Replacing Pickering:

The Next Step in the GTA's Clean Energy Transition

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About

Pollution Probe is a national, not-for-profit, charitable organization that exists to improve the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.

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Part 1 The Problem

1.1 Overview

In 2010, the Ontario government announced the planned closure of the Pickering Nuclear Generating Station (NGS), judging the cost to refurbish the stations to be prohibitive. Yet, nearly a decade after deciding to close Pickering, there is still no plan for replacing it with non-emitting solutions. This problem will be made worse by the overlapping nuclear refurbishment of two 900 MW Darlington units and two 825 MW Bruce units in 2022 as well.

Based on forecasts by the Independent Electricity System Operator (IESO), it is expected that increased natural gas-fired generation will replace the energy services that Pickering currently provides, leading to an increase in approximately 10-15 TWh of natural gas generation per year. The GHG emissions for the province associated with the additional 10 TWh of gas-fired generation per year would be about an additional 4.5 Mt CO_2eq a year. With Pickering's output heavily supplying the GTA, the GTA's share of the increase in provincial gas-fired generation due to the closure is about 50%, roughly 2.25 Mt.[1]

While the Greater Toronto Area (GTA) cannot and should not go alone, given its high share of provincial demand the people in the region will need to take more responsibility for their energy and in deploying non-emitting solutions. At the same time, provincial policy, market and regulatory barriers are limiting the potential for the region to implement non-emitting solutions that could help replace Pickering while retaining Ontario's clean electricity grid. This also reduces the other numerous benefits to the region from deploying new non-emitting solutions, such as lower costs, resiliency and economic development.

1. For more information on calculations and Toronto's share, see Appendix A: Technical summary. From this point forward, the unit 'Mt CO_s eq' will be expressed as 'Mt.'

1.2 The role of Pickering in Ontario's electricity supply

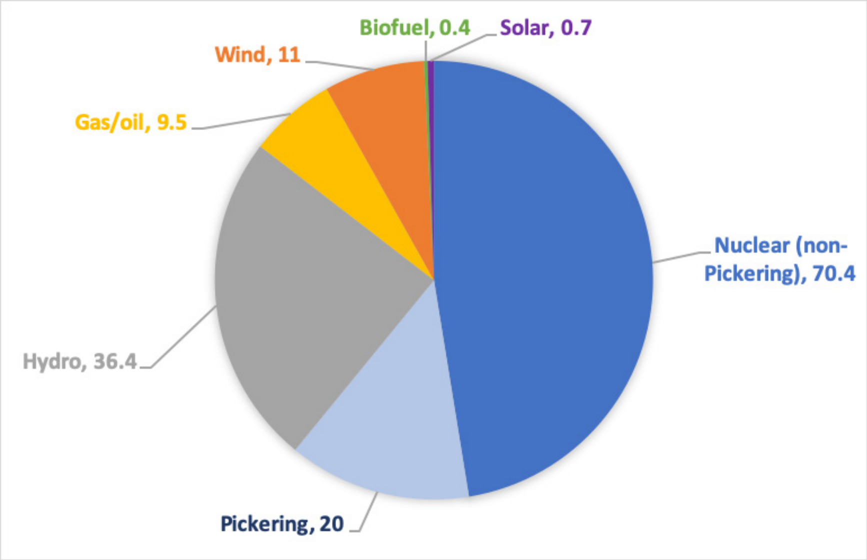
Located within the GTA, the Pickering NGS has been a key provider of zero-emissions electricity to Toronto and the surrounding area since it first went into operation in 1971. Originally the plant consisted of eight reactors, but four of them were shut down in 1997 and only two were refurbished and put back online between 2003 and 2005. Currently there are six operating reactors, two units generating 515 MW each and four units generating 516 MW each.

In 2010, the Ontario government announced the planned closure of Pickering, judging the cost to refurbish the stations to be prohibitive. The government and Ontario Power Generation (OPG) have now committed to closing the two Pickering "A" reactors in 2022 (~1,000 MW) and the four Pickering "B" reactors in 2024 (~2,000 MW). The government has recently said it would look into extending the Pickering A reactors to 2024 and the Pickering B reactors to 2025. That will mean that the plant will be retired in 2025, rather than 2024, if OPG receives regulatory permission for the extensions.[2]

The six operating Pickering reactors provide roughly 3,000 MW of capacity, generating approximately 20 TWh of electricity annually. At peak periods, Pickering displaces gas-fired generation with about a quarter of its output.[3] As Ontario currently has surplus baseload generation, not all of Pickering's output will be required. We estimate that 10 TWh of additional generation will be required to replace Pickering.[4]

Ontario's electricity grid is fueled by a mix of different resources. Figure 1 shows Ontario's 2019 transmission-connected generation output by fuel type. It's important to note that Ontario has a very clean electricity grid, with on average 94-95% of power being generated by non-emitting sources.[5]

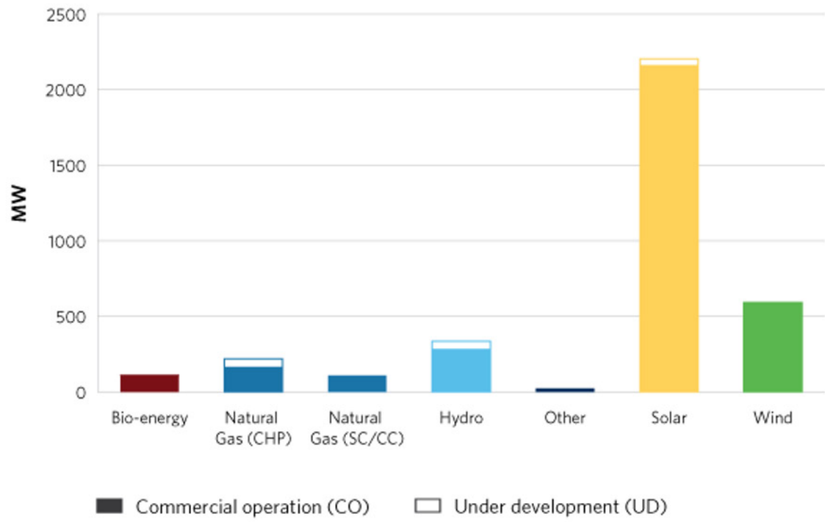
Figure 1: Ontario's transmission-connected electricity supply output by fuel type in 2019 in TWh[6]



2. Matthew McClearn and Kathryn Blaze Baum, "Ontario government supports OPG proposal to operate Pickering nuclear station past planned 2024 closing," *Globe and Mail*, January 16, 2020. At https://www.theglobeandmail.com/canada/article-ontario-government-supports-opg-proposal-to-operate-pickering-nuclear/
3. Environmental Defence Interrogatory #28, Ontario Energy Board, 2016-10-26 EB-2016-0152 Exhibit L Tab 6.5 Schedule 7 ED-028. This assumes that Pickering will produce 62 TWh of generation between 2021 and 2024. Note that the two Pickering "A" reactors are set to close in 2022, which reduces the output of the station.
4. The data for the estimates and numbers for this section can be found in Appendix A: Technical summary.
5. IESO, Supply Overview, 2020. At http://www.ieso.ca/Power-Data/Supply-Overview/Transmission-Connected-Generation
6. IESO, "Yearly Energy Output by Fuel Type," *Transmission-Connected Generation*, 2020. At http://www.ieso.ca/en/Power-Data/Supply-Overview/Transmission-Connected-Generation

In addition to transmission-connected electricity generation Ontario has around 4,000 MW of generation connected at distribution level, the vast majority of which is solar PV (see Figure 2).

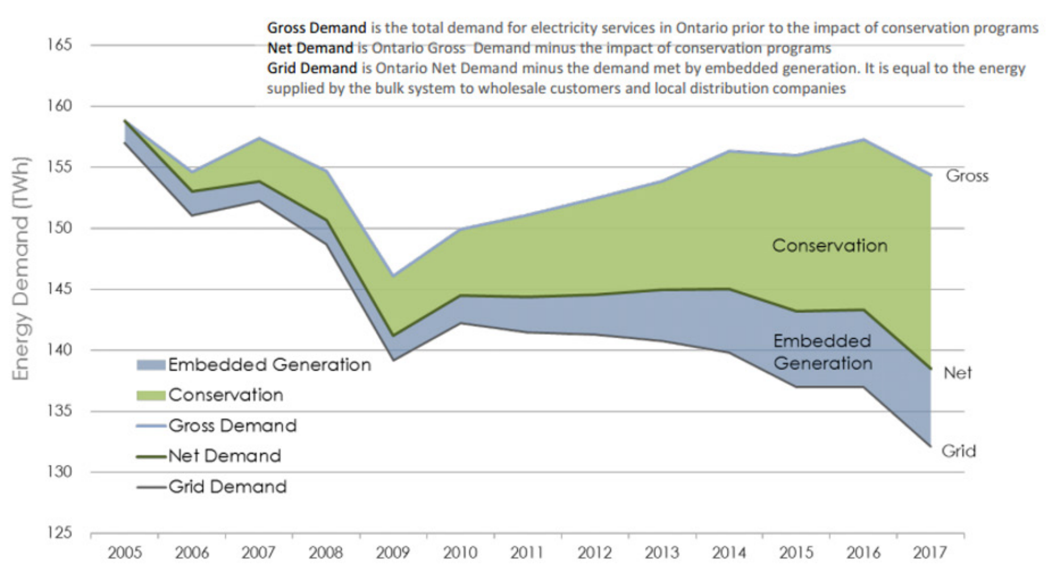
Figure 2: Distribution-connected contracted electricity generation[7]



1.3 Ontario's electricity grid – supply and demand

Over the last decade Ontario's gross energy demand for the electricity grid has been on a downward trend. While economic drivers play a large role in controlling demand, conservation and distributed energy resources (DERs), also referred to as embedded generation, have become growing factors. Figure 3 highlights that declining trend and the growing impact of demand management, such as conservation programs, standards and codes, which has become a significant contributor to reducing grid demand, along with increased generation from embedded generation.

Figure 3: Electricity demand 2005-2015[8]



7. IESO, *Ontario's Power System*, 2020. At http://www.ieso.ca/en/Learn/Ontario-Power-System/A-Smarter-Grid/Distributed-Energy-Resources
8. IESO, *MODULE 1: State of the Electricity System: 10-Year Review*, August 2016. At http://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/Ontario-Planning-Outlook/MODULE-1-State-of-the-Electricity-System-20160901-pdf.pdf?la=en

Planning Energy in Ontario

For **natural gas**, Enbridge Gas prepares integrated resource plans that it submits to the OEB.

On the **electricity side**, things are more complicated. The IESO, Hydro One (which runs the transmission grid) and the LDCs prepare regional plans. The first step is a needs screening and scoping assessment that decides the next steps. Based on that assessment there are two options:

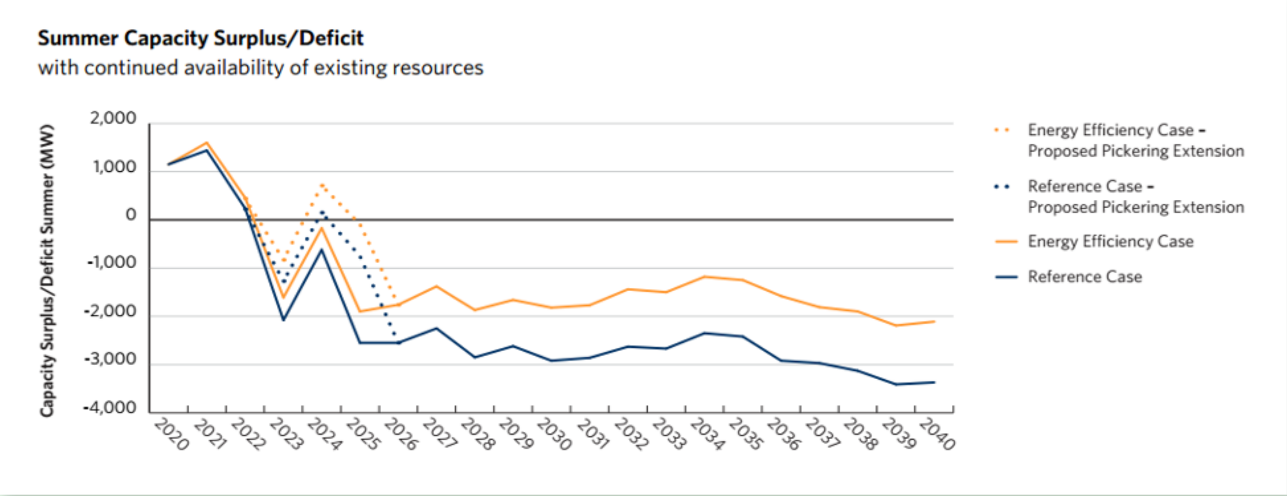
- A Regional Infrastructure Plan (RIP) if there is a small need that can be met through transmission or wires-only plan, or:
- An Integrated Regional Resource Plan (IRRP) if the needs of the region are greater than what can be provided from a wires-only solution.

IRRPs are prepared by the LDCs, Hydro One (in its capacity as the transmitter) and the IESO. The IRRPs include transmission options, and may also include generation and distributed energy resources (DER) options, which includes conservation and demand management (CDM), although there is no requirement and the IRRPs completed to date have focused on transmission.

For local input, the IESO is creating local advisory committees, which are expected to include representatives from municipalities, First Nation communities, consumers, businesses and environmental and conservation groups. These committees provide advice and commentary to the IRRP.

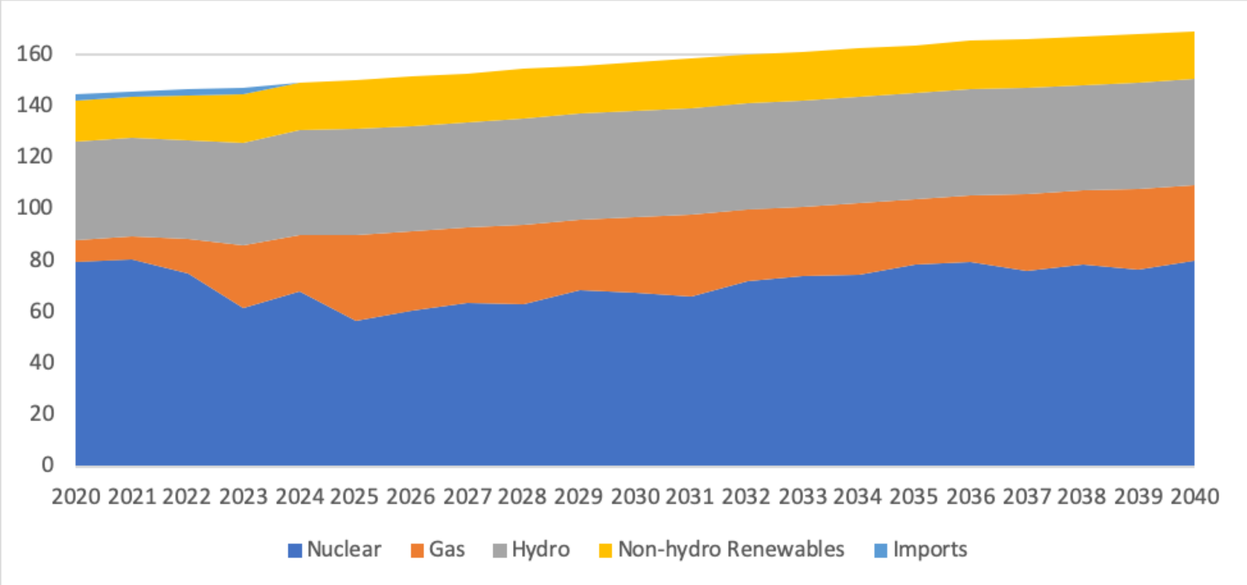
While demand has been declining, the IESO is projecting a capacity gap starting in 2022 due to varying factors such as increased electrification, the nuclear refurbishment schedule, and the closure of the Pickering nuclear generating station. Figure 4 shows the projected summer capacity deficit for the next 20 years. With a projected capacity deficit comes the need to think about what options there are to increase supply. The IESO's Reference Case energy production outlook is shown in Figure 5.

Figure 4: Capacity surplus/deficit in summer[9]



9. IESO, *Annual Planning Outlook*, January 2020. At http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook

Figure 5: Energy production in the reference case (TWh)[10]



With the decrease in nuclear supply due to the closure of Pickering, natural gas-fired generation compensates, increasing by 10-15 TWh per year to total about 25 TWh in 2025, and somewhat less after that. The remaining gap from Pickering's current output is made up by reducing surplus baseload generation (SBG) and exports. In summary, approximately 10 TWh of additional gas-fired generation per year can be attributed to the closure of the Pickering NGS in 2024/5.

In terms of supplying energy to the GTA, Pickering's retirement will not lead to overall supply concerns on the grid. Depending on growth of demand in the GTA, however, there may be limitations on the capability of delivering energy to GTA east. With Pickering's retirement, power flow from western Ontario will increase to GTA east to make up for the loss from Pickering. Future grid reinforcements to allow power to transfer from the west to the east will be needed with increased demand, or alternatively, additional generation resources will need to be located east of Toronto.[11]

1.4 Impact of Pickering's closure on GHG emissions and the GTA

In 2005, Ontario's electricity system was a major contributor of GHG emissions. Ontario became a low-emissions success story with the phasing out of 29.3 TWh a year of coal used in the electricity supply. From 2005 to 2017 Ontario's electricity system went from 74% low-carbon generation to 96% low-carbon generation.[12] This resulted in a major decline in GHG emissions in the electricity sector, as shown in Figure 6.

We estimate that the closure of Pickering will lead to an additional 10 TWh of gas-fired generation per year, resulting in an additional 4.5 Mt a year of GHG emissions.[13]

10. IESO, *Annual Planning Outlook*, January 2020. At http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook
11. IESO, *Annual Planning Outlook*, January 2020, pp. 27-28. At http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook
12. ECO, *Making Connections: Straight Talk about Electricity in Ontario*, April 2018. At https://eco.auditor.on.ca/reports/2018-making-connections/
13. For details on the calculations, see Appendix A: Technical summary.

In 2016, Ontario's emissions were 161 Mt – the addition of 4.5 Mt would result in in an additional 2%-3% of Ontario's emissions and result in Ontario's electricity grid going from an approximately 95% non-emitting grid to an 85% non-emitting grid (see Figure 7).

Figure 6: Ontario historical GHG emissions by economic sector relative to 1990 levels[14]

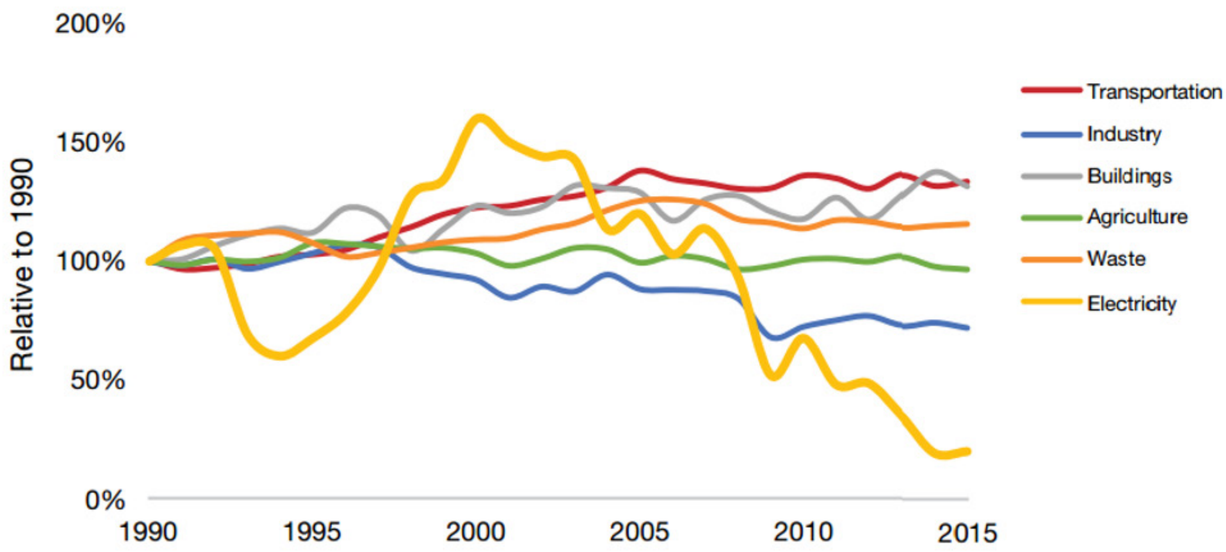
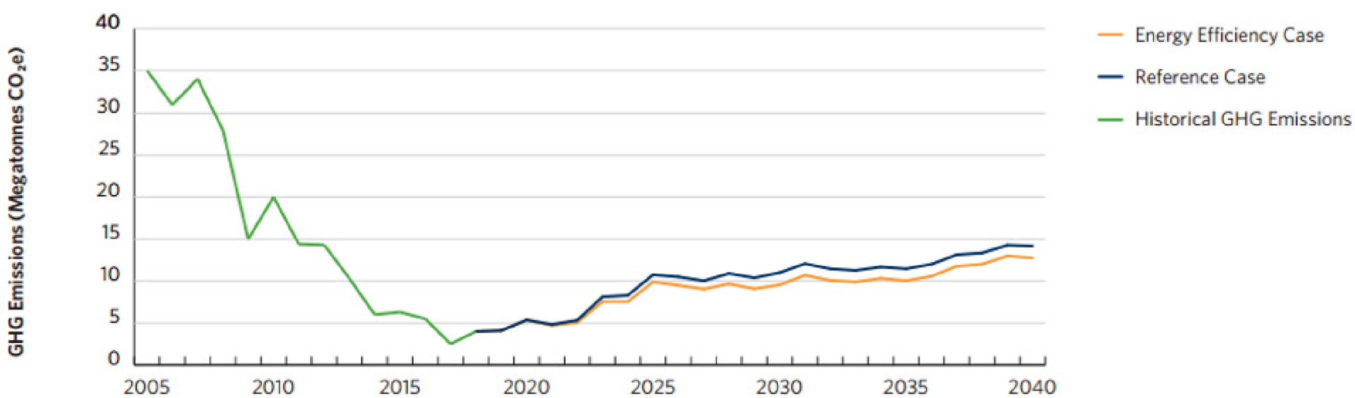


Figure 7: Electricity sector GHG emissions, historical and forecasted[15]



Pickering in many respects is an unusual nuclear station. For one, it is located within an urban area. As a result, its output is heavily used in the GTA. As the GTA looks to reduce its own emissions, incremental increases in emissions due to Pickering's closure need to be considered. The GTA's share of the increase in provincial gas-fired generation with Pickering's closure is about 50%, roughly 2.25 Mt. This is derived from an estimate of the GTA's share of provincial energy demand, recognizing that the GTA has a peakier demand profile than the rest of the province due to the higher use of air conditioning in the GTA and the lower level of industrial demand, which tends to be relatively flat.

14. ECO, *Making Connections: Straight Talk about Electricity in Ontario*, April 2018. At https://eco.auditor.on.ca/reports/2018-making-connections/
15. IESO, *Annual Planning Outlook*, January 2020. At http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook

Case Study: Replacing Nuclear Power in California

In January 2018, state regulators voted unanimously to shut down the Diablo Canyon Nuclear Generating Station, which has been operational since 1985 and which, as of 2018, supplied close to 10% of the state's grid supply. The decision followed prolonged negotiations between the plant's operators, Pacific Gas and Electric (PG&E), and regional environmental and labour groups. The plan, approved by the California Public Utilities Commission (CPUC), would see the plant close by 2025 and includes a proposal for a 53% increase in PG&E energy efficiency programs to help replace Diablo Canyon's supply after its closure.

The initial negotiations to establish terms for the plant's shutdown highlighted the need for zero-carbon energy sources as replacement, but the Commission's plan does not include any explicit provision for this, prompting concern that California will turn to natural gas to make up the shortfall. Such concerns are not unfounded. California's emissions rose significantly after the closure of the San Onofre Nuclear Generating Station (SONGS) in 2013 due to an increase in natural gas generation, though there has been comparatively much more time to plan for the closure of Diablo Canyon.

The specifics of how Diablo Canyon's supply will be replaced remain in flux, although according to the Natural Resources Defence Council (NRDC), major efficiency gains at PG&E, new solar power, and other distributed energy resources would both make up the shortfall and save PG&E ratepayers a significant amount of money (approximately US$ 1 billion, compared to the cost of keeping the Diablo Canyon reactors running.) Carbon capture and storage is considered a potential option, as is hydrogen. The Los Angeles Department of Water and Power has set out plans for transitioning the coal-fired Intermountain Power Plant to a first-of-its-kind fully hydrogen-fueled plant by 2045, in time to meet California's deadline for a 100% clean energy supply.[16]

16. Jeff St. John, "Diablo Canyon to Close without Clean Energy Guarantees," *Greentech Media*, January 11, 2018. At https://www.greentechmedia.com/articles/read/diablo-canyon-to-close-without-key-clean-energy-and-efficiency-guarantees

1.5 The GTA and GHG reduction

The Greater Toronto Area (GTA) had emissions of 38.8 Mt in 2017[17] – equivalent to the total emissions from New Brunswick, Nova Scotia and PEI combined. Buildings were the single largest source of emissions at 42.8%, primarily from the burning of natural gas but also from electricity generation. An addition of 2.25 Mt associated with the GTA due to the closure of the Pickering NGS would result in a 6% increase in the GTA's emission profile.

The City of Toronto has the largest population in the GTA, and is responsible for over a third of emissions in the GTA. The City has also developed an ambitious climate change strategy, TransformTO. Under the TransformTO plan, the city has targets to reduce emissions from 1990 levels by 30% by 2020 (a target already achieved), 65% by 2030 and to be net zero by 2050, or sooner.[18] Plans to reach these targets include a suite of 36 actions that will improve building energy efficiency, advance electric vehicle adoption and increase waste diversion (to name a few).[19] As an example of the impact of Pickering's closure, the goals of the TransformTO plan will be harder to achieve if emissions from the electricity system increase.

Increased electrification of heating and transportation and population growth in the GTA could increase electrical demand, which may lead to higher use of gas-fired generation if non-emitting solutions are not implemented. With a growing reliance on electricity it is as important as ever to try to keep the grid as emissions free as possible.[20]

An addition of 2.25 Mt associated with the GTA due to the closure of Pickering would be a tremendous setback to the region's ambitious GHG emissions reduction targets. To avoid this scenario, local and non-emitting options to reduce the additional use of 10 TWh of gas-fired generation must be assessed. This creates a unique opportunity to consider what both demand-side management and non-emitting generation opportunities should be considered for a large, dense urban area.

17. The Atmospheric Fund, *Carbon Emissions Inventory for the GTHA*, 2019. At https://taf.ca/gtha-carbon-emissions/
18. City of Toronto, *TransformTO*, 2020. At https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/
19. City of Toronto, *2050 Pathway to a Low-Carbon Toronto*, April 2017. At https://www.toronto.ca/wp-content/uploads/2017/10/91c7-TransformTO-2050-Pathway-to-a-Low-Carbon-Toronto-Highlights-Report.pdf and City of Toronto, TransformTO Overview. At https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/transformto-climate-action-strategy/
20. Julie Leach, "Exciting news: Toronto's carbon emissions are declining. What does it mean?" TAF, February 5, 2019. At https://taf.ca/exciting-news-torontos-carbon-emissions-are-declining-what-does-it-mean/

Case Study: New York – Reforming the Energy Vision (REV)

Over the past few years New York has been a hotspot for energy innovation. In 2014 New York launched **Reforming the Energy Vision (REV)**, a comprehensive energy strategy for New York that includes multi-year regulatory proceedings and policy initiatives. The strategy has some impressive clean energy goals for 2030:

- 40% reduction in greenhouse gas emissions from 1990 levels
- 50% generation of New York State's electricity must come from renewable energy sources
- 23% decrease in energy consumption of buildings from 2012 levels.

The Governor of New York assigned the New York Public Service Commission (PSC), the New York State Energy Research and Development Authority (NYSERDA), the New York Power Authority (NYPA), and the Long Island Power Authority (LIPA) to help implement a clean, resilient, and more affordable energy system by advancing innovation, investment, and consumer choice.[21] To reach these targets New York is attempting to deviate from the development of more traditional centralized way of doing things and move towards a decentralized energy system.[22] The goals for this transformation are to alleviate financial burdens on customers, reduce GHG emissions and create a resilient and efficient system. The framework for action of REV is broken down into three sections: regulatory reform, market activation and leading by example.[23]

There are a number of regulatory overhauls taking place as well as innovative ways utilities are using unconventional solutions dubbed **non-wires solutions (NWSs)**. While energy efficiency is typically the fastest demand management strategy to roll out, non-wires approaches to grid limitations are usually a range of resources that hinge heavily on managing and shifting peak demand.[24] For this case study we will look at the Brooklyn Queen's Neighborhood Program and the role of energy storage.

The Brooklyn-Queens Neighborhood Program

The Brooklyn-Queens Neighborhood Program is among the most well-known of the utility NWS projects. With rising growth in in the boroughs of Brooklyn and Queens there were forecasts for capacity gaps of 69 MW by 2018. Rather than spending $1.2 billion for new substations, feeders, and switching stations, the utility Consolidated Edison (ConEd) decided to launch the program to look at a range of demand-side options, as well as utility-sited resources, to solve locational issues on the distribution network.In 2018 the program was scheduled to end but was extended by the Public Service Commission so that additional demand reductions could be made to reduce the need for further traditional infrastructure investments. By this point more than 52 MW of non-traditional and customer-side solutions, including distributed generation and demand response, had been contracted at a cost of $200 million, much less than the traditional capital costs of $1.2 billion.[25]

21. New York State, *White Paper REV*, March 2016. At https://www.ny.gov/sites/ny.gov/files/atoms/files/WhitePaperREVMarch2016.pdf
22. New York State, *About REV*. At https://rev.ny.gov/about
23. New York State, *White Paper REV*, March 2016. At https://www.ny.gov/sites/ny.gov/files/atoms/files/WhitePaperREVMarch2016.pdf
24. Gavin Bade, "ConEd awards 22 MW of demand response contracts in Brooklyn-Queens project", *Utility Dive*, August 8, 2016. At https://www.utilitydive.com/news/coned-awards-22-mw-of-demand-response-contracts-in-brooklyn-queens-project/424034/
25. Mowat Energy, *Emerging Energy Trends*, December 2016. At https://munkschool.utoronto.ca/mowatcentre/wp-content/uploads/publications/141_emerging_energy_trends.pdf

Energy Storage

With New York State having additional targets of 100% renewable electricity by 2040 and 3 GW of energy storage by 2030, storage projects are on the mind. Storage is a particularly important piece to supporting the grid at times of peak demand. New York's state Governor pledged US$400 million of funding towards a climate agenda that includes US$280 million in support for energy storage.[26]

ConEd, the same utility that is running the Brooklyn-Queens Neighborhood Program, is seeking 300 MW of energy storage of at least four hours duration. While the program already has 13 MWh of storage and a solar-plus-storage microgrid the utility wants to use more battery energy storage systems (BESS) and virtual power plants via aggregated behind-the-meter (BTM) resources to relieve grid congestion in the area.[27]

With aggressive targets, storage projects are on the rise but there are still barriers. Strict planning and permitting processes have been considered one significant barrier to deployment so far, especially in New York City, due to it being a densely packed urban area.[28]

26. Andy Colthorpe, "New York's Green New Deal puts US$350m investment into energy storage", *Energy Storage News*, April 29, 2019. At https://www.energy-storage.news/news/new-yorks-green-new-deal-puts-us350m-investment-into-energy-storage
27. Andy Colthorpe, "New York City's biggest: Enel X connects grid-scale battery storage in Brooklyn", *Energy Storage News*, December 9, 2019. At https://www.energy-storage.news/news/new-york-citys-biggest-enel-x-connects-grid-scale-battery-storage-in-brookl
28. Andy Colthorpe, "Con Edison seeks 300MW of storage of 'at least four hours' duration to meet New York goals", *Energy Storage News*, July 24, 2019. At https://www.energy-storage.news/news/coned-seeks-300mw-of-storage-of-at-least-four-hours-duration-to-meet-new-yo

PART 2

What Can Be Done?

Nearly a decade after deciding to close Pickering, there has been no plan on how to replace it with non-emitting solutions. There is an urgent need to identify and build support for the deployment of non-emitting energy solutions to replace the Pickering nuclear station when it closes and avoid an increase of 2.25 Mt of GHG emissions in the GTA.

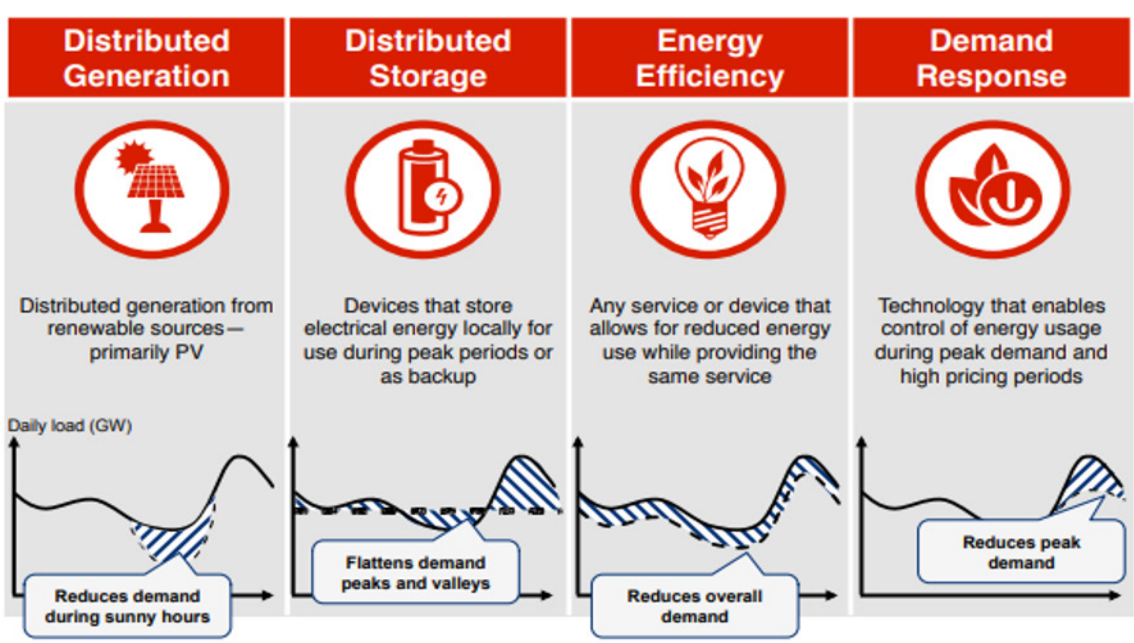
2.1 The options

The non-emitting solutions that can help meet the GTA's energy needs with the closure of Pickering generally fall into four areas:

- the **demand side**, which is controlling customer loads and increasing conservation and energy efficiency so that less generation is required after the Pickering closure
- the **supply side**, which are non-emitting (or potentially lower-emitting) solutions to meeting energy needs
- **storage**, which can include both demand and supply characteristics
- **microgrids**, which can facilitate integration of new energy resources and enhance resiliency.

Different technological alternatives can play different roles in the region, which can contribute to meeting the GTA's electricity needs (Figure 8).

Figure 8: Role of different distributed resources in the electricity sector[29]



29. World Economic Forum, *The Future of Electricity: New Technologies Transforming the Grid Edge*, 2017. At http://www3.weforum.org/docs/WEF_Future_of_Electricity_2017.pdf

Types of Distributed Energy Resources

DISTRIBUTED GENERATION (DG)
Power-generating technologies, including variable renewable energy sources such as solar and wind, as well as gas-fired and diesel-fired generators.

ENERGY STORAGE
Includes both electricity storage technologies such as batteries or fly wheels, and other forms that allow energy to be used at a later point (such as heat storage). Electric vehicles could be used as energy storage.

DEMAND RESPONSE (DR)
Technology that allows consumers to alter their consumption patterns based on some signal, such as market prices or grid congestion.

ENERGY EFFICIENCY AND CONSERVATION
Technologies that reduce overall consumption, such as LED bulbs or more efficient air conditioning.

MICROGRIDS
Small localized grids that can operate independently of the larger public grid.

Source: Richard Carlson, Petar Prazic and Paul Sommerville, Emerging Energy Trends: Regulatory Responses To Ontario's Energy Future, December 2016.

2.1.1 Demand side

It was generally agreed that in a dense urban area, demand side solutions, namely conservation and energy efficiency, are the most practical given the lack of available space for large-scale energy production.

Ontario has been successful in reducing electricity consumption, and the Conservation and Demand Management (CDM) "interim framework" from April 1, 2019 to December 31, 2020 targets 1.4 TWh in energy savings and 189 MW in demand savings.[30]

However, the current CDM program is due to end in December 2020, and no replacement has been announced. As such, this could be the ideal time to move to location-targeted strategic demand reduction to integrate conservation into system planning where the value to the system is higher. However, it is likely that the current system will need to be extended to allow time to develop a new CDM framework.

Demand-side measures such as conservation and energy efficiency can reduce the gap between energy used now and what could be needed by 2024. As an example, the City of Toronto's TransformTO plan has ambitious energy efficiency targets, including all new buildings to be net zero by 2030 and a reduction in energy consumption of 40% from all existing buildings by 2050. This would mean that the average building in Toronto would use approximately 70 kWh per square metre annually, compared to over 200 kWh per square metre annually which is currently used.[31]

Demand response (DR) programs provide incentives in the forms of payments or reduced energy costs for customers that are willing to reduce their use during peak periods. Historically DR programs have focused on industrial loads as they were the only ones that had the capacity to respond to signals from the system operator and had a large enough demand that their responses would make a material difference.

Ontario has held a DR auction annually since 2015, and prices have declined by 36%. There is uncertainty about future DR auctions as it may be included in the proposed capacity auction.[32]

30. Efficiency Canada, Energy Efficiency Database: Ontario, 2019. At https://database.efficiencycanada.org/ON/
31. *The City of Toronto Zero Emissions Buildings Framework*, March 2017. At https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf
32. IESO, *IESO Announces Results of Demand Response Auction*, December 12, 2019. At http://www.ieso.ca/en/Sector-Participants/IESO-News/2019/12/IESO-Announces-Results-of-Demand-Response-Auction

Another form of DR in Ontario is the Industrial Conservation Initiative (ICI), which bases an organization's electricity payments for the Global Adjustment on their demand during the five highest peak periods in Ontario. As a result, reducing demand during those five top peak hours can be very beneficial for large consumers. The threshold to participate in the ICI in Ontario was recently lowered to average monthly peak demand of 500 kW.[33]

Strategic Demand Reduction is a new technique that uses energy efficiency and demand response to provide system resources. SDRs reduce system costs by reducing demand at specific times and specific locations to optimize the electricity system and to reduce emissions. SDRs minimizes system costs by reducing the need to procure additional system resources on the supply side.

SDRs can provide four main services:

- incent energy efficiency and behaviour change
- mitigate need for ramping resources and help capture surplus renewable generation
- manage contingency and allow for better load-following of supply resources
- provide ancillary services such as frequency regulation.

Through these services, SDRs can reduce peak demand in the local distribution system, reducing the need for additional grid infrastructure, as well as reducing the need for new peaking supply. SDR can also reduce demand when the power on the grid is emissions-intensive, and increase demand when there is spare capacity on the grid and a surplus of non-emitting generation.

In the US, 13 states have SDR performance incentive mechanisms (PIMs) that reward utilities for developing SDR programs that reduce system costs. These PIMs include shared-savings mechanisms, or bonuses for meeting peak reduction targets.[34]

Location-specific conservation will provide the highest value to the Ontario grid. Large areas of the province may not have immediate need for conservation, although it may continue to provide for long-term value and benefit consumers. Given that the current conservation and demand management program will be ending in December 2020, developing a new program that is partially based on location-targeted SDR could provide significant benefit to the GTA as it could help with assessing the system resources that will be needed with the closing of Pickering.

2.1.2 Supply side

Dense urban areas have limited non-emitting supply options. There are, however, some possibilities.

Renewable electricity: Solar PV has been identified as a good option, given the declining costs of the technology and its inherent alignment with the region's increasingly air conditioning-driven summer demand peaks. Despite the increasing number of residential and commercial towers in the downtown core, which tend to be tall and not offer a lot of roof space, the GTA offers a wide range of highly suitable locations for additional solar PV, particularly on

33. IESO, *Industrial Conservation Initiative Backgrounder*, August 2019.
34. For more details see Rachel Gold, Amanda Myers, Michael O'Boyle and Grace Relf, *Performance Incentive Mechanisms for Strategic Demand Reduction*, American Council for an Energy-Efficient Economy, February 2020. At https://www.aceee.org/sites/default/files/publications/researchreports/u2003.pdf

commercial and industrial buildings, and they could be used in conjunction with storage (see below) to help reduce peak demand.

The abundant wind resource availability in Lake Ontario could in theory make offshore wind a viable solution for the region, but offshore wind generation remains subject to a provincial ban on development.

District energy: The City of Toronto has a target to connect 30% of the city's gross floor area to low-carbon district energy (DE).[35] The city has additionally identified 30 sites for potential low carbon, thermal energy networks in growth areas in Toronto.[36]

The City of Toronto has the Enwave system which heats and cools Toronto's downtown buildings. While generally using gas-fired DE for heating, Enwave has a Deep Lake Cooling System that uses cold water from Lake Ontario for cooling in the downtown core. The lake cooling system reduces electricity demand in the core by 61 MW, equivalent to 5-6% of electricity demand of the downtown core, and a planned expansion would increase that reduction.[37]

To move away from natural gas, some DE systems can use low-grade waste heat, rather than steam, from other processes to heat and cool. In the False Creek area of Vancouver a district energy system uses a two stage sewage heat pump that recovers waste heat from untreated urban wastewater to provide heating and hot water, reducing GHG emissions more than 60% compared to a traditional solution.[38] The Telus Garden mixed-use development in Vancouver uses waste heat from a Telus data centre next door to provide heating and cooling.[39]

Enwave is also developing a low-carbon hot water heating and cooling system that will couple in with their existing system. This system can use heat pumps and transfer heat from the lake water cooling system, or the outside air. As an example, the Well, a new development downtown, will include a hot and cold-water storage tank (depending on season) to help backup the low-carbon DE system.[40]

By providing cooling, such DE system would reduce electricity demand during peak summer days, reducing the need for additional gas generation. In addition, the natural gas used for heating could be replaced with non-emitting solutions such as renewable natural gas, biomass and hydrogen.[41]

35. City of Toronto, *2050 Pathway to a Low-Carbon Toronto: Report 2: Highlights of the City of Toronto Staff Report*, April 2017. At https://www.toronto.ca/wp-content/uploads/2017/10/91c7-TransformTO-2050-Pathway-to-a-Low-Carbon-Toronto-Highlights-Report.pdf
36. *The City of Toronto Zero Emissions Buildings Framework*, March 2017. At https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf
37. Enwave, *Case Study: Enwave and Toronto Water tap into innovative energy source.* https://www.enwave.com/case-studies/enwave-and-toronto-water-tap-into-innovative-energy-source/
38. City of Vancouver, *Southeast False Creek Neighbourhood Energy Utility*, 2019. At https://vancouver.ca/home-property-development/southeast-false-creek-neighbourhood-energy-utility.aspx
39. "Telus Garden towers in Vancouver to use recycled heat," *Daily Hive*, December 19, 2017. At https://dailyhive.com/vancouver/telus-garden-towers-in-vancouver-to-use-recycled-heat/
40. Enwave, *Groundbreaking expansion project brings water to The Well.* At https://www.enwave.com/case-studies/groundbreaking-expansion-project-brings-water-to-the-well/
41. For more see Pollution Probe, *What Does the Future Hold for Natural Gas? Considering the role of natural gas and the gas system in Canada's low-emissions future*, November 2019. At https://www.pollutionprobe.org/future-hold-natural-gas-report/

2.1.3 Storage

Energy storage, be that chemical batteries, compressed air, mechanical or other forms, can be both a source of demand response – altering charging based on grid conditions – and a form of supply. In Ontario as of early 2019, 56 MW of storage has been contracted for ancillary services, and another 55 MW procured in 2017 for regulation services and grid balancing. An additional 400 MW of storage is located behind-the-meter at commercial and industrial locations.[42]

NRStor, an Ontario storage company, sees 6,000 MW of storage potential in the next decade, and could foresee storage covering one-third of Pickering's output, although ensuring they charge during period when the grid is clean will be crucial for reducing emissions. New York State has a target of 1,500 MW of storage by 2025 and up to 3,000 MW by 2030. In a study by the New York Public Service Commission, 275 MW of peaking units, or about 6% of the total rated capacity of New York's peaking fleet, could be replaced by storage with a 6-hour duration. This could increase to 500 MW of peaking power by storage with an 8-hour duration.[43] In California, PG&E, a utility, is replacing three gas-fired plants with storage.[44] NV Energy in Nevada also recently received regulatory approval to build three solar projects totaling 1,190 MW and 590 MW of energy storage as part of the state's commitment to transition to 100% carbon-free electricity by 2050.[45]

Of course, storage is only non-emitting when the electricity that is stored is non-emitting to begin with. Renewable generation, such as from roof-top solar, can be used but solar will not produce significant amounts in winter. Another option is software that limits charging to times when there is sufficient non-emitting generation on the grid. California has begun to examine how to better implement such charging.[46]

The storage doesn't have to be stationary. Electric vehicles (EVs) have large potential to supply energy storage services, to the grid or to buildings. In many respects, EVs can be considered mobile storage units. Peak Power in Toronto is currently running a trial using Nissan Leafs and bi-directional charging to reduce peak demand in downtown buildings (see case study on page 19).

42. Energy Storage Canada, *Maximizing Value and Efficiency for Ratepayers through Energy Storage: A Roadmap for Ontario, May 2019*. At https://static1.squarespace.com/static/54485dc4e4b0f7bd2239a06b/t/5cf03c6866565b0001edac77/1559247981823/ENERGY+STORAGE+ROADMAP+ESC+Slide+Deck+2019.pdf
43. New York Public Service Commission, *The Potential for Energy Storage to Repower or Replace Peaking Units in New York State*, July 2019. At http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B2F0A202D-CAB9-4961-96F3-56AEA67C6052%7D
44. Gavin Bade, "Storage will replace 3 California gas plants as PG&E nabs approval for world's largest batteries," *Utility Dive*, November 9, 2018. At https://www.utilitydive.com/news/storage-will-replace-3-california-gas-plants-as-pge-nabs-approval-for-worl/541870/
45. Robert Walton, "Nevada regulators approve NV Energy plan for 1,190 MW solar, 590 MW storage," *Utility Dive*, December 9, 2019. At https://www.utilitydive.com/news/nevada-regulators-approve-nv-energy-plan-for-1190-mw-of-new-solar-resource/568659/
46. David Roberts, "California solves batteries' embarrassing climate problem," *Vox*, December 2, 2019. At https://www.vox.com/energy-and-environment/2019/12/2/20983341/climate-change-california-batteries-emissions-watttime

Case Study: Electric Vehicles as Mobile Storage

Electric vehicles (EVs) can be thought of as batteries on wheels. All cars spend around 95% of their time parked. Given the right incentives and markets, EV batteries can be used not only to move around but to provide energy services when they are not needed for transportation.

Peak Power, a Toronto energy company, is investigating using EVs to help building owners reduce their peak, and their Global Adjustment charges. Peak Power has started a pilot program using 20 2019 Nissan Leafs, each with a 60 kWh battery. Volunteers were given a significantly discounted lease for the vehicles and free parking spaces at downtown buildings – under the condition that they bring their fully-charged vehicle and plug it into bi-directional chargers when asked. The EVs can then be used to reduce the building's energy demand from the grid during these peak system times, substantially reducing costs. The pilot is ongoing, and there are some concerns around battery life and warranties that still need to be considered.[47]

The International Renewable Energy Agency (IRENA) likewise sees EVs and the ability to "smart charge" them (being able to charge based on grid demand or even bi-directionally) can be an important element of the flexibility needed in the electricity system to enable more solar and wind power.[48]

47. For more information see Peter Kelly-Detwiler, "Driving Change: Transportation and Electric Utility Industries Will Soon Collide – In A Good Way", *Forbes*, October 15, 2019. At https://www.forbes.com/sites/peterdetwiler/2019/10/15/driving-change-transportation-and-electric-utility-industries-will-soon-collide--in-a-good-way/#464b817247ca
48. IRENA, *Innovation Outlook: Smart charging for electric vehicles*, May 2019. At https://www.irena.org/publications/2019/May/Innovation-Outlook-Smart-Charging

2.1.4 Microgrids

Microgrids themselves are not a single technology, but instead can incorporate a number of different clean technologies, such as renewable generation, storage and even DE. A microgrid can be thought of as a small energy grid that services a particular location. The microgrid can be completely isolated from the larger, provincial grid at all times, or, more often, microgrids rely on the larger grid for parts of energy supply, is able to trade power back and forth between the two grids, and in the case of a larger blackout, the microgrid could "island" itself off from the larger grid to continue to provide energy services.

In addition to the ability for communities to be able to better control their energy services, microgrids' ability to island themselves off from the larger grid in case of emergency can improve resiliency to extreme weather events, events that are likely to increase due to climate change. Following Superstorm Sandy, for example, New York State, including the Governor's Office of Storm Recovery, launched a US$40 million contest to fund the development of a number of microgrid systems to modernize the energy system and provide additional resiliency.[49] New Jersey Transit is developing a microgrid to ensure that its trains can continue operating during bulk grid disruptions.[50] Across the US, there are numerous microgrid projects,[51] and the US military are developing microgrids at their facilities for resiliency.[52]

Development in Canada has been slower, and microgrids have so far been limited to a small number of campuses.

2.2 Ability of technology to provide energy services

When considering technological options for replacing Pickering it is crucial to look at the services different technology can provide.

While generally people focus on ensuring needed energy is available – usually measured in kWh or MWh – or if there is sufficient capacity – measured in MW – to meet peak demand, other services are required. As electricity needs to be balanced on second-by-second basis there are other services needed that are usually lumped together as ancillary services, including:

- operating reserve (emergency backup in case a power plant has problems or demand changes unexpectedly)
- load following (being able to adjust on a second-by-second basis to changes in demand)
- frequency regulation (being able to adjust output to ensure that the frequency of the electricity stays within certain bounds).

Currently most ancillary services in Ontario are provided by hydropower facilities and fossil-fuel generators. One notable exception was a request for proposals (RFP) in 2017 for frequency regulation, which are facilities that are able to make changes in supply and demand to keep the electricity grid balanced. That RFP was won by two energy storage projects totalling 55 MW, which were able to win the RFP based on solely upon ability and cost.[53]

49. NYSERDA, *NY Prize: Powering a New Generation of Community Energy*. At https://www.nyserda.ny.gov/All%20Programs/Programs/NY%20Prize
50. NJ Transit, *Resiliency Program*. At https://njtransitresilienceprogram.com/nj-transitgrid-overview/
51. See http://microgridprojects.com/property-location/united-states/
52. Emma Foehringer Merchant, "US Military Microgrids Are Using More Renewables and Batteries," *Greentech Media*, November 9, 2018.https://www.greentechmedia.com/articles/read/for-the-u-s-military-energy-resilience-has-long-been-a-priority
53. IESO, *Energy Storage Projects Selected to Provide Essential Grid-Balancing Service*, November 28, 2017. At http://www.ieso.ca/Corporate-IESO/Media/News-Releases/2017/11/Energy-Storage-Projects-Selected-to-Provide-Essential-Grid-Balancing-Service

According to the IESO's 2018 Planning Outlook, the IESO does not see renewable energy system being able to provide significant amounts of ancillary services, or even capacity. Table 1 below highlights the areas where the IESO sees renewable energy system contributing.

Table 1: Energy technologies and potential services offered[54]

Resource	Capacity	Energy	Operating reserve	Load following	Frequency regulation	Capacity factor	Winter peak contribution	Summer peak Contribution
Conservation	Yes	Yes	No	No	No	Depends on measures		
Demand response	Yes	No	Yes	Yes	Limited	N/A	90%	90%
Solar PV	Limited	Yes	No	Limited	No	15%	5%	33%
Wind	Limited	Yes	No	Limited	No	30-40%	27%	11%
Bioenergy	Yes	Yes	Yes	Limited	No	40-80%	92%	92%
Storage	Yes	No	Yes	Yes	Yes	Depends on technology		
Waterpower	Yes	Yes	Yes	Yes	Yes	30-70%	74%	68%
Nuclear	Yes	Yes	No	Limited	No	70-95%	94%	93%
Natural Gas	Yes	Yes	Yes	Yes	Yes	<65%	86%	80%

However, the services in the shaded area of Table 1 have been open to those technologies in other jurisdiction through aggregation or opening up ancillary services. The inability in Ontario is mostly down to market or planning constraints.

One method to ensure that small distributed energy resources (DERs) can fully participate in the market is through aggregation, where a group of smaller DER facilities pool their resources to act as one participant in the market. Another way is to create what is known as a virtual power plant (VPP) where a group of DERs are assembled so they can act as if they were a traditional large-scale plant, something electricity system operators and planners are more comfortable with. Location-targeted strategic demand reduction (SDR) can also provide many of the same services, either as a stand-alone service or aggregated into a VPP with renewable generation.

Currently in Ontario, facilities need to be at least 1 MW to participate in the market. While there is some discussion of lowering that threshold, there may still be barriers to entry in terms of the requirements of participating in the market that may stop small DER facilities.[55] Aggregation can be done by private companies, utilities or even system operators. As an example, the UK's National Grid, the electricity system operator, has created a Distributed Resource Desk that is tasked with providing better insight and control of DER facilities in order to help them better integrate and provide more value as well as to help aid the growth of DERs.[56]

Opening up ancillary service markets to DERs is another way of allowing for more participation, and to help ensure that DERs provide value to the electricity system.

54. For more details see Appendix A: Technical summary
55. IESO, *Exploring Expanded DER Participation in the IESO-Administered Markets: Part 1 – Conceptual Models for DER Participation*. At http://www.ieso.ca/en/Get-Involved/Innovation/White-papers
56. National Grid ESO, *Every little helps…big boost for smaller electricity providers*, January 23, 2019. At http://media.nationalgrid.com/press-releases/uk-press-releases/national-grid-eso/every-little-helps-big-boost-for-smaller-electricity-providers/

Innovative projects in the GTA

Ontario utilities are not standing still on looking at DER integration and evaluating how they can provide benefits to the system and to consumers. Two projects in the GTA are the Power. House Hybrid in York Region and the Bulwer Battery Energy Storage System in Toronto.

Power.House Hybrid

Alectra Utilities, Enbridge Gas, the City of Markham and Ryerson University have started a Power.House Hybrid pilot project that integrates solar PV, battery storage, electric vehicle charging, as well as a hybrid heating system based on air source heat pumps, micro-CHP, high efficiency boiler and smart air handlers. Natural Resources Canada has contributed funding. The fleet of 10 Power.House Hybrid homes will be integrated to create one virtual power plant (VPP). The system will respond in real-time to the emissions intensity of the centralized system to reduce overall emissions. Installation in the 10 homes will start in 2020, and the pilot will run until 2022.[57]

Bulwer Battery Energy Storage System (BESS) Project

The Bulwer BESS project is a 2 MW/8 MWh Ontario Smart Grid funded project that will be located at Bulwer Municipal Station, a retired Toronto Hydro electrical substation located in downtown Toronto. The BESS improves reliability of the system in case of outage, and also reduces peak demand on the local distribution system, thereby avoiding need for costly new infrastructure.

Case Study: Opening up ancillary markets to DERs

In the UK, the National Grid, the electricity system operator, and UK Power Networks, the local distributor, started the Power Potential project in south-west England. In that region there are large amounts of offshore wind, solar PV, plus a 2 GW DC connector with Europe and a large nuclear plant, all of which create network congestion and voltage regulation challenges. The project looks at how congestion can be reduced, and how DER systems can participate in the transmission market. It is expected to save up to £425 million by 2050, and allow for greater renewable energy generation. Using new software, National Grid and UK Power Networks will be able to communicate more efficiently, and DERs can participate in the active and reactive markets.[58] As part of that project in November 2019 the St Francis solar plant in East Sussex, a 4 MW plant owned by Lightsource BP, was able to provide reactive service at night using smart inverters.[59] The California ISO, the National Renewable Energy Laboratory and First Solar project, also used advanced inverter technology at a 300 MW solar plant to show it could provide active and reactive power as well as frequency and voltage regulation, and do it more accurately and faster than gas turbines.[60]

57. Alectra Utilities, *Backgrounder–Power.House Hybrid*, June 21, 2019. At http://alectrautilities.com/wp-content/uploads/Backgrounder-Power.House-Hybrid.pdf.
58. For more information see National Grid ESO, *Power Potential*. At https://www.nationalgrideso.com/innovation/projects/power-potential
59. BP, Lightsource BP pioneers UK's first night-time solar service, November 29, 2019. At https://www.bp.com/en/global/corporate/news-and-insights/press-releases/lightsource-bp-pioneers-uks-first-night-time-solar-service.html
60. NREL, NREL, *California Independent System Operator, and First Solar Demonstrate Essential Reliability Services with Utility-Scale Solar*. At https://www.nrel.gov/esif/partnerships-caiso-first-solar.html

PART 3

Getting over the barriers

3.1 Barriers

To help us identify barriers and potential solution, we held an Expert Workshop in January 2020, which included representatives from all major utilities, government, industry and civil society. At our Expert Workshop, the one comment we got from nearly everyone was that technology is not the barrier. We have the means to develop local non-emitting or low-emitting solutions in an economic, timely and cost effective manner if we can overcome the policy, regulatory and business barriers.

While there is a range of existing barriers, we've grouped the results from our workshop into five sections of barriers: market signals, planning, policy uncertainty, cost and information.

3.1.1 Market signals

One of the most prominent barriers is that time-of-use rates for residential customers are not **reflective of the true market cost** and the set standardized rates are not as extreme as they ought to be. Drastically lowering the price for off peak times, or at times when the emissions-intensity of the grid is low, and raising the price for peak times would better encourage a shift of consumption to off peak periods or when the grid has surplus clean electricity. While the rates are stabilized to better protect customers that are unable to shift their time of energy use, this limits the potential of customer response to shave peak savings.

Another major barrier is the lack of locational values in rates for DERs. Ontario uses **postage stamp rates**, a method of cost allocation where any rate class charge is the same anywhere on the interconnected system, regardless of the geographical region in the province.[61] The problem with this is that the rate value is not dependent on the local needs and conditions. The GTA in particular is seeing high increases in energy demand due to population growth. The costs need to reflect the system costs of providing electricity to the GTA. By adding locational values, it could help leverage strategic demand response and DERs in regions with growing demand and other system needs. What is needed are more sophisticated rate designs where locational issues can be solved using local distribution networks. As discussed in the New York Case Study, the Brooklyn-Queens Neighborhood Program decided to not build an expensive substation but signed contracts for multiple customer-side solutions.

There are also more barriers that are restricting the access and use of distributed energy resources. This includes **regulatory barriers to virtual net metering, permitting, and a lack of standards to allow connection**. Reshaping regulation to better take advantage of decentralized energy, a growing supply and demand asset, is necessary to improve access to local generating solutions by sending the right signals to all stakeholders.

61. Government of BC, Postage Stamp Rates. At https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/electricity/iepr/iepr_postage_stamp_rates.pdf

3.1.2 Planning

Along with market signals there are also planning barriers when it comes to better integrating DERs into the energy system. Traditionally the energy system has been planned from a centralized point of view (forecasting demand and upgrading the grid based on that) but now integrating DERs into the process is what can help optimize the balance of supply and demand at both the provincial (bulk) level and the local levels. This represents a bottom-up, rather than a traditional top-down approach.

Currently planning is very top-down focused and does not asses where DERs can play a role, which often removes local options from even being considered. What is needed is a better **market design** that includes transparent tools and processes around valuing local non-wires solutions and DER options that **promote value stacking**, the capability to perform and be compensated for multiple energy services at the same time. For example, energy storage facilities have multiple value streams that can be considered since they have the ability to provide peak shaving, demand response and storage capabilities. Such values are best discovered through local planning. The market design also needs to embrace flexibility and ensure we don't lock ourselves into a high-carbon future through long-term contracts.

A problem when trying to increase opportunities for local solutions is that the regulations differ depending on different projects, creating **regulatory silos**.

3.1.3 Policy uncertainty

When it comes to energy, **policy uncertainty is always a challenge**. Too often emphasis is put on decisions being made on short-term political cycles and long-term planning is not prioritized. This sends mixed market signals and deters investment.

3.1.4 Cost

Electricity rates for most residential consumers are set by the Ontario Energy Board (OEB). There are two different types of rating systems, time-of-use and tiered. As previously mentioned, the rates are stabilized to protect customers. While this is important, cost is critical to changing behaviour when it comes to reducing energy use at peak periods. Costs have been declining for many non-emitting generation options, but there are still barriers when it comes to DERs. What continues to be a challenge is the **consideration of multiple benefits**. A business case for options that puts value on all of the benefits, climate, resiliency, economic and environmental, needs to be considered.

Local Energy Markets

Developing a local clean energy market is another option to allow for the development of non-emitting resources in the GTA. The IESO, in partnership with Alectra Utilities and Natural Resources Canada, is starting a local energy market in the York Region. The energy market will look at how owners of solar, wind and storage can be used in the area to avoid building new transmission infrastructure.

The market plan will hold capacity auctions, initially for 10 MW and then 20 MW in the second auction. The first auction is planned for the end of 2020, with a second at the end of 2021. The results of the pilot will be used to investigate how to better integrate local energy markets into the larger market.

Source: For more information see IESO, *IESO Demonstration Project to Test Ontario's First Local Electricity Market*, August 29, 2019. APPRo, IESO releases conceptual design and timeline for Local Energy Market demo, December 2019.

3.1.5 Information

The problem with having energy silos when it comes to technology, policy, and regulations, is that information is not availalable to all participants, making it difficult to holistically assess opportunities. This leads to information gaps and a **lack of education** surrounding the trade-offs between options. Working in silos also creates inconsistencies from **differing methods of data analysis and modelling**, causing the energy sector to be more divided than united.

Lack of data and data governance surrounding energy data usage is another barrier. While smart metering and advanced software is a progressive tool for demand-side-management, it is hard for developers to access and use data and other information to identify areas of the grid with high value potential.

Case Study: Value stack compensation for distributed energy resources

Providing a value for distributed energy resources located on the distribution grid that cannot participate in wholesale markets has been a struggle. To kick-start the industry feed-in tariffs have been used, and lately there has been a move to net-metering, which values the export of any electricity at the standard residential rate. Both of these have helped develop the industry, but as DER installations increase, it is necessary to develop more sophisticated tariffs that fairly value the costs and benefits of a DER project.

As part of New York's Reforming Energy Vision (REV, see previous case study on page 12), the Department of Public Service, the regulator in New York, developed a Value of DER tariff, also called the Value Stack, that attempts to provide a transparent method to properly evaluate the different values that a DER project can bring. This tariff is currently available for projects 750 kW or larger. Smaller projects continue to use net-energy metering, but are expected to transition in coming years.

As a first step, the regulator required each utility to file a "Benefits-Cost Assessment" (BCA) handbook. The BCA includes such elements as avoided carbon emissions and impact on grid reliability. Each utility also, every month, provides information on hosting capacity for their grids, and identifies areas where congestion or other grid issues could increase compensation. DER developers can then assess where the optimal places for DER investment could occur.[62]

With the Value of DER tariff, utilities compensate DER owners for the following benefits:

- Energy (kWh): The market value of the of kWh delivered to the grid
- Capacity (kW): The market value of the capacity delivered
- Environmental impact: The reduction in emissions from using renewable electricity
- Demand reduction: The value of the reduction in distribution peak demand and the avoidance of new distribution capacity
- Locational System Relief: Location specific value of the DER to a given utility, based on specific grid conditions such as voltage support or avoiding new infrastructure.

All the information to develop the Value Stack is publicly available and provided by the utility, and a Value of DER Calculator is provided to help developers identify the best locations for development.[63]

62. In addition to the information on the utilities' websites, the information can also be found at the New York State Energy Research and Development Authority website at https://www.nyserda.ny.gov/All%20Programs/Programs/NY%20Sun/Contractors/Value%20of%20Distributed%20Energy%20Resources.
63. Additional information can be found at REV Connect, *Value Of DER: Pricing Distributed Resources.* At https://nyrevconnect.com/rev-briefings/value-der-pricing-distributed-resources/.

3.2 Overcoming barriers with solutions

As discussed above, there are a wide range of non-emitting when it comes to replacing Pickering. The next steps are to overcome the barriers with the right suite of solutions that will ultimately develop an action roadmap.

Table 2 is a breakdown of the barriers and their associated solutions for overcoming them.

Table 2: : Matching the barriers with solutions

Area	Barriers	Solutions
Market Signals	Standardized time of use rates limit incentives for customers to shift their consumption to off peak times.	1. Optional Peak Pricing: Allow for an optional pricing model with higher on-peak and lower off-peak to incent customers to shift demand with EV charging and heat electrification. This would allow customers to shift their demand if they are able to while also protecting customers that can't. The tariffs should be designed with a focus both on times of low demand, but also at times of high generation of non-emitting resources (such as mid-day in the summer). 2. Strategic demand reduction (SDR) targeted to reduce peak demand in the GTA and provide system services currently provided by Pickering. 3. Offering unique services to customers to reduce their peak-demand use such as discounted off-peak rates for electrification of heating or smart charging for vehicles.
	The lack of competitive procurement for energy needs does not allow for all viable options or technologies to compete.	1. Allow virtual net metering for customers. 2. Require the IESO and LDCs to transparently consider non-wires solutions (NWS) vs. traditional wires solutions when considering new infrastructure. 3. Have RFPs for system needs, such as those in constrained areas, so that competition can reveal the best solutions (like in the Brooklyn-Queens Neighborhood Program).
	There are limited measures in place that properly consider value stacking.	Create a value of DER tariff that adequately reflects a standardized cost-benefit analysis of a DER installation, allows for value stacking and includes locational values.

Area	Barriers	Solutions
Planning	The lack of integrated regional planning is causing municipalities to have limited influence on energy systems, which are largely in the hands of provincial regulators. The regional planning needs to become more effective.	1. Make electricity planners and regulatory applications demonstrate consideration of community/municipal energy plans in the early stages and throughout the planning process, and show how community preferences were considered in the final plan. 2. Consider whole-energy solutions that look at how electricity, heating and transportation can be combined. District energy, possibly with combined heat and power, is a local solution that is planned at the local level.
	Utility planning does not have a strong ability to consider non-wires solutions.	Require the IESO and LDCs to transparently consider NWS vs. traditional solutions when considering new infrastructure.
	There are limited measures in place that properly consider value stacking.	Create a value of DER tariff that adequately reflects a standardized cost-benefit analysis of a DER installation, allows for value stacking and includes locational and carbon values.
Policy	Policy uncertainty impedes development and planning to short term cycles.	1. Improve regulatory coordination between the regulatory and planning bodies like the provincial government, the IESO and the OEB. 2. Have long-term energy-planning frameworks. 3. Put emphasis on long-term targets and goals.
	Short political cycles deter long term energy planning.	Have long-term energy targets with clear planning frameworks.
	There is a need to address challenges beyond the GTA.	Evaluate new province-wide solutions for meeting electricity demand, such as imports of clean electricity or other new technologies.
Cost	The high number of fixed costs for alternatives makes non-emitting and low-emitting options difficult to implement.	1. Develop a mechanism so that utilities can receive a regulated return for implementing non-wires solutions. 2. Have a consistent DER connection process. 3. Allow more innovative energy efficiency offerings including strategic demand reduction through Energy Service Companies, either third-party or through utilities. Allow energy efficiency to participate as a DER resources.
	Multiple costs and benefits are too often not considered in energy planning.	Including multiple benefits, including economic, climate, and resiliency in planning and policy.
Information	There is a lack of energy data and information on the potential value of DER solutions.	1. Require utilities to provide locational, system-level data at the "transformer level" to provide locational values. 2. Require utilities to transparently develop cost-benefit calculators for DER projects, including locational values.
	Energy silos (i.e. wires vs pipes) leads to a lack of shared information	Ensure that all-energy planning is conducted, and that all utilities and the cities are part of the planning process.

Part 4

The Plan

4.1 Putting it all together

Once Pickering closes, there will be a large reduction in Ontario's non-emitting electricity generation. This will undercut the recent successes – paid for by Ontarians – that have contributed to making Ontario's electricity system largely non-emitting.

But as we have seen, there are actions that can be taken to reduce the need for additional natural gas-fired electricity generation to meet the GTA's energy needs and retain Ontario's low-emissions electricity system. While some of the activities can be led by GTA residents and municipal governments, there are limits to what the GTA can do by itself. Provincial policy and regulatory changes will be needed. The actions can be bundled into two areas:

1. **Promote conservation and energy efficiency**: Conservation and other demand-side measures are key, and the continuation of Ontario's conservation program is required. But the conservation framework also needs to change so that it can reduce the need for additional generation and reduce electricity use at times when the grid is particularly carbon-intense. Large-scale energy efficiency measures in congested areas can provide value, especially to consumers, through improvements to buildings and new appliances. At the same time strategic demand reduction can target specific system needs, such as deferral of new grid infrastructure or reducing demand when the emissions-intensity of the system is high. Many of these system needs will be location and time specific, and that needs to be included in any redesign.

In addition, optional new time-of-use rates should incent electricity use when the carbon intensity of the grid is at the lowest, such as at night or even during summer days when solar generation is at its highest. These new rates could be targeted at consumers who have switched to an electric vehicle or heat electrification to provide value for both them and the system for reducing the impact on the entire grid.

2. **Develop flexible markets and value-based DER programs**: The sector is changing rapidly, and any new market design has to have flexibility at its core to ensure we don't lock ourselves into carbon intensive long-term contracts. New DER installations can provide significant value to the grid and in replacing Pickering's output if they are sited in the right place and provide the needed energy services. Pickering is used to meet peak needs in the GTA (although the nuclear refurbishment schedule will change that). Therefore, reducing peak demand could reduce the amount of additional natural gas-fired generation needed, allowing Toronto to continue to benefit from a low-carbon electricity system.

A value-based DER compensation system could encourage building owners to optimize the use of storage and renewable generation to provide the required energy services, where and when they are needed, to help reduce peak demand in Toronto and hence the associated increase in emissions. There are interesting challenges for how and where to charge EVs and how that fits in to local infrastructure development. The Peak Power example is a good start in that direction, and changing tariffs to encourage charging when demand is low or when there is an abundance of non-emitting generation available could help with managing peak times.

4.2 Roadmap to action

To achieve those actions, we have created a roadmap of the best options for the next steps based on what we heard at the Expert Workshop (Figure 9). This roadmap has been broken down into three sections, the short-term actions (2020-2022), medium-term actions (2022-2024) and the long-term actions (2024-2030). While the GTA can help push these recommendations, much will have to be done at the provincial level and include the government, the IESO and the OEB to allow for effective integration with the Ontario electricity system.

Figure 9: Roadmap for replacing Pickering and integrating more local-energy planning and resources

Short-Term Actions 2020-2022

- Allow virtual net metering and aggregation
- Continue current conservation and develop an SDR framework
- Implement optional peak pricing
- Mandate inclusion of community energy plans into utility planning
- Require utilities to transparently consider non-wires solutions to infrastructure needs, and allow utilities to hold RFPs to find NWS
- Set long-term policy targets

Medium-Term Actions 2022-2024

- Ensure all stakeholders contribute to all-energy regional plans
- Allow for innovative energy efficiency offerings
- Integrate SDR into system planning
- Flexibility in future market reforms
- Develop comprehensive cost-benefit calculator for DERs
- Create a value of DER tariff
- Criteria for consideration of multiple benefits, such as cost, environmental and resiliency

Long-Term Actions 2024-onwards

- Update long-term policy commitments
- Evaluate new provincial solutions for meeting energy needs
- Implement long-term energy planning framework with targets
- Future market designs to include non-emitting DERs

How this could look: A residential example

How integrating value of DER tariffs and strategic demand reduction in a residential house can be confusing, so this how it could potentially look.

Envisioned here, a house in Toronto is extremely energy efficient and heavily insulated with best-in-class measures. Heating and cooling would be provided by an air-source heat pump, possibly with natural gas backup for the very cold days, all controlled by a smart thermostat. The natural gas is blended with RNG and hydrogen. The house would have one EV, as well as solar panels on the roof.

The occupants of the house have chosen the "Peak Saver Plus" tariff that has a lower off-peak rate but a much higher on-peak rate, and the timing for the on-peak and off-peak changes frequently to account for seasonal conditionals and grid conditions. The changes could even come daily, but the smart thermostat ensures that high electricity loads are only turned on when the price is low.

The smart thermostat would pre-heat or pre-cool the building based on an assessment of the carbon intensity of the grid. For example, in the summer, it would cool itself when the solar panels on the roof are at peak capacity during the day. In the winter, it would pre-heat the house at times of low demand, or when renewables were high on the grid. At peak periods, or when the grid is carbon intensive, heating or cooling could pause, allowing the in-door temperature to adjust within a prescribed limit.

When the EV is charged would again be based on both congestion on the local distribution grid as well as the carbon intensity of the grid. The EV can also provide storage services to the house in a blackout, or to reduce on-peak demand. The EV owner also charges at work, where they are compensated by the building owner for allowing their EV's battery to help reduce the building's on-peak demand.

The compensation they receive from the utility for their solar PV system are high as they are located in a congested area where the combination of their solar PV, smart heating and cooling, and use of the EV as storage allows for a deferral of new utility infrastructure. Most of their neighbours have similar systems, and they are all controlled by the utility to ensure that peak demand is reduced in their location, and that they optimize their electricity use when the grid has large amounts of renewable energy that would otherwise not be able to be used.

4.2.1 Short-term (2020-2022)

Pickering's retirement in 2024 or 2025 is fast approaching. But there are a number of measures that can be made relatively quickly to start moving the GTA in the right direction, but will require working with larger provincial entities, including the government, the IESO and the OEB.

One of the first activities can be for the province to allow **virtual net metering**. Given the limited number of sites for large-scale generation, virtual net metering, wherein a customer could purchase electricity from a renewable energy facility located outside the GTA to offset their consumption could help incent additional renewable energy development in Ontario. This could be of particular interest to large corporations interested in demonstrating leadership in reducing emissions and using non-emitting electricity. Virtual net metering can be seen as an interim measure while a more detailed DER tariff that provides for value stacking is prepared.

Conservation and demand management (CDM) has been a success story in Ontario, and is one area that can be relatively quickly expanded in the GTA to see short-term success in reducing the need for additional peaking power after Pickering. The value in conservation and demand reduction varies depending on the needs of a region. By **transitioning conservation programs in Ontario to a strategic demand reduction (SDR) mechanism**, conservation can be targeted at where it would provide the greatest system value. For this to happen, locational values for demand reduction would be needed. However, this transition will not be quick, and given that Ontario's CDM program ends in December 2020, the current program should be extended until the end of 2021 while a new system is developed.

Utilities also need to **transparently demonstrate consideration of non-wire solutions (NWS)** when new infrastructure or upgrades are proposed, including both demand reduction and non-emitting supply. While traditional infrastructure may be selected in the end for various reasons, utilities need to demonstrate why that was selected over the alternatives, and the reasons for that decision. Where NWS can be used, as was done in the Brooklyn-Queens Neighborhood Program, **RFPs for non-emitting services** should be encouraged to allow for innovative offerings that could allow developers to value stack projects. A shared-savings system whereby utilities can be compensated for choosing NWS over traditional solutions can be introduced, potentially modelled on the Lost Revenue Adjustment Mechanism (LRAM) that was used under the previous conservation framework. Another option could be further rate decoupling, where the volumetric rates are trued-up to maintain a revenue target. This could encourage energy efficiency and the use of NWS.

SDR programs should be an integral part of the NWS considered by utilities, and systems can be combined, such as efficient chillers and heat pumps with connected thermostats for DR, coupled potentially with storage or solar.

At the same time as allowing more choice in generation, new pricing models for consumers can be introduced, initially as "opt in". These new **peak pricing tariffs** can provide for a lower off-peak pricing with a higher on-peak price, and for different hours than is currently allowed. This new pricing system can be particularly useful for owners of EVs or for those with electric heating to incent off-peak use. The price could be based on locational prices, and designed to prioritize demand when there is an abundance of non-emitting generation on the grid, such as mid-day in the summer.[64]

64. As an example, see Robert Walton, "Ameren's hourly pricing program could reduce EV charging costs almost 90%, study finds," *Utility Dive*, February 11, 2020. At https://www.utilitydive.com/news/amerens-hourly-pricing-program-could-reduce-ev-charging-costs-50-study-f/572075/

All utility plans – electric and gas – need to provide **more consideration of community energy plans** and allow for community choice. As an example the TransformTO plan was not referenced in the 2019 Toronto Integrated Regional Resource Plan. Utilities need to consider other factors than the needs of the city, and there may be justifiable reasons for having utility plans diverge from community energy plans. But utilities still need to demonstrate that they have fully considered the city plans, and how community energy plans have influenced planning needs to be demonstrated.

Guidance will be needed to be given to the OEB and to the IESO. The government needs to provide **long-term policy targets** to guide and provide certainty to agencies, utilities and developers. Certainty on future policy will reduce risk, and hence costs.

4.2.2 Medium-term (2022-2024)

The short-term actions will help start moving the system, and allow for greater consideration of non-emitting options that could be implemented in the GTA. But to help meet the needs of the electricity system in the future, more will be required. While these actions will mostly be completed by 2024, planning for their inclusion needs to start immediately.

Regional energy planning needs to be expanded to include all regional stakeholders. Electricity planning has been conducted primarily by the IESO, the LDCs and Hydro One. While those participants hold the required technical expertise, as regions and communities start to choose their own paths, and as regional needs diverge given the economic changes in the provinces, plus the densification in urban areas, other stakeholders need to be part of energy planning. Any future plan is only as good as the will and support to see the plan succeed, and energy planning can no longer be divorced from the social and economic landscape. At a minimum, the cities, the natural gas networks, and any thermal network owners need to be at the table from the beginning and throughout the planning process. The planning needs to identify locations on the grid where demand reduction or non-emitting supply could provide value.

While much has been done on improving energy efficiency and promoting conservation in Ontario, there is scope for additional work. Toronto's TransformTO initiative has aggressive efficiency targets that will help reduce the need for additional energy after Pickering. Future building codes and the requirement for net-zero, or close to net-zero, buildings will help reduce energy needs.

In addition, **innovative energy efficiency programs** can help meet these targets. Such programs may include local improvement charges or on-bill financing. Another concept is known as Property Assessed Clean Energy (PACE). PACE lowers the risk and cost of the capital by making energy upgrade loans directly linked to the property's municipal tax obligations. Other forms of financing provided by Energy Service Companies (ESCOs) have been available for some time, while Green Bonds and business models that take over responsibility for infrastructure and sell energy as a service (EaaS) are emerging.[65]

65. Natural Resources Canada, *Financing Energy Efficiency Retrofits in the Built Environment*, August 2016. At https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Financing%20Report-acc_en.pdf.

Integrating SDR to meet system needs at a lower cost should be part of this, and incenting utilities to consider SDR as a system resource. One option to start SDR programs would be to procure energy efficiency through auctions at locations where it would provide system value. This would require delivery agents and potentially the use of the "Save on Energy" brand. In the US, a number of jurisdictions have developed energy efficiency resource standard (EERS), which are long-term targets that utilities must meet and could include SDR. As an example, in Massachusetts and Rhode Island, the EERS requires the utilities to reduce demand by 2.5% annually. The advantage seen for EERS is that the long-term goals allows for clear market signals and encourages large-scale investment.[66]

Market reform is needed to ensure future flexibility and to not lock us into long-term contracts with suppliers that may not be beneficial in the future. While in the short-term additional gas-fired generation may be needed, we need flexibility to move to non-emitting sources when available. When considering new generation in the GTA, we will need to move away from net-energy metering to more sophisticated tariffs that consider the costs and the benefits of any new project. As with the Value of DER tariff program in New York, utilities need to develop **transparent and comprehensive cost-benefit calculators for DERs that include locational benefits**. From these cost-benefit calculators, **value of DER tariffs** can be developed where developers can identify areas of the system where needs are greatest, and hence the value of any project could be higher, and identify the technology or technologies that could provide the greatest value to electricity system. Locational values will be key, and utilities must be transparent about the information on where energy services – be that for energy, capacity or ancillary services – are needed. The Value of DER tariffs will need to be continually updated to ensure that it provides the greatest value to all consumers.

The **comprehensive regional and local energy planning** identified above will be key in identifying those areas where DER installations can benefit the system the most. As part of the consideration of local energy plans, all-energy solutions, including electricity, heating and transportation, can be developed. District energy, possibly with combined heat and power, is a local solution that is planned at the local level. We also need to develop criteria for considering the multiple benefits of any potential solution, to move beyond strictly economics to properly value such considerations as environmental and resiliency benefits.

4.2.3 Long-term (2024-onwards)

The short- and medium-term actions will help move the GTA and all of Ontario to a future energy system that is innovative, flexible and less expensive. But as we look beyond Pickering, more actions will be needed.

The government's **long-term policy commitments will likely need to be continually updated** as new developments make Ontario re-evaluate what we want for the future. To understand the optimal solutions for reducing emissions in Toronto and Ontario, policy certainty and the development of a carbon reduction cost-abatement curve would help in deciding where resources could be more cost effectively invested in reducing emissions. Electricity may not be the most effective place. But without clarity, it is hard to know.

66. American Council for an Energy-Efficient Economy, *Energy Efficiency Resource Standard (EERS)*. At https://aceee.org/topics/energy-efficiency-resource-standard-eers.February 11, 2020. At https://www.utilitydive.com/news/amerens-hourly-pricing-program-could-reduce-ev-charging-costs-50-study-f/572075/

Technology will change, and **new solutions may arise that could be used to help reduce Toronto's emissions**. This includes clean electricity imports, more advanced storage, the introduction of hydrogen or renewable natural gas or even advanced small-modular reactors, all of which could change the energy system as we look past-2025. Energy planning will need to be flexible enough to ensure that the best solutions can be introduced.

And to allow for that, a continuation and deepening of a **fully integrated all-energy planning system** will be needed, thereby ensuring that energy planning meets present and future provincial, regional and community needs. Future electricity market designs will need to be designed to ensure that non-emitting DERs can effectively compete.

Part 5 Conclusion

Replacing Pickering with non-emitting solutions over the next half decade is an ambitious goal. But what we heard is that technology is not barrier. The technology exists.

It will not be easy. The way Torontonians use and provide electricity will need to change. And while people in the GTA can start the changes, energy is larger than just the GTA, and the provincial government, system operators and regulators will need to be partners in creating a future energy system that can benefit everyone.

On the use side, there are numerous measures that can be taken to reduce energy use without compromising our lifestyle. Reducing our demand has the added benefit of lowering costs in the long term as less energy, and less costly infrastructure to provide that energy, is required in the future. We need to continue to support conservation, while at the same time shifting to a more detailed demand reduction system that can provide value to the system as well as the customer.

On the supply side, we need to ensure we don't lock high emitting generation into the system. Non-emitting generation technologies, including district energy, are available, and storage can provide significant value – if they are integrated properly, and if the rates they receive properly compensate them for both the costs and benefits of their solution. The hope is that by providing proper price signals, developers and building owners – residential and commercial – will make efforts to unlock these benefits. We need to ensure that the market has the flexibility to take advantage of cost-effective non-emitting solutions.

To replace Pickering, the real need is in the full integration of the demand and supply sides. New techniques of integrating demand management with non-emitting DERs, and managing the resources so they provide value to the electricity system, can not only reduce costs and improve service, it can help reduce emissions from our electricity sector. There is great potential for real integration – merging demand-side measures with DERs, including storage – that will allow for much greater value to both consumers and the grid.

There is thus great opportunity to keep our low-emissions electricity grid, while also saving money for consumers and providing additional benefits such as resiliency and economic development. The barriers we heard were around how these new solutions could be applied in Toronto, and how their value can be recognized. The main barriers here were seen in the planning, regulatory, market and policy process. In one sense this is great: such barriers are more easily solved, if we all work together.

Firstly, the planning process for the system operator, the electric and gas utilities needs to be improved. The IESO has made great improvements in its planning processes over the past decade. More can be done, and it is crucial that those who live there, and their representatives are integrally part of planning. Our energy system is not created in a vacuum. It is there to serve people and communities, many of whom want to determine their own energy futures.

On the regulatory side, there needs to be the development of a clear understanding of how utilities need to consider communities needs and desires when developing their plans and proposing infrastructure. Utilities need to be encouraged to try new methods of doing things, such as NWS. The direction and guidance needs to come from the regulator.

The market needs to be revised to ensure that the value DERs can provide, including strategic demand reduction, is adequately compensated. This will require development of a sophisticated value of DER tariff, based on transparent and consistent cost-benefit analysis, with open data, and include locational values. A transparent cost-benefit system will enable developer and innovators to find new and innovative solutions.

Of course, for all of this to happen effectively, there needs to be clear long-term policy. Policy inconsistency and uncertainty hampers innovation and investment.[67] While the GTA and its residents can do a lot, they cannot do it alone, and political commitment from the province is required for a sustained and effective transition.[68]

We can develop non-emitting solutions – both on the demand and supply side – to help Ontario retain its clean electricity system, and prepare for an even cleaner future.

67. See Bruce Cameron, Richard Carlson, and James Coons, *Canada's Energy Transformation: Evolution or Revolution?*, Pollution Probe and QUEST, April 2019. At https://www.pollutionprobe.org/wp-content/uploads/QUEST_Pollution-Probe-Policy-Innovation-Report.pdf
68. World Economic Forum, *Fostering Effective Energy Transition, 2019 edition*, March 2019. At http://www3.weforum.org/docs/WEF_Fostering_Effective_Energy_Transition_2019.pdf