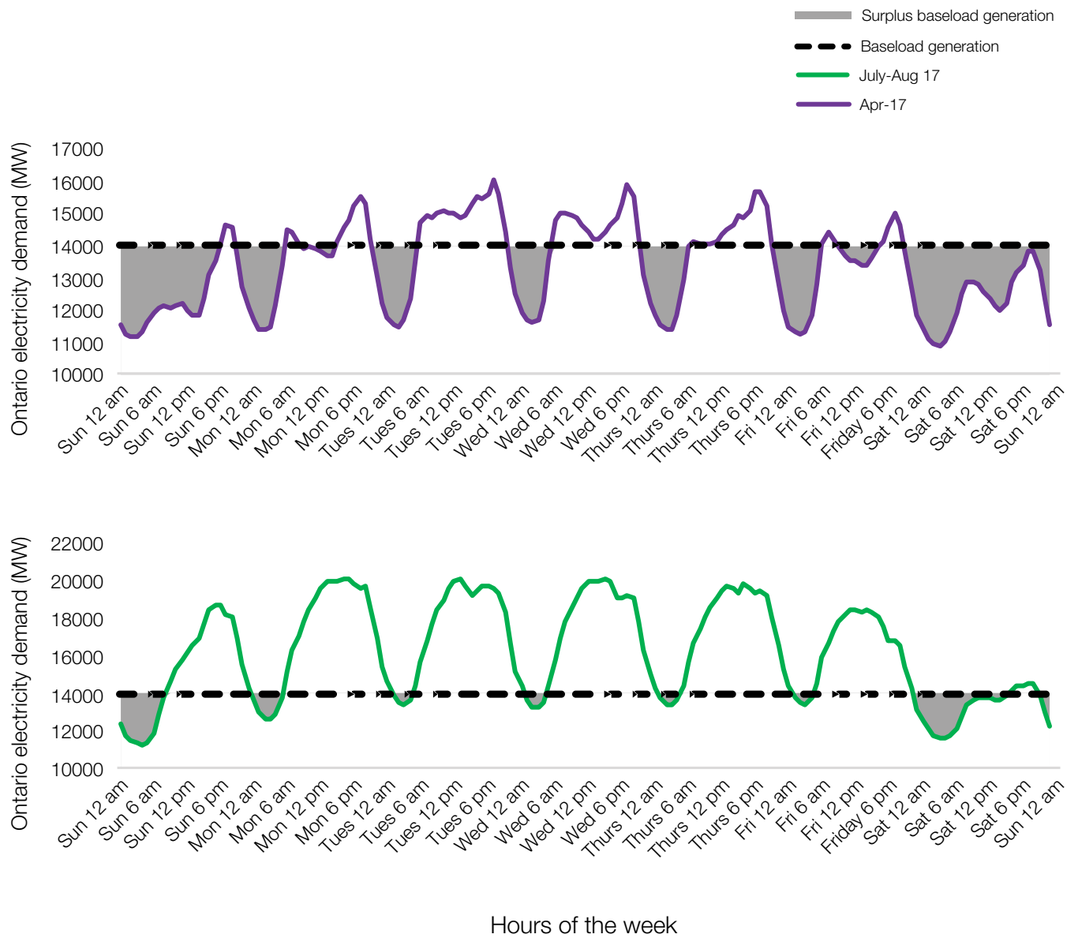


Figure 7.1. Surplus baseload generation, April 2017 and July-August 2017 (Ontario).

Note: The baseload generation line is an average estimated based on the IESO's latest 18-Month Outlook and does not represent actual baseload generation during the times represented in the graph.

Source: "Hourly Market and Actual Demand Data 2002-2017" online: Independent Electricity System Operator <www.ieso.ca/-/media/files/ieso/power-data/data-directory/hourlydemands_2002-2017.csv?la=en> [Accessed 6 March 2018].

Baseload generation has increased primarily due to two nuclear units.

Why does Ontario have surplus baseload generation?

Two factors contribute to surplus baseload generation – the amount of baseload generation, and Ontario's minimum demand.

Baseload generation has increased in recent years. This is primarily due to the return to service of two nuclear units at Bruce in 2012 that added roughly 1,500 MW of baseload generation in most hours. As well, more wind and solar facilities were brought into service, which add a varying amount of generation that can be high, depending on wind and sun conditions. At times, new generation was required to be in service before scheduled nuclear refurbishments to ensure the reliability of the grid.

Just as important is Ontario's minimum demand for electricity. Surplus baseload generation usually occurs on weekends or overnight hours when Ontario's need for electricity is low, particularly in the spring and fall. Ontario electricity use at these times can be less than half of electricity use in peak hours. Ontario's minimum demand has dropped by about 1,500 MW since 2005.[3] The drop in industrial electricity use, which provides a steady demand for around-the-clock power, is a key reason. The province did not anticipate the loss in industrial demand.Conservation and efficiency programs have also played a contributing role, as some conservation programs will reduce electricity demand in all hours. Changes in demand patterns are discussed in more detail in Q3.

Surplus baseload generation is to a large extent a growing pain associated with the transition to a low-carbon electricity system. With a few exceptions, Ontario's low-carbon electricity resources do not have a lot of ability to adjust the timing of their electricity production. Shutting down and powering up a nuclear generation plant is cumbersome and expensive. Wind and solar generation is intermittent in nature – it is easy to turn power production down if the energy is not needed, but the power that could have been produced at that moment is then lost forever. The same applies to hydro generation that is spilled.

Some renewable resources do offer flexibility, particularly waterpower where there are dams, and the pumped storage facility at Niagara. The Niagara Beck Pump Generating Station is capable of pumping 680,000 liters of water per second. It can fill a 300 hectare reservoir in about 8 hours, that can then be used for power production.[4] In addition, biomass used at the Thunder Bay and Atikokan generating stations in Ontario that previously ran on coal, can provide flexibility, but at a high cost.

The gap between Ontario's minimum and peak demand can be up to 12,000 MW. The bulk of this gap used to be filled by coal and gas. These resources were flexible in meeting demand changes, but at the cost of high greenhouse gas emissions and air pollution. Eliminating coal and minimizing the use of gas will require increasing the flexibility of our electricity system, and solutions are explored in Q16. There is no instant solution. Now let's take a look at what Ontario currently does with this surplus electricity.

Ontario's minimum demand has dropped.

How much surplus electricity does Ontario have and what is done with it?

13.2% of Ontario's power production was surplus (exported or curtailed) in 2016 (see Figure 7.4). The number will probably be higher in 2017.

Figure 7.2 presents the number of hours in which some of the electricity generated was surplus to Ontario requirements, year by year since 2011. Note that the number of hours in which surplus baseload generation exists (more than 50% of hours in 4 of the past 5 years) does not represent the amount of surplus electricity, as most of the electricity produced in these hours is still used productively in Ontario

13.2% of Ontario's power production was surplus (exported or curtailed) in 2016.

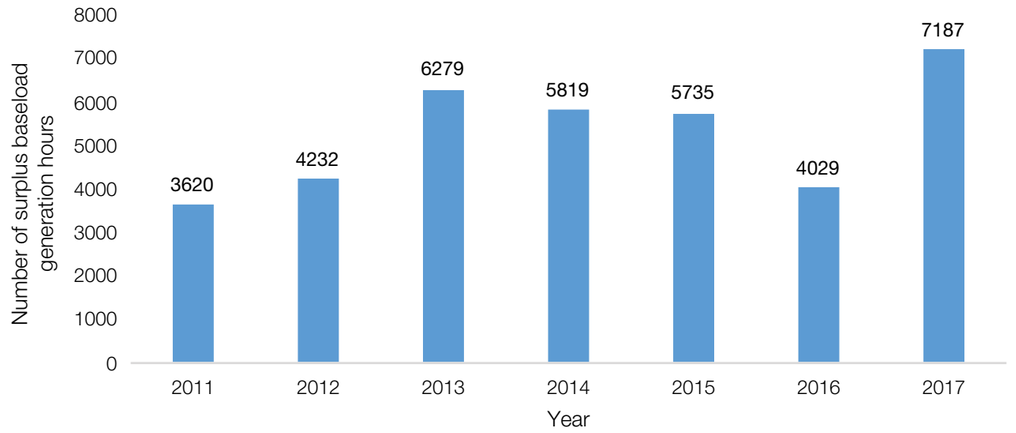


Figure 7.2. Number of surplus baseload generation hours, 2011-2017 (Ontario).

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (5 March 2018).

At times of surplus, the average hourly Ontario electricity price (HOEP) will be low, zero or even negative. This leads to two possible consequences, which often occur in combination:

1. electricity exports to other jurisdictions will increase, when the Ontario price falls lower than the price of supply in these other locations; and /or
2. generators in Ontario will be required to shut down (curtail) production.

Figure 7.3 shows that more of the surplus electricity is exported, less is curtailed.

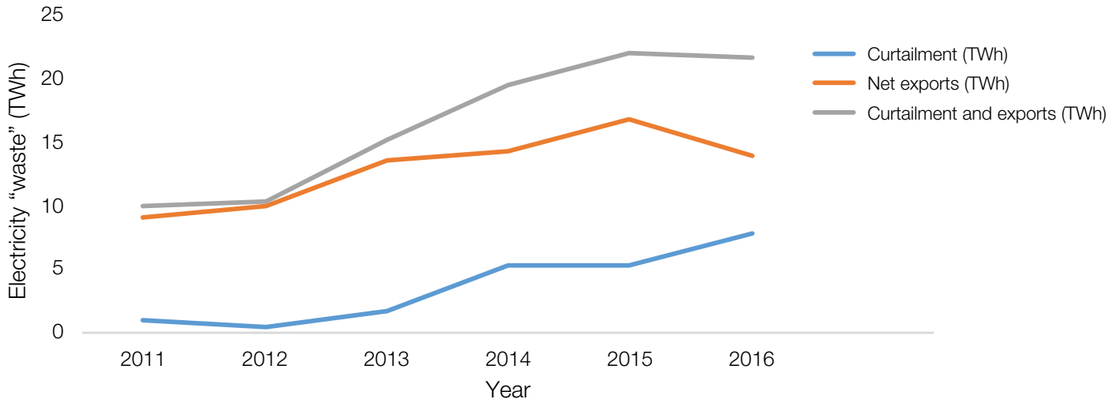


Figure 7.3. Ontario electricity export (net) and curtailment trends 2011-2016.

Note: Complete data only available until end of 2016.

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (31 January 2018); Ontario Power Generation, information provided in response to ECO inquiry (6 February 2018).

Figure 7.4 shows the amount of electricity that was exported and curtailed in proportion to total electricity production.

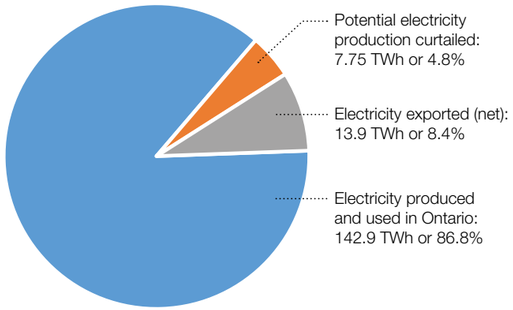


Figure 7.4. Electricity export and curtailment proportionate to total production in 2016.

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (31 January 2018); Ontario Power Generation, information provided in response to ECO inquiry (6 February 2018).

Ontario is a net exporter of electricity

The province has been a net exporter of electricity since 2005.[5] The gap between exports and imports have widened in recent years, as presented in Figure 7.5, largely due to increased exports at times of surplus baseload generation.[6] Exports increase when the province has surplus low marginal cost, low-carbon electricity compared to interconnected systems such as New York and Michigan, whose gas generation burns fuel and therefore typically has a higher marginal cost than Ontario's nuclear/ renewables.[7] The province sometimes also exports natural gas generated electricity when Ontario has power to spare and prices are higher in other jurisdictions.[8]

Figure 7.5. Import and export trends in Ontario 1997-2016.

Source: "Imports and Exports", online: Independent Electricity System Operator <www.ieso.ca/power-data/supply-overview/imports-and-exports>. [Accessed 6 March 2018]

Does Ontario make money or lose money exporting electricity?

Ontario sells its surplus power to other jurisdictions for more than it costs to make that power. So why do people sometimes say that Ontario sells surplus power at a loss? Because of confusion between the cost to have something available and the cost to use it on a particular occasion. Economists call this the difference between average and marginal costs.

Ontario sells its surplus power for more than it costs to make that power.

Do we sell surplus power at a loss? No, we don't

To understand the difference between average and marginal costs, consider a family car. The Canadian Automotive Association estimates that the annual cost of driving a compact car in Ontario is about $7,500. This is based on 20,000 km of driving per year, and keeping the car for five years. The $7,500 includes your monthly car payments, insurance, maintenance, and license and registration, which are relatively fixed costs that don't change if the car is driven a little more or less. The average cost of driving works out to be $38 per 100 kilometers.[9] About $8 of that is for fuel.

Now imagine that your friend (a very good driver) asks to borrow your car for occasional errands, at night when you are not using it. The friend offers to pay you $20 to drive your car for each 100 km trip. Do you lose money by letting your friend use your car?

It is a good deal for your friend, but it's a good deal for you too. The $20 that your friend is offering is less than $38, which is your average cost to drive 100 km. But the extra (or marginal) cost to you if your car is driven an extra 100 km is only about $8, so you would make an extra $12 per trip.

That is essentially what Ontario does when we export surplus power. If you average the cost of the entire power system over every kWh generated in a year, it might look as if Ontario is exporting power at a loss. But this is misleading. Ontario has to pay all the fixed costs of our electricity system anyway, just to have power available for ourselves when we want it. The surplus power that we export costs us little or nothing extra on top of the fixed costs, because:

- Our renewable power has extremely low operating costs; and
- Our nuclear plants cost virtually the same whether they are making power or not.

So, because importing jurisdictions pay us more than the very small amount it costs to make the specific surplus power that we export, both importer and exporter end up ahead.

To calculate the "average unit cost" of Ontario electricity, one divides the total costs of Ontario's electricity system by total Ontario electricity demand. As Figure 7.6 shows, surplus power is exported for less than this **average** annual cost.[10] As in the case of the family car, this makes financial sense because the surplus power is exported for more than the marginal cost to us of producing it.

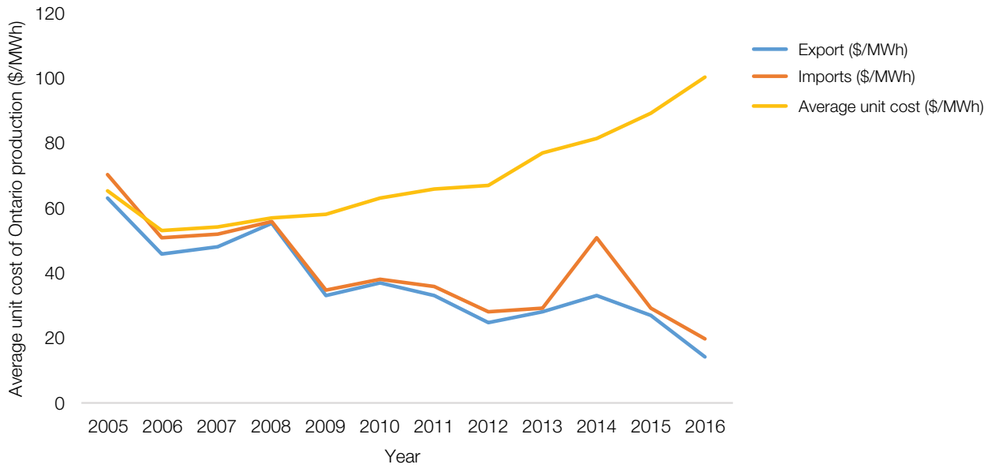


Figure 7.6. Unit cost comparison of average unit cost of producing electricity vs. average export price.

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018).

In other words, Ontario exports electricity at a lower price than Ontario customers usually pay, because Ontario must cover the total costs of its electricity system, while exports need only make more than the marginal costs of the surplus power.

The way this works in the electricity market is that surplus power is exported without the Global Adjustment. The generation component of the electricity price paid by Ontario residential and business customers includes two elements- the Hourly Ontario Electricity Price (HOEP) and the Global Adjustment (GA). The Global Adjustment's share of the generation cost has risen in recent years, to about 85% in 2016, because Ontario has so much generation (nuclear and renewables) with very low marginal costs.[11] The HOEP, the wholesale price of electricity, is determined by the real-time market demand and supply of electricity in the market. When the market has surplus generation with low marginal costs, supply far exceeds demand and the HOEP decreases and can even become zero or negative. When the HOEP is lower than the marginal cost of generation in other jurisdictions, Ontario can sell surplus electricity to its neighbours. Ontario's neighbours pay only the HOEP and are not charged the Global Adjustment.[12] See $ Q9 for more details on electricity price changes.

Ontario must cover the total costs of its electricity system, while exports need only make more than the marginal costs.

Why doesn't the export price of electricity include the Global Adjustment?

Why aren't export customers charged the Global Adjustment (GA), which is included in all Ontarians' electricity rates? The GA makes up the difference between the price that generators with long-term contracts or regulated rates must be paid, and the (lower) energy market price (see Q9 for more details). These costs were incurred to build the electricity infrastructure for Ontario's needs (e.g., to meet the province's capacity needs and to ensure its reliability, and to support Ontario's environmental and economic development objectives). Ontario has first call on its electricity–when required, electricity exports are interrupted to meet provincial needs.[13] Since exports are not backed by firm capacity, export prices do not include the Global Adjustment.[14]

Charging the Global Adjustment on exports would not reduce costs for Ontarians anyway. Export levels are highly sensitive to price changes since transactions occur at the marginal price.[15] An increase of export prices (either changing the Export Transmission Service tariff or adding all or a portion of the GA) would likely dramatically cut export levels, although the IESO has not done a recent analysis specific to Ontario's current circumstances.[16] This would mean that Ontario would not earn the export revenue it does today which offsets that would otherwise be added to the GA. In addition, the province may have to find more expensive alternatives to reduce its electricity surplus, such as shutting down nuclear units for several days at a time.

In total, exports contributed $236 million in 2016 towards reducing Ontario's electricity system costs.

As long as Ontario sells surplus electricity for more than its marginal cost, exporting power is a financial benefit for the province. Since 2005, net revenue from exports have totalled close to $8 billion.[17] Without exports, much of this amount would have been added to Ontario electricity costs.

Very occasionally, the HOEP is negative and other jurisdictions are paid to briefly take Ontario's electricity, in order to avoid larger curtailment costs. Such negative HOEP payments are very small–about $3 million in 2016, in comparison to net export revenue during the same year of $576 million.[18] In total, exports contributed $236 million in 2016 towards reducing Ontario's electricity system costs, i.e., towards reducing the GA.[19]

Globally, there are environmental benefits from exporting surplus electricity instead of curtailing Ontario production, as it will often be displacing fossil-fuelled generation in Michigan and New York, the primary destinations for Ontario exports.

Curtailment or "waste" of electricity

Dispatching electricity generation facilities down or off, known as curtailment, results in spilling water at hydroelectric stations, bypassing steam around turbines at nuclear facilities (or shutting production down entirely), and turning down or off grid-connected renewable resources such as wind and solar. In these cases, potential electricity production with zero marginal cost goes unused or is "wasted".[20] A small amount of gas-fired generation from non-utility generators (NUGs) also used to be curtailed.[21]

Figure 7.7 details the amount of electricity curtailed by the province by generation source since 2011.

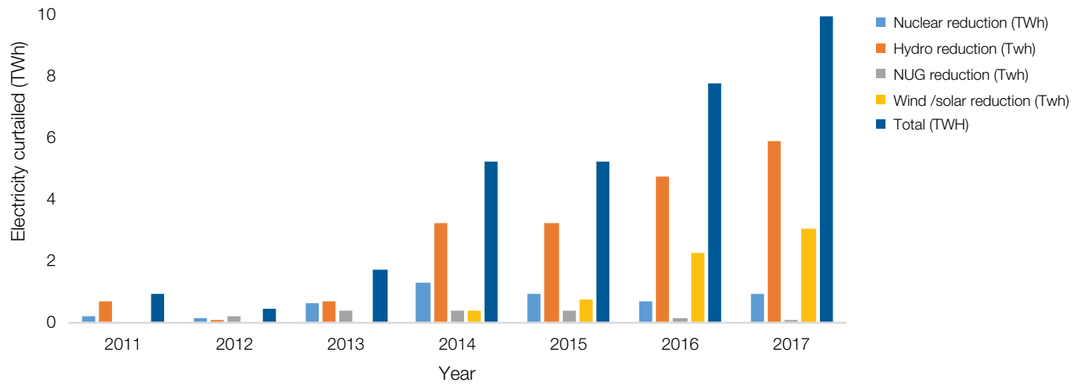


Figure 7.7. Electricity curtailment in Ontario by generation source, 2011-2017.

Note: All 2017 data except the hydro (provided by OPG) is until November 2017. Wind/solar curtailments began after 2013. NUGs are gas-fired non-utility generators.

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (31 January 2018); Ontario Power Generation, information provided in response to ECO inquiry (6 February 2018).

Curtailment occurs in response to market price signals. Generators of all types are typically compensated for curtailed production, so the order of curtailment does not greatly affect generators.[22] Figure 7.8 represents the total amount of curtailment by year paid by the IESO to generators to date.

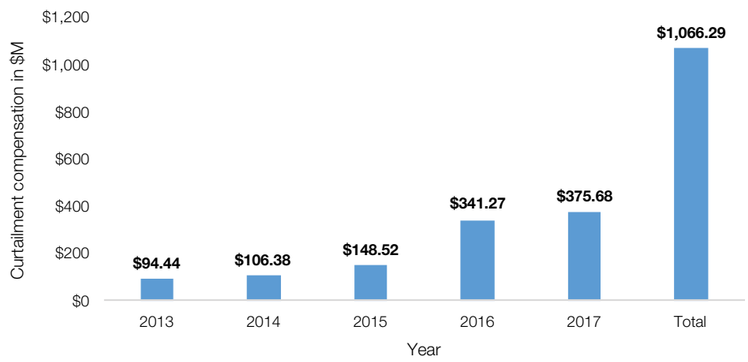


Figure 7.8. Curtailment payments to generators 2013-2017 (Ontario).

Note: IESO only provided the curtailment dollars in aggregate by year and did not break down by payments to specific generators.

Wind and solar curtailments began in 2013. Compensation for curtailments is specific to IESO-Administered Contracts, and is inclusive of Nuclear SBG, Hydro SBG, and Wind and Solar curtailments. These payments do not include adjustments for surplus generation for Ontario Power Generation assets regulated by the Ontario Energy Board. 2017 compensation values are only until September 2017.

Source: Independent Electricity System Operator, information provided in response to ECO inquiry (31 January 2018).

In the current market, when there is a surplus of electricity, hydro is typically shut down first, followed by wind/solar, and then nuclear.[23] When the HOEP falls below the Gross Revenue Charge (tax), OPG, which owns and operates most of the province's hydroelectric generation stations, spills some of the water instead of generating electricity. OPG's ability to spill water depends on other factors, including water levels, public safety requirements, and other regulatory restrictions.[24] As Figure 7.9 shows, there was a spike in hydro spill in 2016, in part because of higher water flows.[25]

Apart from spilling water, the IESO also has options to reduce renewable generation (mostly wind) and nuclear generation. For operating reasons, wind production is usually curtailed before nuclear.

Nuclear reductions can be achieved in two ways – bypassing the steam around the turbines in a closed loop, or completely shutting down a reactor. If a reactor needs to be shut down completely, it must remain offline for 48 to 96 hours.[26] Bypassing steam is more flexible, but operating units can still only be reduced in large blocks of 300 MW at a time and not for sustained periods of time. This means that additional generation, from potentially more expensive and GHG-emitting gas-fired generation, could need to be called upon to make up the smaller differences.[27]

As renewables are more flexible (quicker to respond, i.e., dispatchable at 5-minute intervals; and able to adjust their power output in smaller increments), wind is dispatched down before the province considers ramping down nuclear generation.[28] This has only been possible since 2013.[29] Since then, wind curtailment has proven to be a flexible and effective measure to respond to surplus conditions, as well as for reliability

The IESO's preferential curtailment of wind power makes wind power look more expensive than it really is .

events on the system. With these changes, the IESO is not only able to minimize electricity waste, but also to avoid ramping up gas generation plants.[30]

The IESO's ability to dispatch wind (and a subsequent rule change that prioritizes wind dispatch above steam bypass at nuclear units)[31] is responsible for the differing curtailment trends for nuclear and wind in recent years, with nuclear curtailment falling slightly since 2014, and wind curtailment increasing dramatically, by more than 200% between 2015 and 2016.[32]

What does the future hold for surplus power?

The IESO's latest 18-Month Outlook predicts that the province's current surplus will continue in the near to medium-term. The IESO expects that the magnitude and frequency of the surplus will be reduced, at least temporarily, by the nuclear refurbishment that began in 2016, which will remove a large amount of baseload generation from service.[33] Longer-term, the amount of surplus will depend upon the choices we make for our energy system.

What is clear is that the current surplus means a lot of clean energy is going to waste. Figure 7.9 shows the curtailment of wind, nuclear and hydro generation in

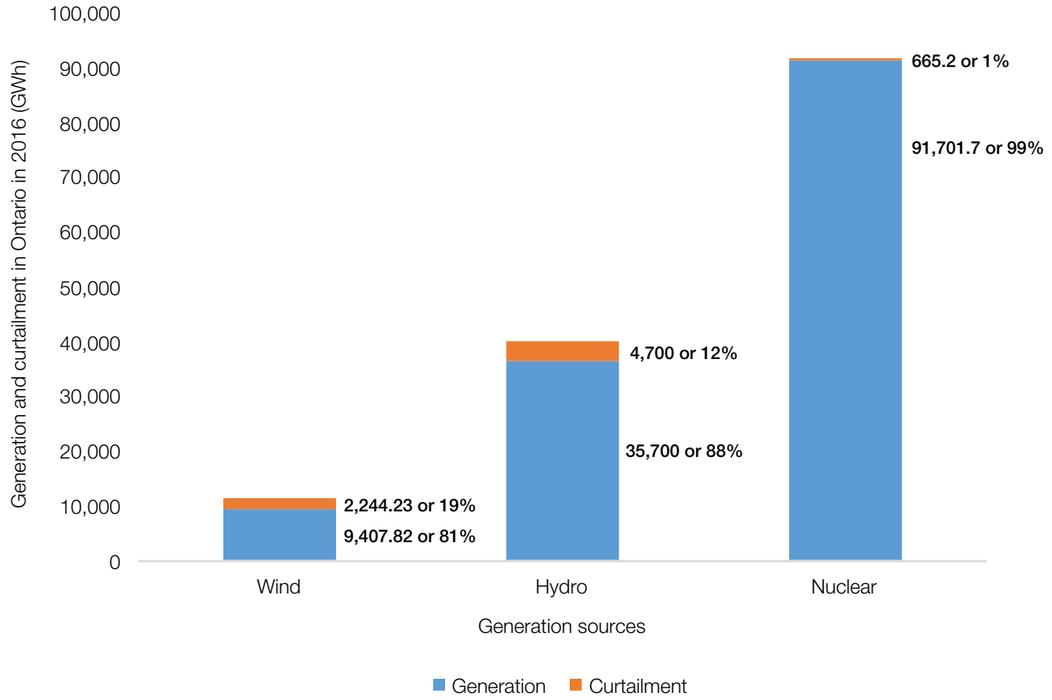


Figure 7.9. Curtailment as a share of Ontario's grid-connected production for wind, hydro and nuclear generation in 2016.

Source: "IESO year end data", online: Independent Electricity System Operator <www.ieso.ca/corporate-ieso/media/year-end-data> [Accessed 5 March2018];"Financial Reports", online: Ontario Power Generation <www.opg.com/about/finance/pages/financial-reports.aspx> [Accessed 5 March 2018]; Ontario Power Generation, information provided in response to ECO inquiry (6 February 2018).

2016. The large curtailment of wind power (about 19% of potential production in 2016) has a noticeable effect on the reported cost of Ontario wind power, since curtailed power is excluded from IESO calculations of unit costs. In other words, the IESO's preferential curtailment of wind power makes wind power look more expensive than it really is (See $ Q9).

Are there better uses for this excess electricity, ones that Ontarians can take advantage of in the short and long run? In Q16, the ECO discusses some innovative measures to make use of surplus electricity, including storage, electric vehicles, innovative pricing policies, and power-to-gas technology.

Endnotes

1. The IESO's official definition of baseload generation comprises of available nuclear energy, must-run hydroelectric generation, self-scheduling, commissioning, intermittent and variable (including wind and solar) generators. "Self-scheduling" generators include some gas-fired facilities. ("Forecast Surplus Baseload Generation", online: Independent Electricity System Operator <www.ieso.ca/weather/mkt4/sbg/SurplusBaseloadGen_h3.pdf> [Accessed 7 March 2018]).
2. Exports are not included in the Surplus Baseload Forecast. However, a separate assessment forecasts how much SBG can be addressed through exports.
3. Independent Electricity System Operator, "Module 1: State of the Electricity System: 10-Year Review" (presentation, August 2016) slide 8.
4. OPG did not provide the quantitative measure of reservoir capacities because the data is commercially sensitive. While Beck has a theoretical storage capacity, actual storage is based on market conditions and also on hydrological conditions at Beck (Ontario Power Generation, information in response to ECO inquiry (6 February 2018)).
5. Independent Electricity System Operator, "Module 1: State of the Electricity System: 10-Year Review" (presentation, August 2016) slide 24.
6. In its 2017 report, the Ontario Society of Professional Engineers presented a methodology to differentiate between total electricity exports and clean electricity exports. The OSPE analyzed electricity load over a 21-month period, and concluded that after considering 900 MW of daily generation as gas (for system flexibility) and the rest of the generation that was consumed in the province, the rest of the generation that was exported was clean generation. Any additional gas generation was also exported but of course did not fall in the category of clean exports. The OSPE used this analysis to argue that the majority of Ontario's exports are clean generation which can be used more effectively within the province. (Ontario Society of Professional Engineers, Empower Ontario's Engineers to Obtain Opportunity, An Analysis of Ontario's Clean Electricity Exports (Toronto: OSPE, November 2017) at 7.)
7. Ibid, at 6.
8. Ibid.
9. "Driving Costs Calculator", online: Canadian Auto Association <www.caa.ca/carcosts/compare>. [Accessed 5 March 2018]
10. The Province may also sell power generated by gas peaking plants during hours of peak demand.
11. "Global Adjustment", online: Independent Electricity System Operator <www.ieso.ca/power-data/price-overview/global-adjustment>. [Accessed 5 March 2018]
12. Exports actually pay the Zonal Clearing Price, which can differ from the HOEP if an intertie is congested. (Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018).)
13. Ontario Society of Professional Engineers, Empower Ontario's Engineers to Obtain Opportunity, An Analysis of Ontario's Clean Electricity Exports (Toronto: OSPE, November 2017) at 8.
14. An exception where firm rights exist regarding access to exports is the Ontario-Quebec agreement which grants Quebec a firm right to 500 MW of Ontario power in the winter.The IESO has also been investigating firm capacity exports of Ontario power to other jurisdictions on a short-term basis, in cases where the generation is not needed for Ontario's reliability. As firm exports are more valuable to the importing jurisdiction, this could allow Ontario generators to earn extra revenue from the export market that would then not need to be recovered from Ontario customers. "Market Renewal – Capacity Exports", online: Independent Electricity System Operator <www.ieso.ca/en/sector-participants/market-renewal/capacity-exports>.[Accessed 9 March 2018]
15. Independent Electricity System Operator, Export Transmission Service (ETS) Tariff Study by Charles River Associates (Toronto: IESO, May 2012) at 5.
16. Ibid, at 44; Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018).
17. Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018).

Year	Export Revenue ($M)
2005	664
2006	557
2007	633
2008	1,296
2009	324
2010	629
2011	484
2012	441
2013	582
2014	721
2015	682
2016	576
2017 (Until October)	430
Total	8,019

18. Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018).
19. Of that, exports in all hours paid approximately $19 million towards market uplifts and $40 million towards transmission charges. The balance of $177 million is from exports during off-peak. Independent Electricity System Operator, information provided in response to ECO inquiry (5 March 2018).
20. "Surplus Baseload Generation in Ontario", online: Environmental Commissioner of Ontario <eco.on.ca/blog/surplus-baseload-electricity-generation-in-ontario/>. [Accessed 5 March 2018]
21. These generators are "self-scheduling" and cannot be dispatched by the IESO through the electricity market, so out-of market actions have been taken. Ideally, these would be the first generators curtailed in times of surplus, as their operations burn fuel and emit greenhouse gases. NUG curtailment has dropped to almost zero in recent years, presumably because NUGs are no longer contributing to SBG, as contracts have expired or been renegotiated to make these generators dispatchable. (Independent Electricity System Operator, information provided in response to ECO inquiry (12 January 2018)).
22. Any financial losses accrued by OPG from these hydro spills is mitigated by the Hydroelectric Surplus Baseload Generation Variance Account that was authorized by the Ontario Energy Board (OEB) for all of OPG's regulated hydroelectric generation stations in 2011 to capture the financial impacts of foregone production (Ontario Power Generation, 2015 Annual Report (Toronto: OPG, 2016) at 69). OPG's latest financial statements (to date) state that the variance account currently has a positive balance of $210 million dollars, an increase of 85% from the same time the year before. The increase in the variance account includes interest and subtracts amortization as well (Ontario Power Generation, Consolidated Financial Statements (Toronto: OPG, 31 December 2016) at 26).
23. Ontario Power Generation, Management's Discussion and Analysis (Toronto: OPG, 31 December 2016) at 8; Ontario Power Generation, information provided in response to ECO inquiry (6 February 2018).
24. Independent Electricity System Operator, Dispatch Order for Baseload Generation: A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration) (IESO: Toronto, 2 November 2011) at 11.
25. The report also notes that in 2016, the province's export options were limited due to transmission constraints in the state of New York. The same report (at 18) anticipates a declining trend in hydro spill in the coming years due to the reduced nuclear availability with the refurbishments at Darlington and Bruce and the shutdown at Pickering (Ontario Power Generation, 2015 Annual Report (Toronto: OPG, 2016) at 69.)
26. Independent Electricity System Operator, Dispatch Order for Baseload Generation: A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration) (IESO: Toronto, 2 November 2011) at 9.
27. Independent Electricity System Operator, "Floor Price Review, Overview of Engagement" (Presentation, July 2015) slide 10.
28. This is achieved by an IESO rule setting different minimum offer prices for nuclear and wind generation. The minimum offer price for wind is higher than nuclear, which means that as the wholesale electricity price falls in times of surplus, it will fall below the wind offer price first, causing wind to be dispatched down.
29. Prior to this, the IESO did not have the ability to dispatch wind, as discussed in Q6. ("Year End Data", online: Independent Electricity System Operator <www.ieso.ca/corporate-ieso/media/year-end-data>. [Accessed 5 March 2018])
30. "Surplus Baseload Generation in Ontario", online: Environmental Commissioner of Ontario <eco.on.ca/blog/surplus-baseload-electricity-generation-in-ontario/>. [Accessed 5 March 2018]
31. This rule change set the minimum offer price for wind above the minimum offer price for steam bypassing at nuclear facilities, meaning that wind curtailment would occur prior to steam bypassing ("Floor Price Review", online: Independent Electricity System Operator <www.ieso.ca/sector-participants/engagement-initiatives/engagements/completed/floor-price-review>. [Accessed 5 March 2018])
32. 0.73 TWh of renewables were curtailed in 2015; in 2016 the amount was 2.24 TWh ("Year End Data", online: Independent Electricity System Operator <www.ieso.ca/corporate-ieso/media/year-end-data>. [Accessed 5 March 2018])
33. The report states that the system will be balanced during SBG conditions using market mechanisms such as inter-tie scheduling, dispatching (curtailment) of hydroelectric and renewable generation, nuclear manoeuvering or shutdown, import cuts (which is rare) and curtailment of linked wheels as and when needed.(Independent Electricity System Operator, 18-Month Outlook: An Assessment of the Reliability and Operability of the Ontario Electricity System, From January 2018 to June 2019 (Toronto: IESO, December 2017) at 29-31.)

Why does Ontario export and curtail so much electricity?
Q7