Overview of Ontario's Electricity System

Queen's University

May 17, 2018

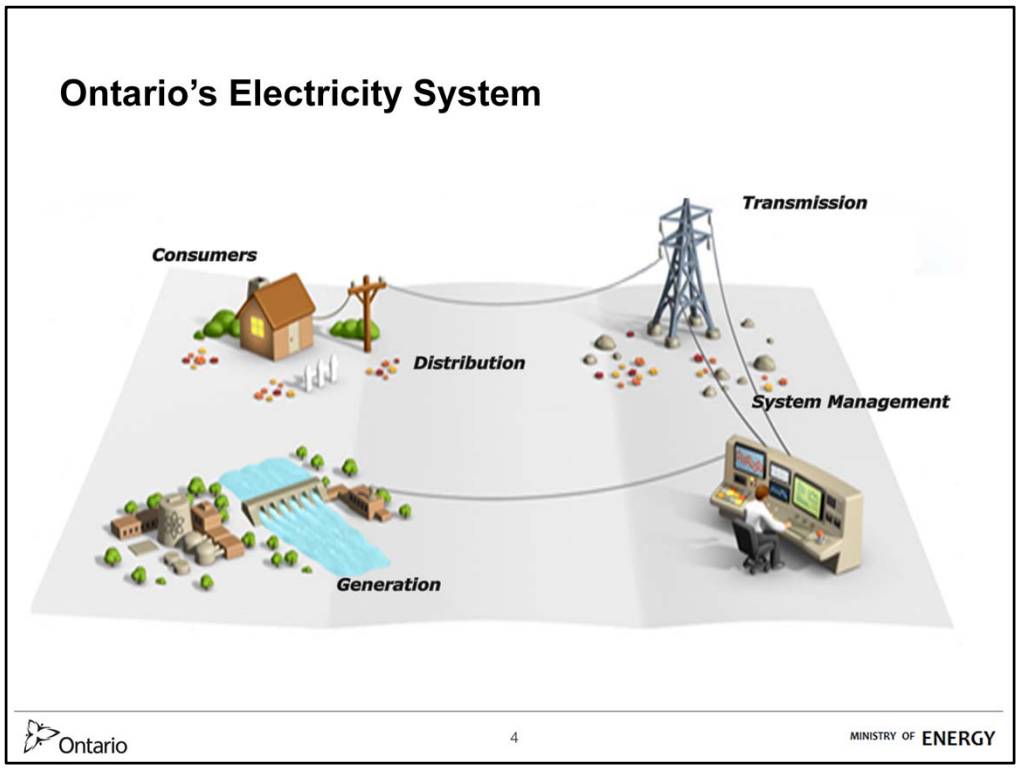
Presentation:

Part I – Key Features of Ontario's Electricity System

Part II – Electricity System Planning

Part III – Key Trends and Initiatives

Part I – Key Features of Ontario's Electricity System



Generation
-Different generators provide baseload power, peaking capacity, intermittent power.

-Baseload power – Generation sources designed to operate more or less continuously through the day and night and across the seasons of the year. Nuclear and many hydro (i.e., run-of-river) generating stations are examples of baseload generation.

-Peaking capacity – Generating sources typically used only to meet the peak demand (highest demand) for electricity during the day; typically provided by hydro (i.e., with reservoirs or dams) or natural gas generators.

-Intermediate generating units – Generators which operate between baseload and peaking generators, and typically vary their output to adapt as demand for electricity changes over the course of the day and year. Note: In Ontario, natural gas generators are the primary intermediate generating units.

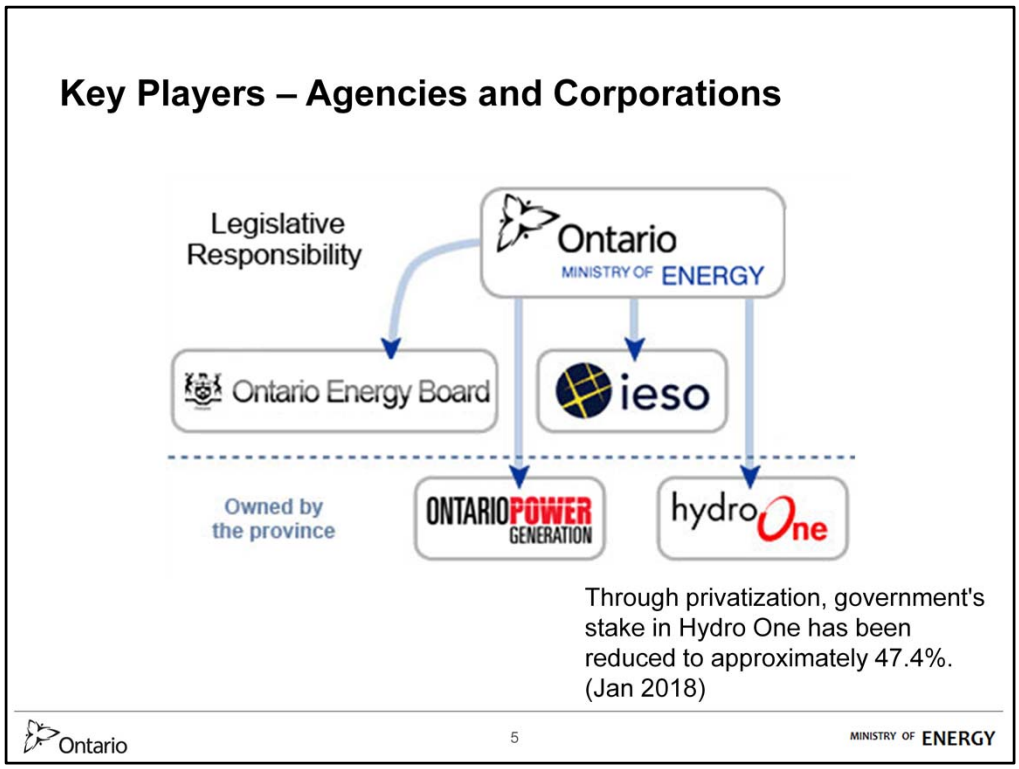
-Intermittent power generation – Generation sources that produce power at varying times, such as wind and solar generators whose output depends on wind speed and solar intensity.

Distribution
- The distribution system brings electricity to low-voltage consumers, which comprise the majority of customers in the province. There are about 5.1 million distribution customers in the province. About 4.6 million are residential, and about 500,000 commercial customers that can be small business or large commercial or industrial customers.

- There are around 70 distributors in the province. The majority are owned by municipalities. However, there are some that are privately owned. Hydro One Networks is the largest distributor with over 1 million customers. It is partially owned by the province and private investors.

Transmission

- The transmission system is the high voltage grid. It connects generators, but also interconnects other regions, such as Quebec, Michigan, New York, Manitoba and Minnesota with Ontario. A small number of high voltage customers (called directly connected customers) connect to the transmission system at transmission voltages. Local distributors also connect to the transmission system.
    - Transmission is legislatively defined in the Ontario Energy Board Act as conveying electricity at voltages greater than 50 kilovolts (kV). Distribution is defined as conveying electricity at 50 kV or less.



Ministry of Energy

- Responsible for oversight of the sector
- Provides planning and regulatory framework for the sector

Ontario Energy Board (OEB)

- Independent adjudicative tribunal responsible for regulating Ontario's natural gas and electricity sectors.
- Part of its mandate is to protect the interests of consumers with respect to prices and the reliability and quality of electricity.

Independent Electricity System Operator (IESO)

- Manages the reliability of Ontario's power system and forecasts the demand and supply of electricity.
- Operates the wholesale electricity market, while ensuring fair competition through market surveillance.

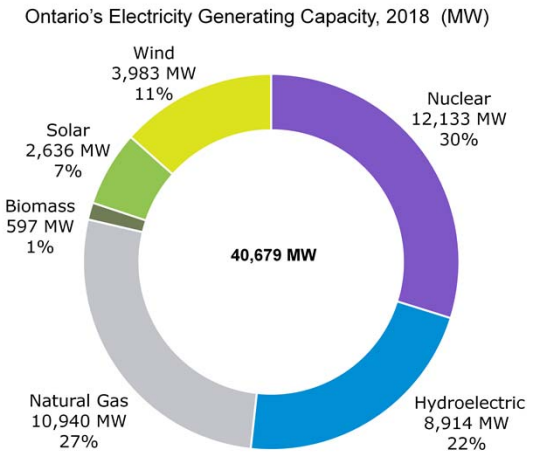
Ontario Power Generation (OPG)

- Provincially-owned electricity generation company - its hydroelectric, nuclear and fossil fuel stations generate approximately 60% of Ontario's electricity.

Hydro One

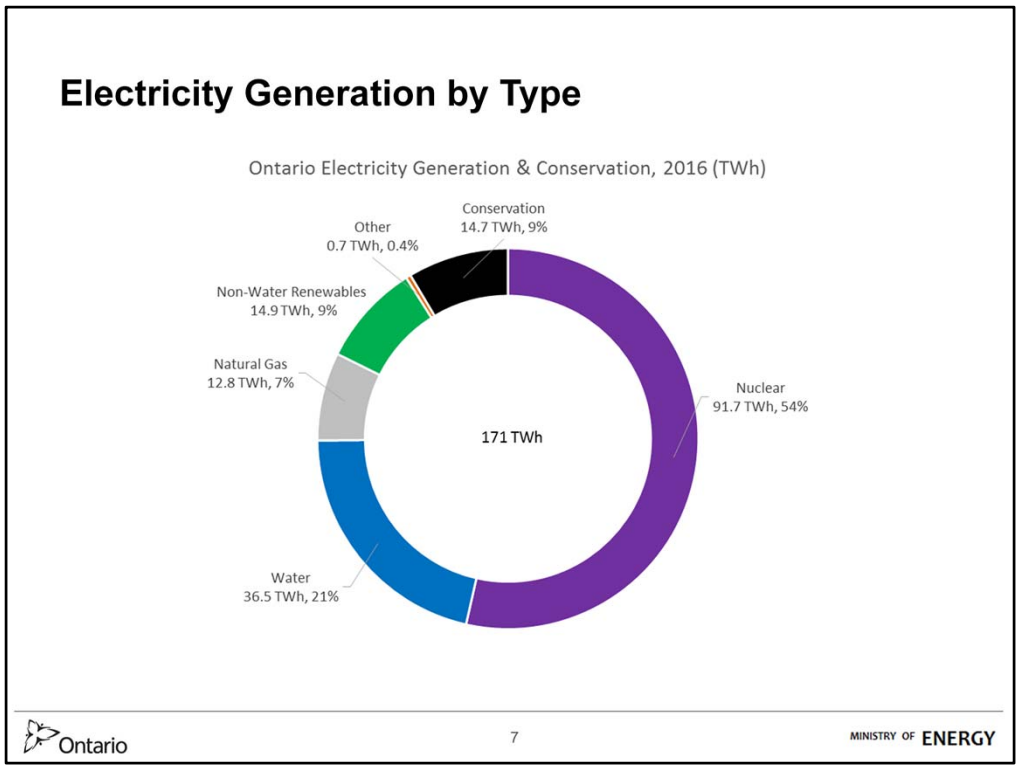
- Operates the majority of Ontario's transmission lines.
- Serves as an electricity local distribution company in some areas of the province.
- Through privatization (2015-2018), Ontario government's stake in the company has been reduced to approximately 47.4%

Generation Capacity by Type



Ontario 6 MINISTRY OF ENERGY

- Two main services provided – energy and capacity
- As electricity cannot be easily stored, we must have enough capacity available to satisfy the highest expected demand.
- The amount generators run is referred to as their capacity factor. Natural gas and nuclear provide about the same amount of capacity, but nuclear produces more than twice as much energy due to its high capacity factor.
- Nuclear and waterpower provide most of the capacity that is always on (i.e., baseload) – 75% of Generation during 2016.
- Coal (and natural gas) used to provide the capacity needed to meet periods of high demand (peaking generation). With the phase-out of coal generation, gas plays an increasingly important role.
- Wind and solar provide intermittent generation that is only available when the wind is blowing or the sun is shining.



- Ontario is unique from other jurisdictions in that it has a <u>diverse</u> supply mix. In 2016, Ontario produced:
  - **More than 50%** of its electricity from nuclear power;
  - With renewable (or non-greenhouse gas (GHG) emitting) resources providing **about 30%**; and
  - Emitting resource accounting for **less than 10%** of total generation, however the natural gas fleet plays an important strategic role by providing peaking and ramping capability.

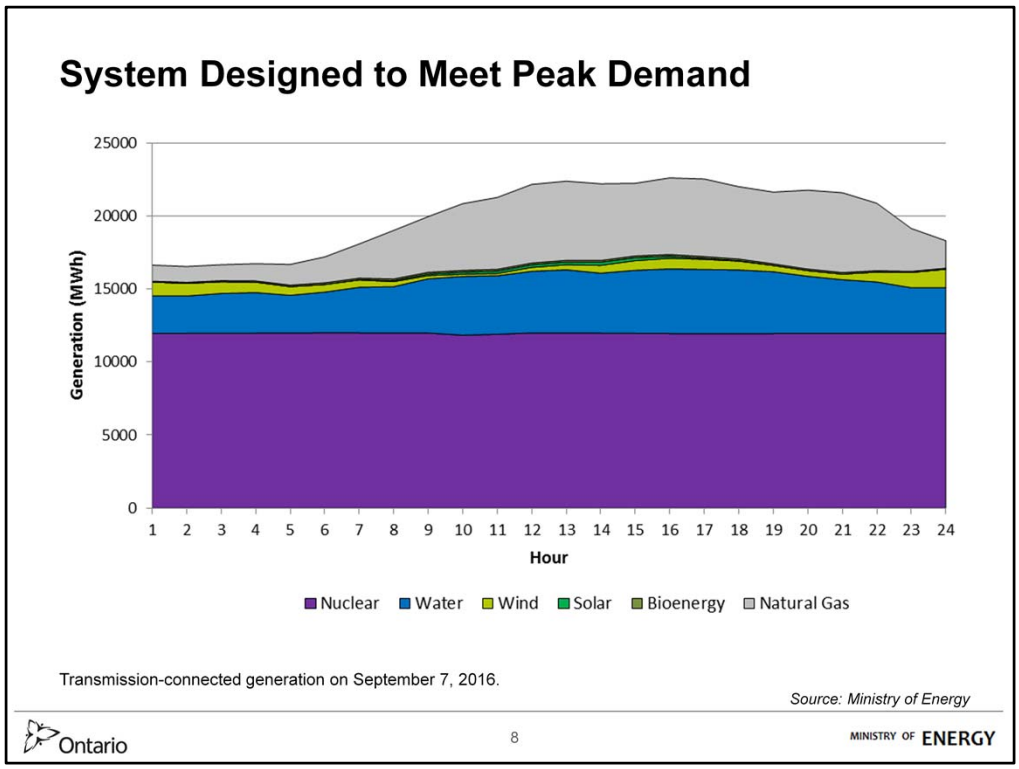
- Conservation also helped by reducing energy consumption by **about 9%**. (~15 TWh)

- This is a significant transformation compared to 2003, when one-third of all generation came from emitting resources. Ontario now has an electricity system that is well-positioned for the future.

<u>2016 Generation and Conservation</u>

- Nuclear – 91.7 TWh
- Hydro – 36.5 TWh
- Natural Gas – 12.8 TWh
- Wind – 10.7 TWh
- Solar – 3.5 TWh
- Biomass – 0.7 TWh
- Other – 0.7 TWh
- Conservation – 14.7 TWh

- Generation reflects the sum of transmission and distribution connected sources.
- Conservation value represents persistent savings in 2016 from programs and codes and standards since 2006.



- Our electricity system is designed to meet the peak demand plus a reserve margin.
- By design, this means that some generators will only be needed during high demand periods such as hot summer days. Natural gas and some waterpower plants increase production through the morning as air conditioning demand is added to the system.
- If there is demand in export markets, any generation that is surplus to domestic needs can run to meet needs in other jurisdictions. Any profit from export sales can be used to defray the fixed costs of running the peaking stations.
- During extremely low demand periods, such as overnight in the spring and fall, some baseload generation may be curtailed if there is insufficient demand on export markets.

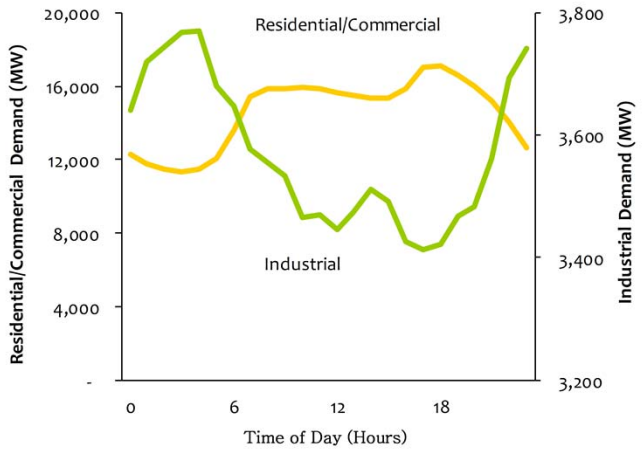
On a warm summer day demand will typically reach around 22,000 MW.

Nuclear stations run continuously, along with some waterpower. Wind plants generate according to wind availability and can be shut off in cases of surplus generation (typically at night).

The summer (and all-time) peak for electricity demand set on August 1, 2006 was 27,005 MW.

The winter peak for electricity demand set on December 20, 2004 was 24,979 MW.

Example of Electricity Demand Through the Day



Source: Ministry of Energy

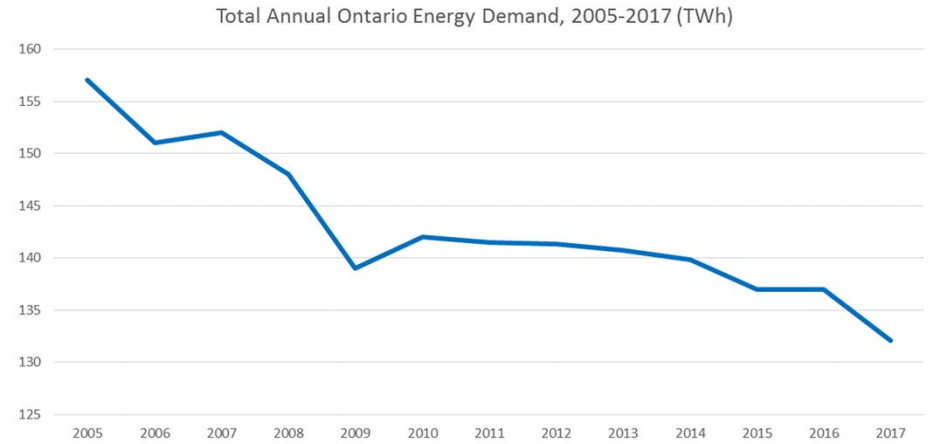
Ontario

9

MINISTRY OF ENERGY

- Industrial demand is highest at night to take advantage of low wholesale electricity prices.
- Residential and commercial demand peaks during the morning and late afternoon. These loads are less responsive to price.
- Summer demand typically reaches its highest levels during late afternoon, and after consecutive hot days.
- Record demand of 27,005 MW was set in the summer of 2006. Current peaks do not exceed 25,000. Baseload (minimum) demand is typically 11,000 to 14,000 MW.

Total Demand Has Been Declining



Source: IESO

Ontario

10

MINISTRY OF ENERGY

- Since 2005, annual grid demand has declined 16% to 132 TWh in 2017 due primarily to the following factors:
  - Changes in the economy;
  - Energy efficiency programs and improvements in building codes and equipment standards;
  - Changes in consumer behaviour; and
  - Growing presence of embedded generation.

- Electricity Demand is shaped by a variety of factors that have different impacts:
  - Decrease demand: Conservation, embedded generation (net metering)
  - Increase demand: Strength of the economy, manufacturing, population growth
  - Shift demand: Time of Use rates (TOU), Industrial Conservation Initiative, etc.

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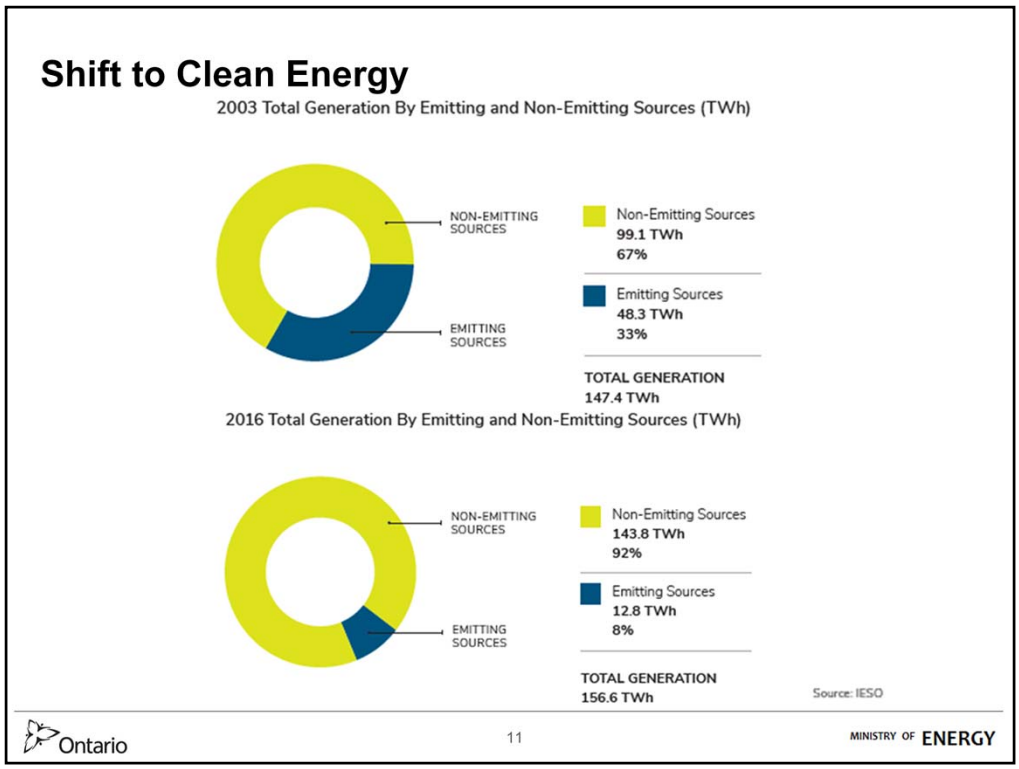
  - Changes in the economy;
  - Energy efficiency programs and improvements in building codes and equipment standards;
  - Changes in consumer behaviour; and

- Growing presence of embedded generation.

- The 2017 Long-Term Energy Plan (2017 LTEP) forecasts that electricity demand will be relatively steady over the planning period. (2017-2035):
- In the longer term, IESO projects an increase in overall demand as electrification of the economy increases.
- The 2017 LTEP demand outlook assumes the equivalent of approximately 2.4 million electric vehicles by 2035 and includes demand from new electrified transit across the province (i.e., GO Rail and light rail projects across the province).



- Nearly $70 billion has been invested in the electricity system since 2003 – these investments have several benefits, including providing a clean, reliable electricity system.
- In 2003, around 33% of the province's generation mix came from sources that emit greenhouse gases (GHG). In 2016, emitting sources only represented about 8% of total generation in Ontario.
    - Coal accounted for 36.6 TWh of generation in 2003, representing about 25% of Ontario's generation.

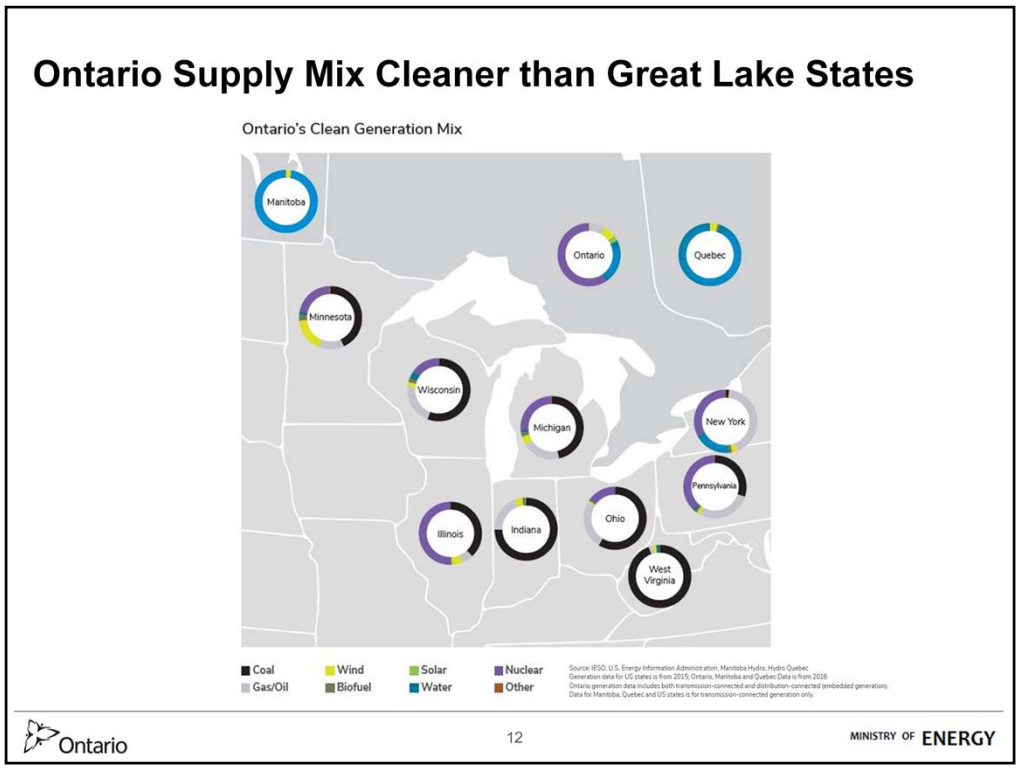
2003 Generation

- Nuclear – 63.2 TWh (43%)
- Hydro – 34.7 TWh (24%)
- Gas/Oil – 11.7 TWh (8%)
- Coal – 36.6 TWh (25%)
- Other – 1.2 TWh (1%)

2016 Generation

- Nuclear – 91.7 TWh (59%)
- Hydro – 36.5 TWh (23%)
- Natural Gas – 12.8 TWh (8%)
- Wind – 10.7 TWh (7%)
- Solar – 3.5 TWh (2%)
- Biomass – 0.7 TWh (0.5%)
- Other – 0.7 TWh (0.5%)

- Hydro is steady, at around 24% of total generation.
- Nuclear has increased from 43% to 59%, showing its importance in providing clean, reliable power generation for Ontario. This includes the return to service of two units at the Bruce Nuclear Generating Station.
- Coal accounted for 36.6 TWh of generation in 2003, representing about 25% of Ontario's generation.
- Significant increase in non-hydro renewables – representing almost 10% of total generation in 2016.

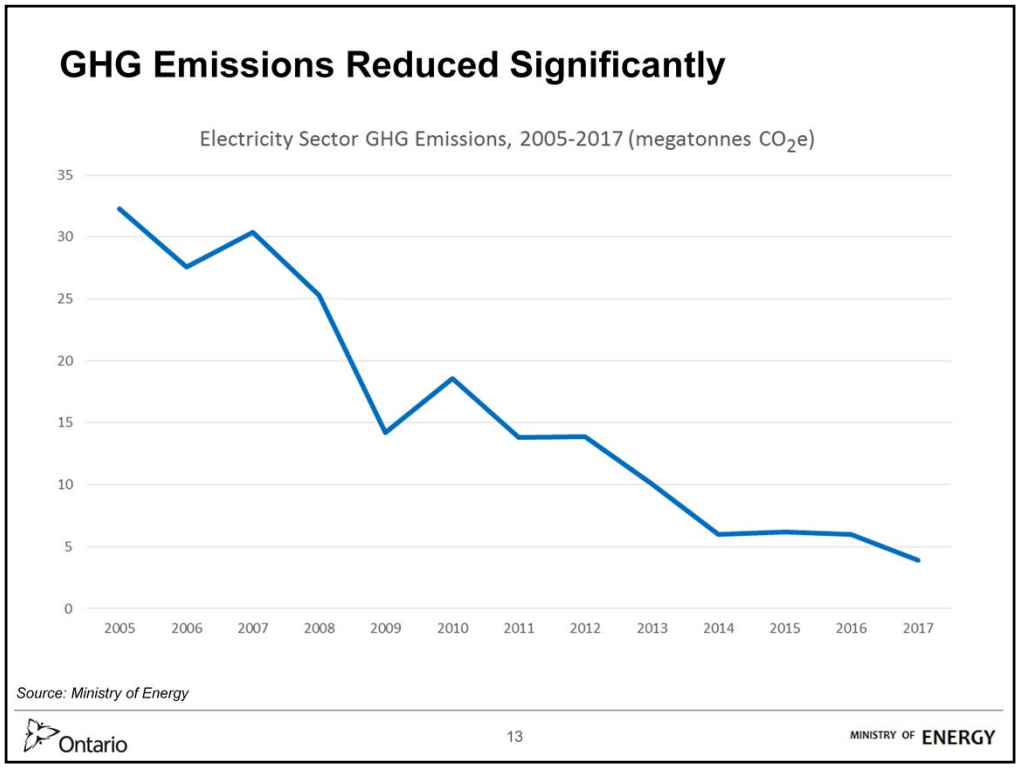


- In comparison to neighbouring states such as Michigan, Minnesota, Ohio, Pennsylvania and New York, which still rely heavily on fossil fuel-fired electricity generation, Ontario has a much cleaner electricity system.
- We have accomplished this without the abundant hydroelectric resources enjoyed by Quebec and Manitoba.

- Ontario was the first jurisdiction in North America with a significant reliance on coal-fired electricity to eliminate coal as a source of electricity production.
- Replacing coal-fired electricity generation was the single largest climate change initiative undertaken in North America.

- **Coal** is heavily used in some of the states depicted in this jurisdictional map.
    - Ohio (59%), Wisconsin (56%), Indiana (75%) and West Virginia (94%) all rely on **coal** for more than 50% of their states' electricity generation.

- **Solar** accounts for the largest percentage of generation in Ontario.
- **Hydro** is highest in Ontario (23%) apart from Quebec and Manitoba, which both boast abundant hydroelectric resources. New York has around 19% hydro generation; the other states all account for less than 3.5% hydro.
- Only Minnesota (17.2%) has a higher **wind** % than Ontario at 7%.
- Many of our neighbouring states also heavily rely on **gas and oil** – New York (42%), Pennsylvania (28%), Michigan (20%), Ohio (25%). Ontario is only 8%.



- As a result of phasing out coal-fired electricity generation in 2014, Ontario's electricity system was over 95% emissions-free in 2017.
- Investments in these types of clean generation sources, along with the elimination of coal-fired electricity generation, have significantly reduced greenhouse gas (GHG) emissions in the province.
- GHG emissions from Ontario's electricity sector declined 88% between 2005 and 2017 – from 32.3 megatonnes GHG emissions to 3.9 – as a result of declining electricity demand and the closure of Ontario's coal-fired generation.
- As a result of phasing out coal-fired electricity generation in 2014, Ontario's electricity system was over 95% emissions-free in 2017 – generated from non-emitting resources such as water, nuclear, wind, solar and bio-energy.
    - Our investments in these types of clean generation resources, along with the elimination of coal-fired electricity generation, have significantly reduced GHG emissions in the province.
- Ontario will continue to look for ways to keep GHG emissions in the electricity sector low and work with non-emitting generators to meet the Province's emissions targets.

Ontario vs. Neighbouring Jurisdictions

- In comparison to neighbouring states such as Michigan, Minnesota, Ohio, Pennsylvania and New York, which still rely heavily on fossil fuel-fired electricity generation, Ontario has a much cleaner electricity system.
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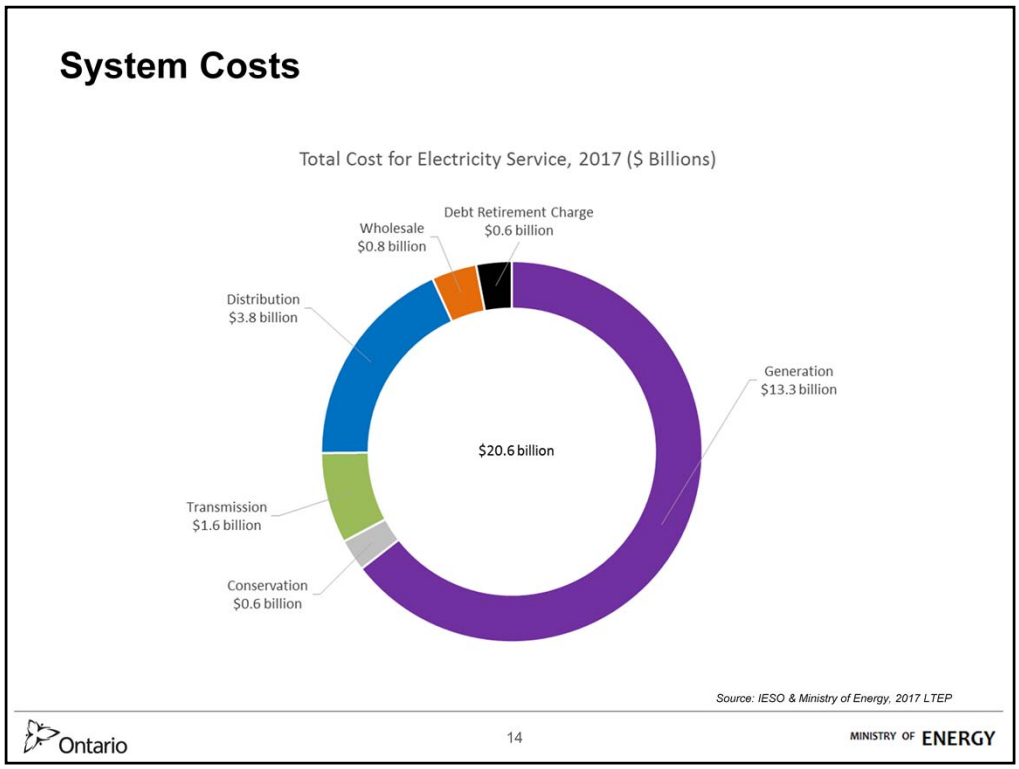


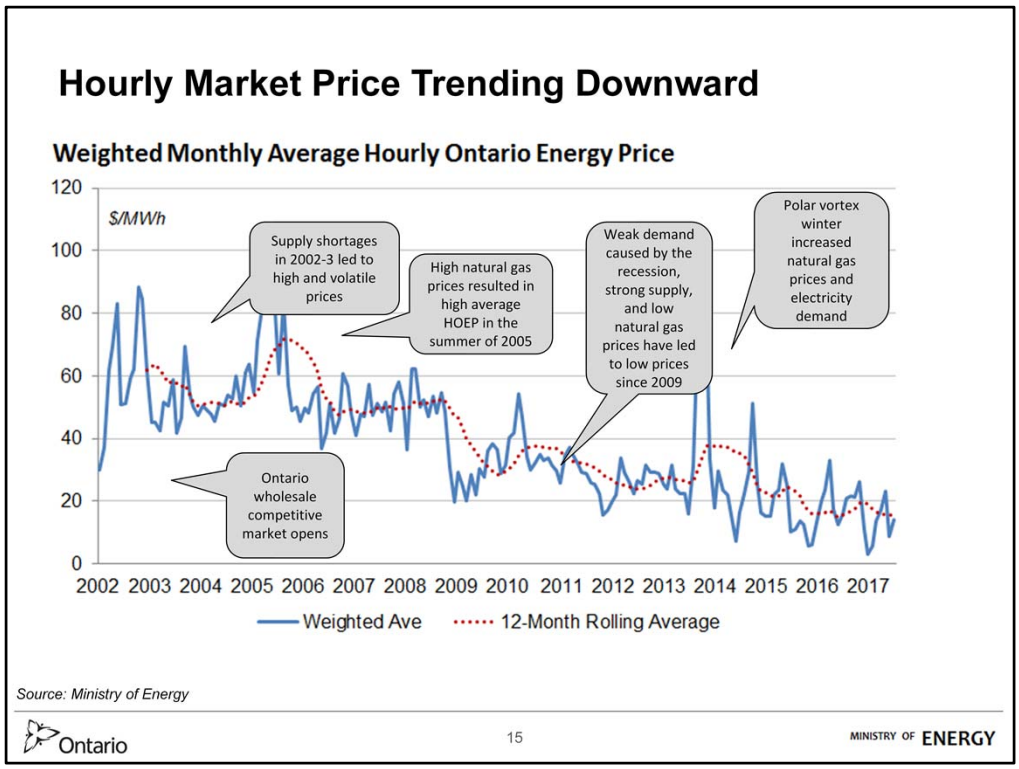
2017 Numbers

- Generation – 64% of total costs. In the current market the majority of this is recovered through GA.
- Distribution – 18%
- Transmission – 8%
- Wholesale – 4%
- Conservation – 3%
- Debt Retirement Charge – 3%

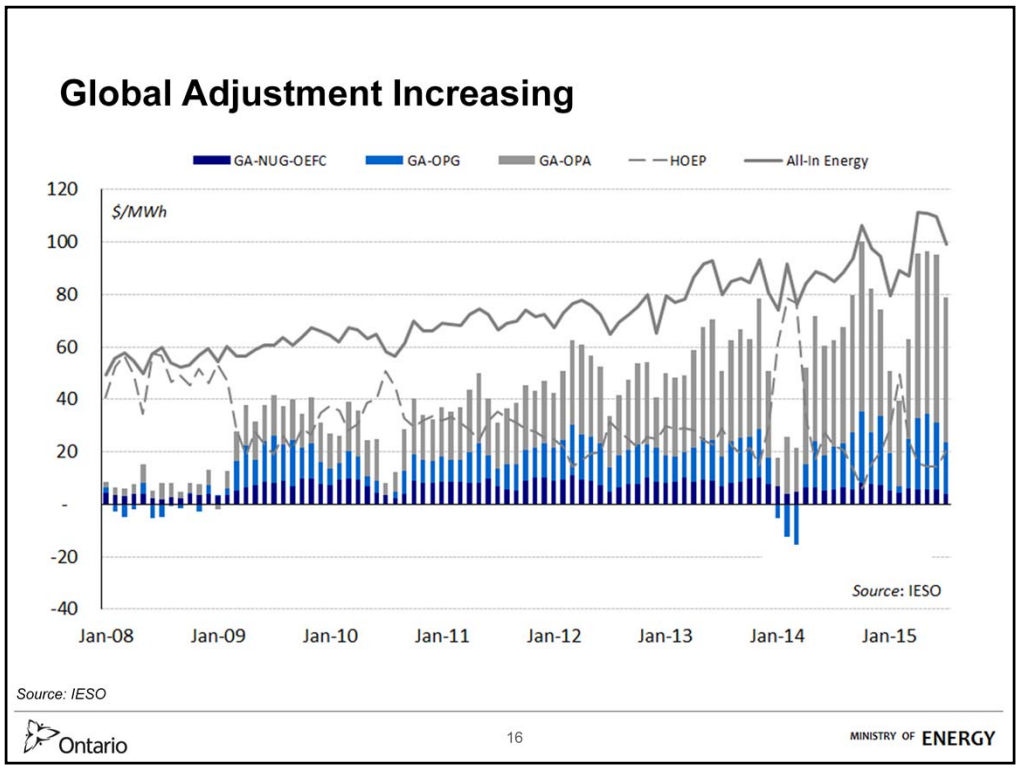
[1] Generation costs include Industrial Electricity Incentive program costs

[2] Conservation costs include Energy Efficiency delivery cost and Aboriginal, Community, and Municipal Funds

- The total cost of electricity service forecast over the period of 2017 to 2035 is fairly steady.
- $20.2 billion in 2019 after Debt Retirement Charge brought down to 0… $19.1 billion in 2035.
- Total cost of electricity service over the planning outlook is a function of demand growth, the cost of operating the existing system and the investments required in new resources to meet potential needs.



- The wholesale price of electricity is determined in the real-time market administered by IESO. All electricity consumers in Ontario pay the wholesale price, also referred to as the commodity price, except for those who have entered into a retail contract. The IESO calculates the hourly Ontario energy price (HOEP), which is charged to large consumers that participate in the market, as well as local distribution companies (LDCs) who recover it from the subset of customers that pay the market price.
- The HOEP is the average of the twelve market clearing prices (MCP) set in each hour. A new MCP is set every five minutes.
- HOEP is influenced by supply and demand factors, as well as underlying commodity prices (generally natural gas) that impact the offers that generators submit into the market.



- HOEP is only one part of the total commodity cost for electricity. Global Adjustment (GA) is the component that covers the cost of building new electricity infrastructure in the province, maintaining existing resources, as well as providing conservation and demand management programs.

- GA is a regulatory mechanism that allows generators to recover costs when wholesale market revenues are insufficient to do so.

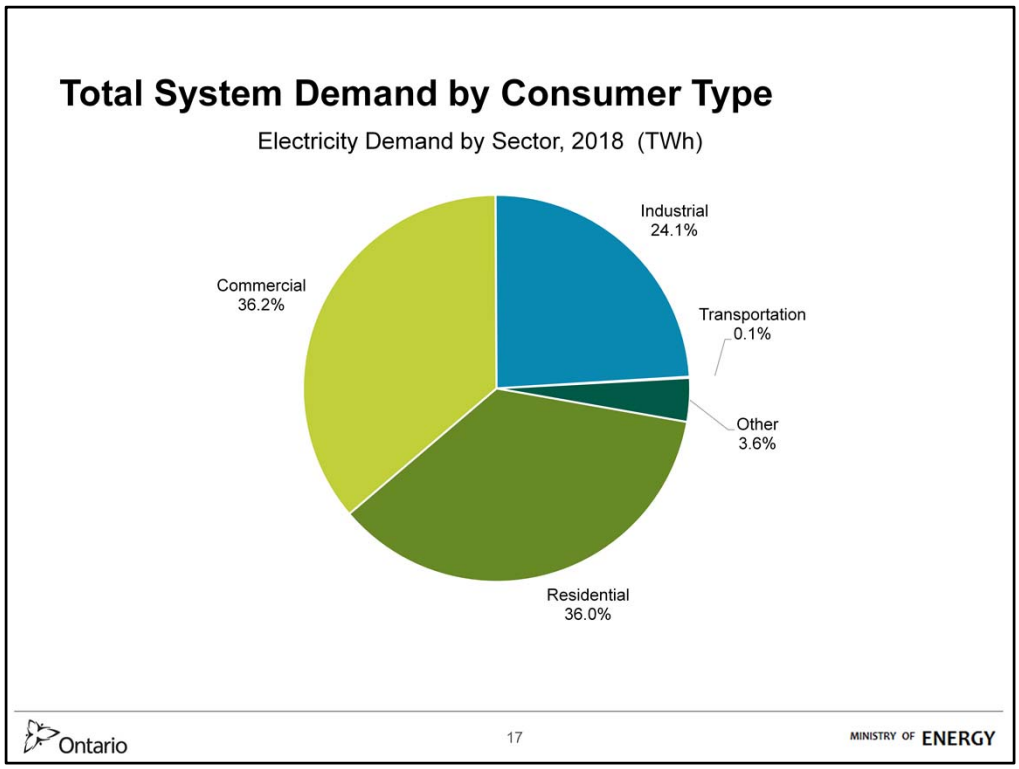
- GA in any given month is equal to the sum of:
  - The difference between the market price and the regulated price OPG is entitled to receive for the output from its regulated facilities;
  - The difference between the market price and the contract price OPA-contracted generators are entitled to receive;
  - The difference between the market price and the payments to Non Utility Generators (NUGs) who have long standing contracts with the Province; and
  - OPA conservation and demand management (CDM) spending.

- GA and HOEP are inversely proportional. As HOEP increases, generators require fewer funds through GA and vice versa.

Ontario's Fair Hydro Plan

- Ontario's Fair Hydro Plan (OFHP) has lowered electricity bills by 25% on average for residential consumers and will hold increases to the rate of inflation for four years, and includes initiatives to reduce costs for businesses. The plan includes the 8% rebate

introduced in January 2017 and builds on previously announced initiatives to deliver broad-based rate relief on all electricity bills.



- Ontario's total electricity demand is the sum of demand from the residential, commercial, industrial, agriculture and transportation sectors.
- In 2018, total Ontario demand is forecast to be about 143 TWh as per the 2017 LTEP.
- The costs borne by ratepayers are as follows:

Residential and Small Business Consumers

1. **Regulated Price Plan (RPP):** About 4.8 million residential and small business consumers pay either time-of-use or tiered prices under the RPP. RPP prices are adjusted every six months (in May and November) by the OEB based on projected supply cost over the next 12 months.

Time-of-use (TOU) prices – Nearly 4.5 million consumers

- TOU prices are intended to provide an incentive to consumers to shift consumption away from high demand periods when the cost to meet province-wide demand is higher.

Tiered prices – About 300,000 consumers

- Some consumers still pay tiered prices that are based on the amount of electricity consumed rather than the time at which the electricity is consumed.
- The threshold is 600 kWh from May to October and 1,000 kWh from November to April, to reflect the fact that households require more electricity in winter months. The threshold for non-residential customers is 750 kWh/month and does not change throughout the year.

2. **Fixed-price contract:** *~350,000 residential and small business consumers*

- Purchase electricity at a fixed rate from private electricity retailers.
- Contracts typically last three to five years.
- Global Adjustment costs are charged on top of the contract price.

Mid-Size and Large Commercial and Large Industrial Consumers

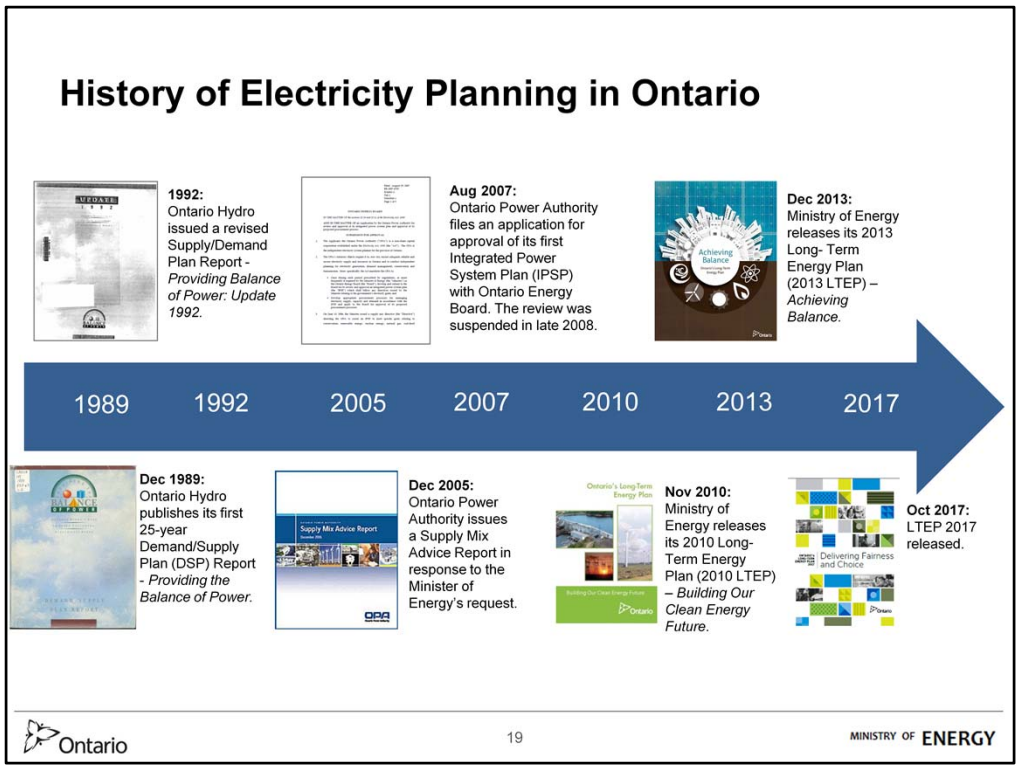
3. Commercial consumers: *All mid-size and large commercial consumers (demand > 50kW)*

- Buy electricity at the wholesale market price from their local utility or though a fixed-price contract with an electricity retailer.
- Commercial electricity prices have increased steadily over the last decade, in large part due to an increase in the commodity portion of the bill.

4. Large industrial/commercial consumers *~1,100 consumers (demand >500 kW)*

- Participate directly in the IESO-administered market, paying the wholesale market price.
- Eligible for Industrial Conservation Initiative

Part II – Electricity System Planning



1989 Demand/Supply Plan

Background

The DSP identified key issues within the electricity system and provided recommendations by stakeholders through submissions and reports, guided by the principles that: programs contribute to customer satisfaction, reliability is paramount, low customer cost is vital, activities are conducted in an environmentally and socially acceptable manner and rates must continue to be based on cost.

Goals of the plan

Consult with customers, the public, governments and the legislature during the planning process

Pursue demand reducing options to the full extent they are economic compared to the available supply options

Aim demand management programs at shifting demand from peak to off-peak times

Develop economic hydroelectric generation

Maintain CANDU nuclear so that it is available for future development

Maintain and improve Ontario Hydro's knowledge of new developing coal burning technologies that promise reduced emissions and/or increased flexibility

Consider long term firm purchases of hydroelectric power from neighbouring provinces as an acceptable alternative to building new supply

1992 Demand/Supply Plan Update

Background

In 1992, the DSP was revised due to a lower than projected demand in the short term. In the long term, demand continued to decrease due to increased efficiency and fuel switching.
By 1993, as the Darlington Nuclear Generating Station came into service and resources from NUGs became available combined with the lower than projected demand during the recession, electricity prices increased in the early 1990s.
This resulted in the government to freeze prices from 1993 to 2002, adding to the debt of Ontario Hydro.
The updated DSP was withdrawn by Ontario Hydro and no additional generating facilities were built.

Goals of the plan
Consistent with the original submission, but some planning considerations were updated to reflect changing conditions
Continue to maximize use of demand management
Extend the life of several fossil stations to make the best use of the existing system
Rely on NUG resources which has increased in supply availability
Take into account special interests of aboriginal community for hydroelectric developments

2005 Supply Mix Advice

Background
The Supply Mix Advice presented recommendations of the OPA to the Minister of Energy on options for the future development of Ontario's electricity system over the long term.
It responded to a request from the Minister on May 2, 2005 for advice on the appropriate mix of electricity supply sources to satisfy the expected demand in Ontario, taking into account conservation targets and new sources of renewable energy out to 2025 to ensure a reliable system, stable rates and considerations of environmental impacts.
This report was issued shortly after a supply shortage in 2004.

Goals of the plan
Phase out of coal fired generation
Produce electricity from combinations of energy sources and generation technologies
Increase generation capacity from alternative energy sources, renewable energy sources or other energy sources
Develop and implement conservation measures, programs and targets on a system wide basis or in particular service areas
2007 Integrated Power System Plan

2007 Integrated Power System Plan

Background
With a mandate to conduct independent planning for electricity and develop integrated power system plans for Ontario, the OPA filed an IPSP to the OEB.
The IPSP was a 20-year plan that assisted the achievement of the government's goals identified in the June 2006 Supply Mix Directive.

Goals of the plan
Reduce demand by 6,300 Mw by 2025

Ensure adequate supply and maintain the ability to use natural gas capacity at peak times
Double the amount of renewable supply to 15,700 Mw by 2025
Plan for nuclear capacity to meet base load requirements but limit the capacity over the life of the plan to 14,000 MW
Replace coal in the earliest practical time frame to ensure adequate generating capacity and electricity system reliability in Ontario
Strengthen transmission system:

- Enable the achievement of the supply mix goals set out in the June 2006 Directive
- Facilitate development and use of renewables resources
- Promote system efficiency and congestion reduction and facility integration of new supply

2010 Long-Term Energy Plan

Background
The focus of the 2010 LTEP was to ensure that Ontario is able to meet its electricity needs until 2030 to build a modern, clean and reliable system.

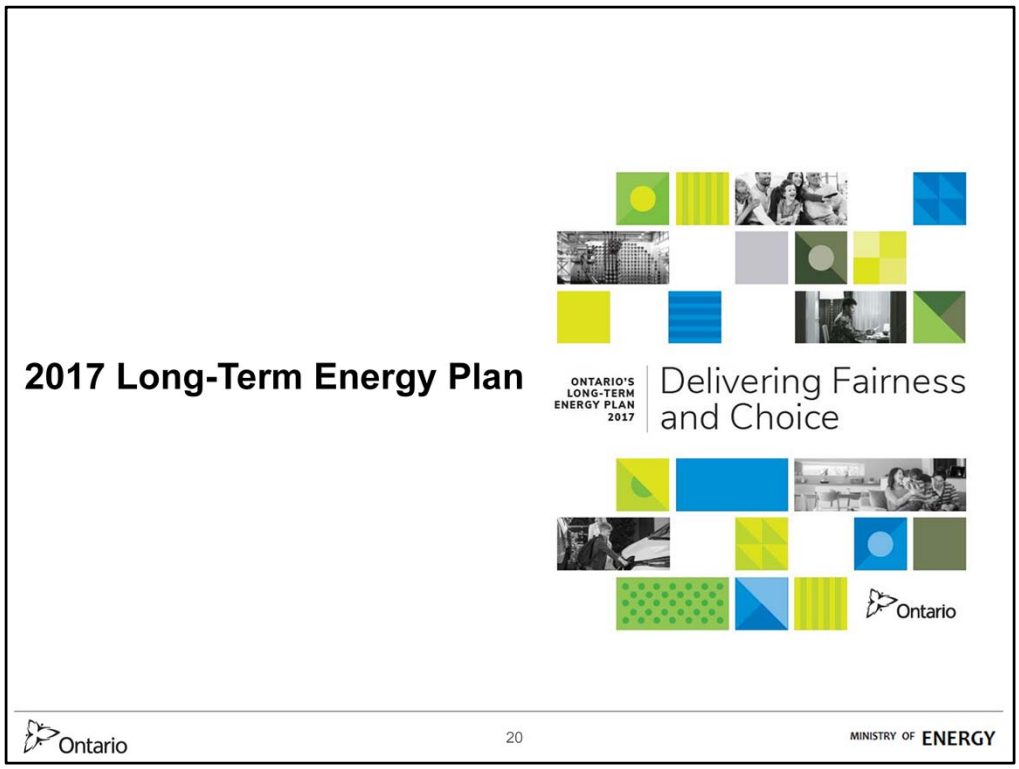
Goals of the plan
Demand to grow moderately between 2010 and 2030, by about 15%
Ontario to be coal free by 2014
Nuclear power remain at about 50% of the province's electricity supply
Grow Ontario's hydroelectric capacity with a target of 9,000 MW by 2018
Grow Ontario's non-hydroelectric renewables with a target of 10,700 MW by 2018, accommodated through transmission expansion and maximizing the use of existing system
Natural gas to be used for peak needs to address local and system reliability issues
CHP to be an energy-efficiency source of power
Proceed with five priority transmission projects for reliability, renewable energy growth and changing demand
Increase Ontario's conservation targets to 7,100 MW and reduce demand by 28 TWh by 2030

2013 Long-Term Energy Plan

Background
Ontario's 2013 LTEP is a balanced approach to meeting energy needs.
The plan is based on what was heard from First Nation and Métis communities, stakeholders, municipalities and consumers from across Ontario and is built around five key principles – cost-effectiveness, reliability, clean energy, community engagement and putting conservation first.

Goals/key elements of the plan
1.Putting conservation first
2.Maintaining a reliable and clean supply
3.Enhancing transmission
4.Regional planning
5.First Nation and Métis Communities
6.Natural Gas

7. Innovation



Background

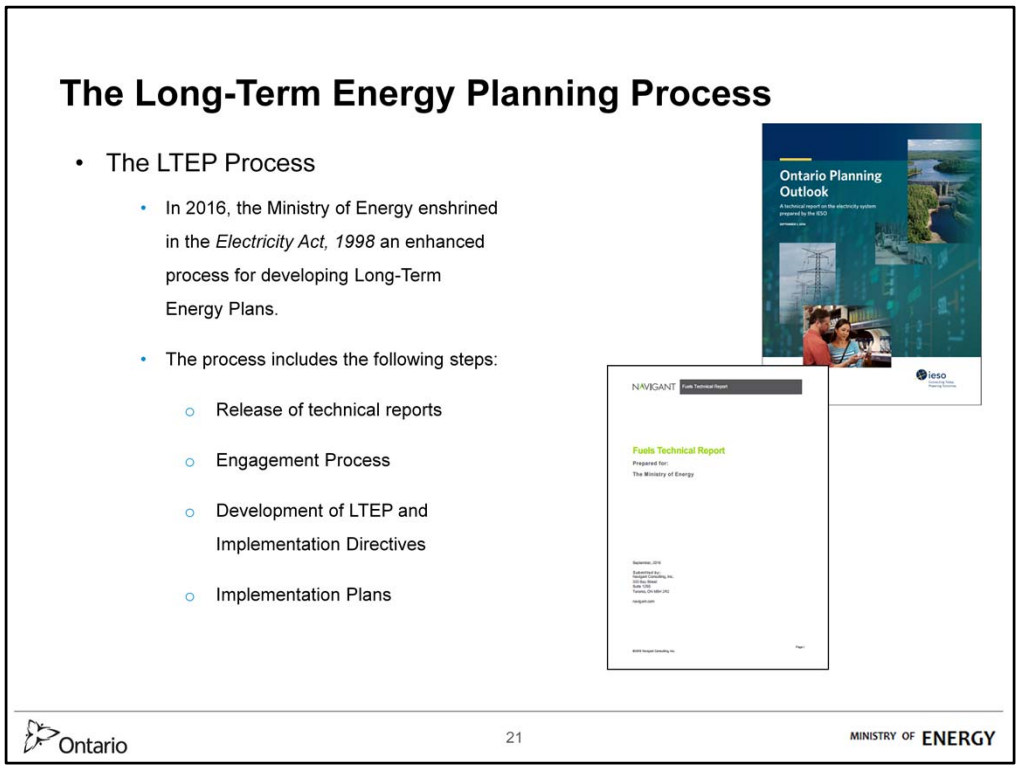
Ontario's latest LTEP is principally focused on the consumer while ensuring a reliable and innovative energy system.

2017 LTEP is the product of the most extensive consultations and engagements the Ministry has ever undertaken – electricity stakeholders and consumers from across the province were consulted through in-person meetings and online submissions. This feedback, together with the IESO's Ontario Planning Outlook, provided key inputs into the development of the 2017 LTEP.

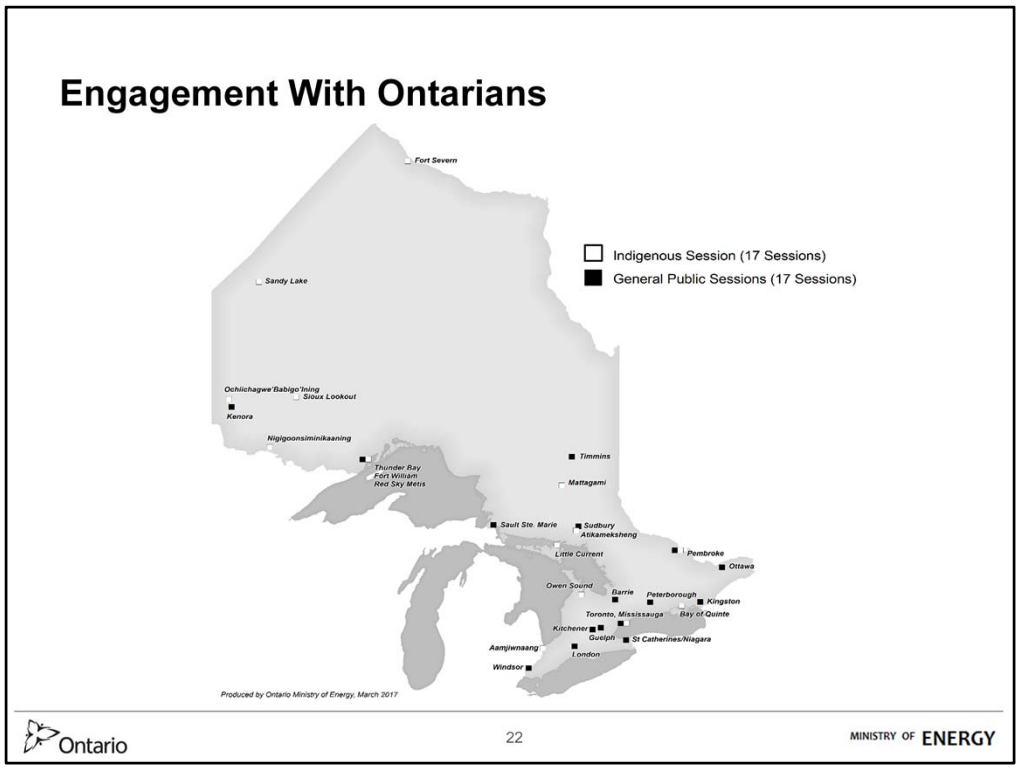
"Delivering Fairness and Choice" ensures that consumer protection remains a top priority.

Goals/key elements of the plan

1.Ensuring affordable and accessible energy
2.Ensuring a flexible energy system
3.Innovating to meet the future
4.Improving value and performance for consumers
5.Strengthening our commitment to energy conservation and efficiency
6.Responding to the challenge of climate change
7.Supporting First Nation and Métis capacity and leadership
8.Supporting regional solutions and infrastructure



- The process for developing the LTEP is set out in the Electricity Act, 1998.
- This process became law in summer 2016, making the 2017 LTEP the first to follow this new legislated process.
- Our process began with the publication of two technical reports in the fall of 2016.
    - The *Ontario Planning Outlook* and the *Fuels Technical Report* present outlooks on the adequacy and reliability of Ontario's electricity and fuels sectors, respectively, to 2035.
- These reports allowed the ministry and stakeholders to start from a common understanding in advance of the LTEP consultation and engagement period from October 2016 to January 2017.
- The LTEP was released on October 26, 2018. Concurrent with the release of the LTEP, the Minister of Energy issued directives to the IESO and OEB, requesting they develop plans for implementing specific LTEP initiatives.
- The directives required the agencies to submit the implementation plans to the Minister of Energy for approval on February 1, 2018, approximately three months after the directive was issued.



- The Ministry held extensive engagement beginning October 2016 and ending January 2017to support LTEP development.

- The Ministry sought feedback through 17 stakeholder roundtable sessions, as shown on this map, which were attended by over 500 stakeholders. Hundreds more people attended one of 17 public open houses in communities across the province.

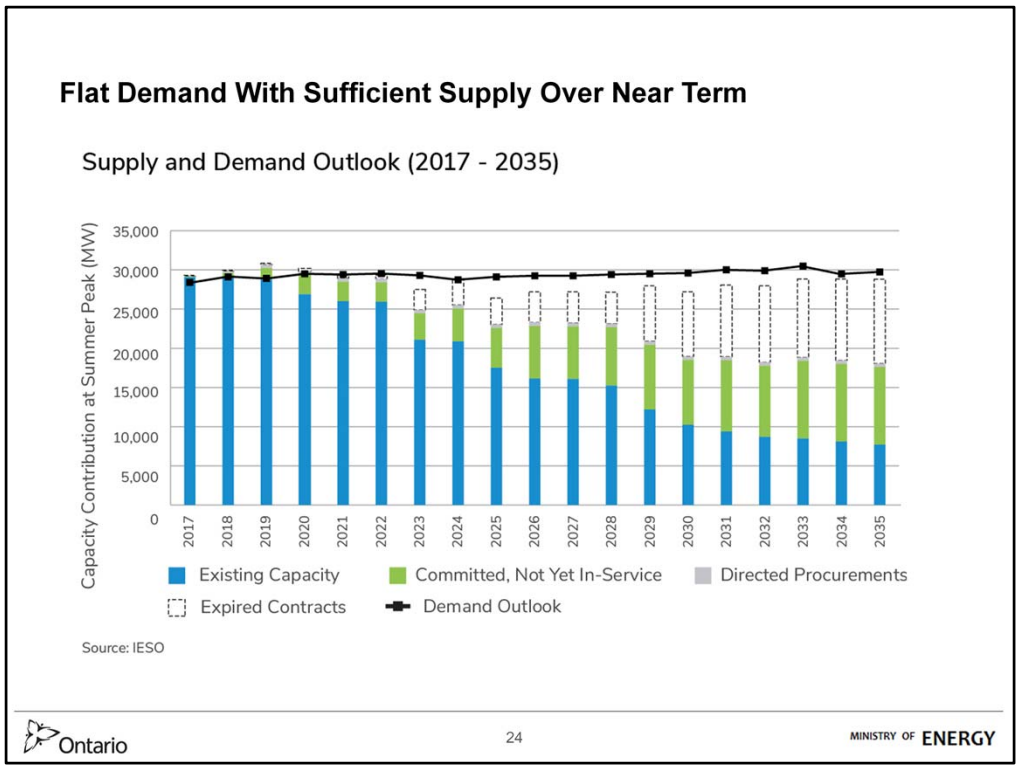
- The Ministry also organized 17 Indigenous engagement sessions with First Nations and Métis groups. The Ministry met with almost 100 Indigenous communities and organizations at these sessions.

- The Ministry received:

    - 1,500 submissions posted through the Environmental Registry;
    - a few hundred letters, emails and paper submissions; and
    - over 2,000 comments through an online survey.

- This input was critical to developing the initiatives that we will describe later in this presentation.

Part III – Key Trends and Initiatives



- This figure shows capacity contribution at summer peak (supply) relative to total resource requirements (demand).

- As for <u>supply</u>, the 2017 LTEP supply outlook over the planning horizon maintains the flexibility to respond to future variations in supply and demand forecasts.

  - A shortfall in capacity is expected beginning **in the early-to-mid 2020s** as the Pickering Nuclear Generating Station reaches its end of life, and nuclear units at Darlington and Bruce are temporarily removed from service for refurbishment.
  - In addition, **18 GW of existing supply resources will reach the end of their contact term by 2035**. The biggest jump is in 2022-2023, when more than 2,000 MW of contracted resources are expected to retire. By 2035, expired contracts will sum to more than 10,500 MW.

- To ensure that our electricity system is able to respond to increases and decreases in future demand, we are maintaining our 2013 LTEP policy of “planned flexibility”.

<u>Market Renewal / Incremental Capacity Auction</u>

- This need for additional capacity will be met through initiatives under IESO’s Market Renewal initiative.
- The IESO, as part of its Market Renewal initiative, is developing an incremental capacity auction (ICA) which is expected to secure the capacity needed to ensure Ontario’s resource adequacy needs are met cost effectively. These resources will also provide flexibility, reliability, and help achieve environmental policy goals.
- The ICA will secure incremental capacity beyond what is already secured through

contract or regulation.

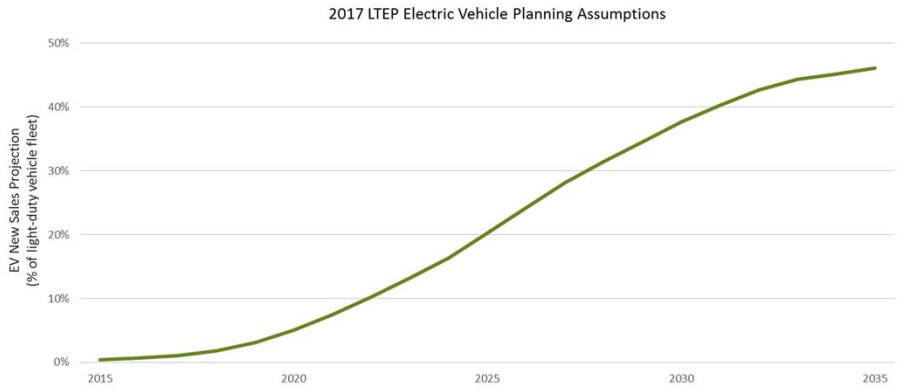
- Domestic electricity generators and importers, demand response providers and emerging new technologies will all be able to participate in the auction, with the most cost-effective resources clearing the auction.

- The 2017 Long-Term Energy Plan (2017 LTEP) forecasts that **electricity <u>demand</u> will be relatively steady over the planning period.**

    - In the longer term, the Independent Electricity System Operator (IESO) projects an increase in overall demand as electrification of the economy increases.
    - It should be noted that the 2017 LTEP demand outlook assumes the equivalent of approximately 2.4 million electric vehicles by 2035 and includes demand from new electrified transit across the province (i.e., GO Rail and light rail projects across the province).
    - Demand is relatively steady over planning period – minimum of 28,373 MW (2017) and maximum of 30,509 MW (2033).

    - See next slide for more detail on aggressive planning assumptions for electric vehicles.

Planning Assumptions on Electric Vehicles

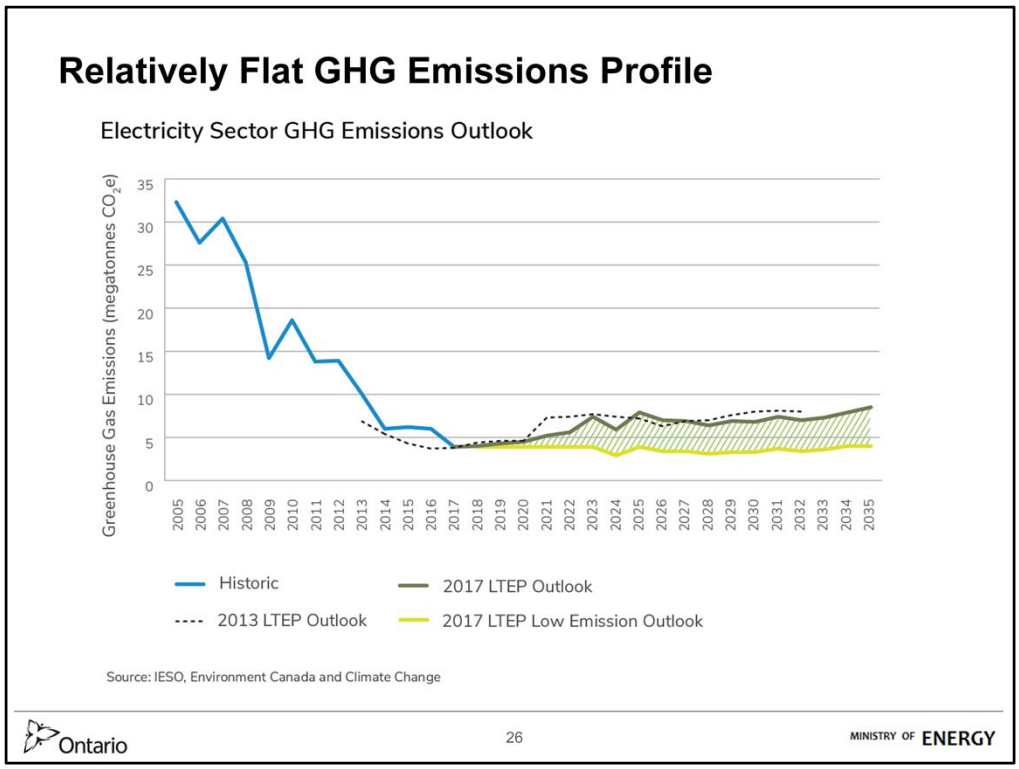


Ontario

25

MINISTRY OF ENERGY

- This chart represents the 2017 LTEP EV forecast (2.4 million by 2035), which goes out to 2035 (and which is also the EV projection in Outlooks C and D of the 2016 OPO).
- The 2017 LTEP forecast anticipates that 46% of new Ontario vehicle sales will be EVs in 2035.
- BNEF (Bloomberg New Energy Finance) outlook is consistent with the IESO's EV outlook used in the OPO and proposed for the 2017 LTEP.
- To date, in most markets, government policy has been one of the most important factors influencing EV adoption. Considering the strong supporting policy in Ontario (incentives, for example), the comparatively strong EV uptake illustrated in the 2017 LTEP outlook between 2020 and 2035 may be appropriate (i.e. Ontario EV uptake ahead of the global average).



- In 2016, **about 90 per cent of the electricity used in Ontario was free of greenhouse gas (GHG) emissions** – generated from non-emitting resources such as water, nuclear, wind, solar and bio-energy.
  - Our investments in these types of clean generation resources, along with the elimination of coal-fired electricity generation, have significantly reduced GHG emissions in the province.
  - In 2003, the electricity sector represented approximately 20% of Ontario's total GHG emissions. As a result of phasing out coal-fired electricity generation in 2014, Ontario's electricity system was over 95% emissions-free in 2017.

- The 2017 LTEP notes that GHG emissions are expected to remain well **below historical levels** and to **be relatively flat** over the planning period (with a range of potential emissions outcomes).
  - Emissions could come in lower than forecast, and a scenario with a low emissions outlook maintained at close to 2017 levels is also shown.

- Ontario will continue to look for ways to keep GHG emissions in the electricity sector low and work with non-emitting generators to meet the Province's emissions targets.

- These investments have significantly decarbonized Ontario's electricity sector, leaving it well positioned to help the province move towards a low-carbon economy and meet its emission reduction commitments. Ontario's clean and reliable electricity system gives the province a strong foundation on which to pursue increased electrification, including the use of more EVs.

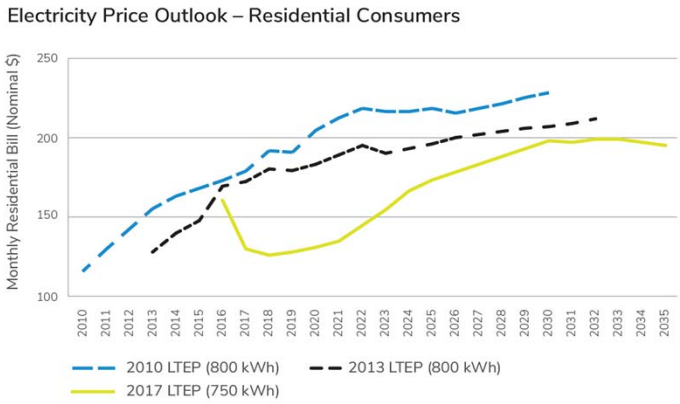
Climate Change Action Plan (CCAP) Targets

- Ontario's reduction targets are ambitious yet achievable, in line with actions taken by other provinces and states and in line with global objectives. Ontario is doing its part with reductions from 1990 emissions levels of 15% in 2020, 37% in 2030 and 80% in 2050.
- Based on GHG reporting data, Ontario has met its 2014 target of 6% cent below 1990 levels. The province achieved this goal by taking bold steps, including closing all of Ontario's coal-fired electricity-generating stations. This remains one of the single largest greenhouse gas reduction actions implemented to date in North America.

Cap and Trade Program

- On January 1, 2017, the Province implemented a cap and trade program. This program is a flexible, market-based program that will be a cornerstone in Ontario's fight against climate change, and is the most cost-effective way of achieving reductions in GHG emissions.
- In addition, all proceeds from the cap and trade program will be used to fund actions to reduce GHG emissions, such as supporting Ontarians in shifting away from fossil fuels and investing in emerging clean technologies.
- Cap and trade will increase the price of fossil fuels and affect how often fossil-fueled generators get called on to meet the province's electricity demand. This will help reduce the province's GHG emissions and shift Ontario towards a low-carbon economy.

Progress on Residential Electricity Prices



Source: IESO, Ministry of Energy

Note: Forecasts used in *Delivering Fairness and Choice* reflect prevailing patterns of consumption. Between late-2009 and mid-2016, the OEB defined the typical residential customer as a household that consumed 800 kWh of electricity per month. As of May 2016, the OEB changed their typical residential consumption to 750 kWh per month, due to declining household consumption.

Ontario 27 MINISTRY OF ENERGY

- There are about five million residential and small business consumers participating in the Regulated Price Plan (RPP). Most residential and small business consumers pay Time-of-Use (TOU) prices under the Ontario Energy Board's (OEB) RPP.
  - RPP prices are adjusted by the OEB based on projected supply cost as well as the Ontario Fair Hydro Act.
  - TOU prices are intended to provide an incentive to consumers to shift consumption away from high demand periods when the cost to meet province-wide demand is higher.

- The 2017 LTEP's outlook for residential prices shows progress compared to earlier **LTEP outlooks in the 2010 and 2013**. The residential price outlook remains below levels projected in the 2013 LTEP outlook for the full planning horizon due to:
  - **Ontario's Fair Hydro Plan;**
  - Removing costs from the electricity system;
  - More efficient consumption of electricity; and
  - Anticipated benefits from implementing initiatives

- Taken together, these changes are delivering the single largest reduction to electricity rates in Ontario's history.

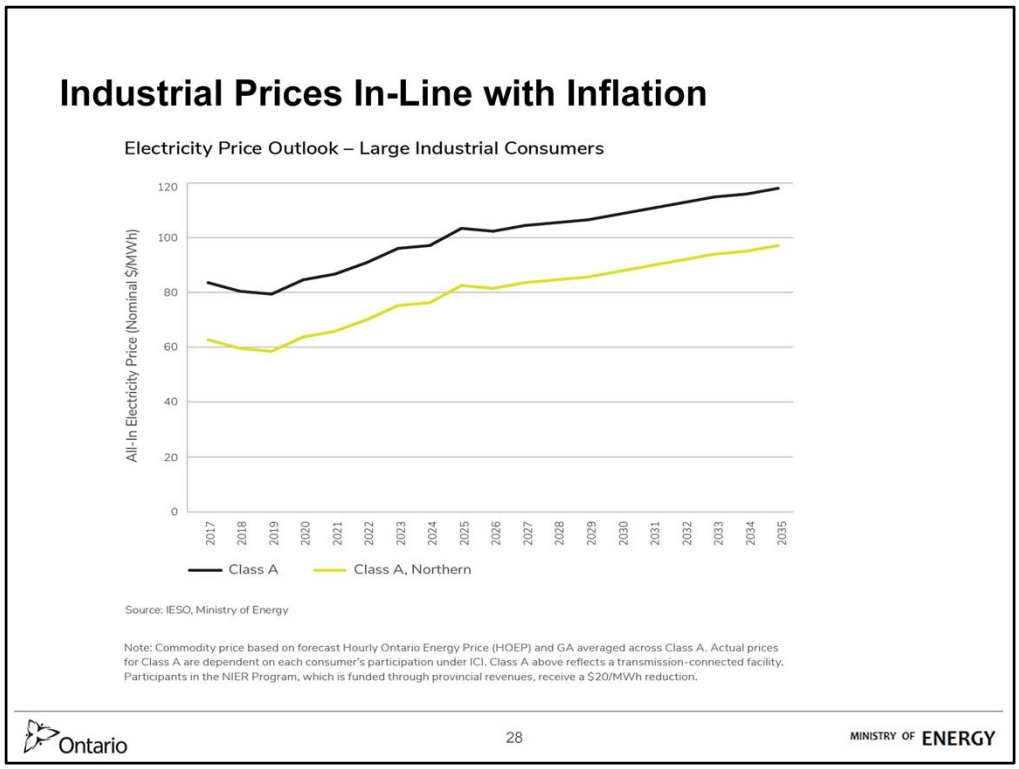
- The 2017 LTEP highlights that Ontario's Fair Hydro Plan lowers typical residential electricity bills by 25% on average and will hold any increases to the rate of inflation for four years.
  - As many as half a million small businesses and farms are also benefitting from the reduction.

  - Following the inflationary cap, residential electricity rates increase at an average of about **5% over the 7-year period from 2021 to 2027**, levelling out by the early 2030s.

- The government remains committed to managing electricity rates and avoiding sharp increases by driving efficiencies and taking additional costs out of the system.

- Additional programs that provide support to Ontario families in paying their bills include:
  - The Ontario Energy and Property Tax Credit saves qualifying individuals up to $1,023 per year, with a maximum of $1,165 per year for qualifying seniors;
  - The Low-Income Energy Assistance Program provides emergency financial support of up to $600 for families and individuals having trouble paying their bills;
  - The Northern Ontario Energy Credit helps families and individuals in Northern Ontario by providing tax credits for low- to middle-income families and individuals living in northern Ontario. The maximum annual credit for a single person is $148, and for a family (including single parents), is $277; and
  - The saveONenergy Home Assistance Program was specifically developed to help income-eligible homeowners and tenants manage their energy use and cost by offering detailed in-home energy assessments and installing energy-saving measures at no cost. Social and assisted housing providers also qualify for assistance in making their buildings more energy efficient.

- Energy conservation and efficiency programs, available through electricity utilities, IESO and natural gas utilities, and the new Green Ontario Fund, also help consumers manage their electricity and other energy bills.



- As we plan for Ontario's electricity needs for the next 20 years, conservation will be the first resource considered, wherever cost effective. Conservation is the cleanest and most cost-effective energy resource, offers customers a way to reduce their electricity bills and reduces the need to build costly new generation, distribution and transmission infrastructure.

- The 2017 LTEP price outlook for large industrial consumers reflects average increases of electricity **in-line with inflation** over the planning period.
  - It should be noted that the actual electricity price paid by a large industrial consumer is dependent on their consumption patterns and can vary among industries and specific consumers.
  - This long-term increase in electricity prices has been the result of the addition of significant generation capacity, including new natural gas-fired generation, renewables (e.g., wind and solar) and refurbished nuclear, as well as the cost of upgrading and maintaining the province's distribution and transmission infrastructure.

- Currently, the indicative **electricity price** for industrial consumers in Ontario is lower than the average price in the Great Lakes region (as highlighted by the U.S. Energy Information Administration).
  - The National Energy Board's *Energy Futures* 2016 report projects that industrial electricity prices are expected to increase in most provinces through 2032.

- Measures in place to mitigate industrial electricity prices include:
  - Industrial Conservation Initiative (ICI);

  - Industrial Electricity Incentive (IEI);
  - Northern Industrial Electricity Rate Program (NIERP);
  - Industrial Accelerator Program (IAP);
  - SaveONenergy for Business Program; and
  - Demand Response Action.

- As part of Ontario's Fair Hydro Plan (OFHP), industrial electricity prices are decreasing due to the funding of support programs (e.g., Rural or Remote Rate Protection, Ontario Electricity Support Program) from provincial revenues instead of electricity bills. This action is lowering regulatory charges by approximately $3/MWh for all consumers.

- The ICI allows large electricity consumers to lower their electricity costs by reducing their demand during peak hours. Reducing demand during peak hours benefits companies financially and benefits the electricity system by deferring the need for new peaking generation.
  - As part of the OFHP, ICI has been expanded to include smaller manufacturers and greenhouses with peak demand between 500 kW and 1 MW, in addition to the consumers over 1 MW who were already eligible. Newly eligible consumers are able to opt-in to the ICI program at their discretion.

- Consumers in Northern Ontario that participate in the Northern Industrial Electricity Rate (NIER) Program can achieve even lower rates.
  - Participants in the NIER Program, **which is funded through provincial revenues**, receive a reduction of 20 dollars per megawatt hour. On average, industrial electricity prices can be reduced by over 20% through the program.

- The IAP assists eligible transmission-connected companies, and their distribution sites, to fast track capital investment in major energy conservation projects. The program provides financial incentives to encourage investment in innovative process changes and equipment retrofits to reduce electricity consumption on the provincial system and to help companies become more competitive by positively impacting their bottom line.

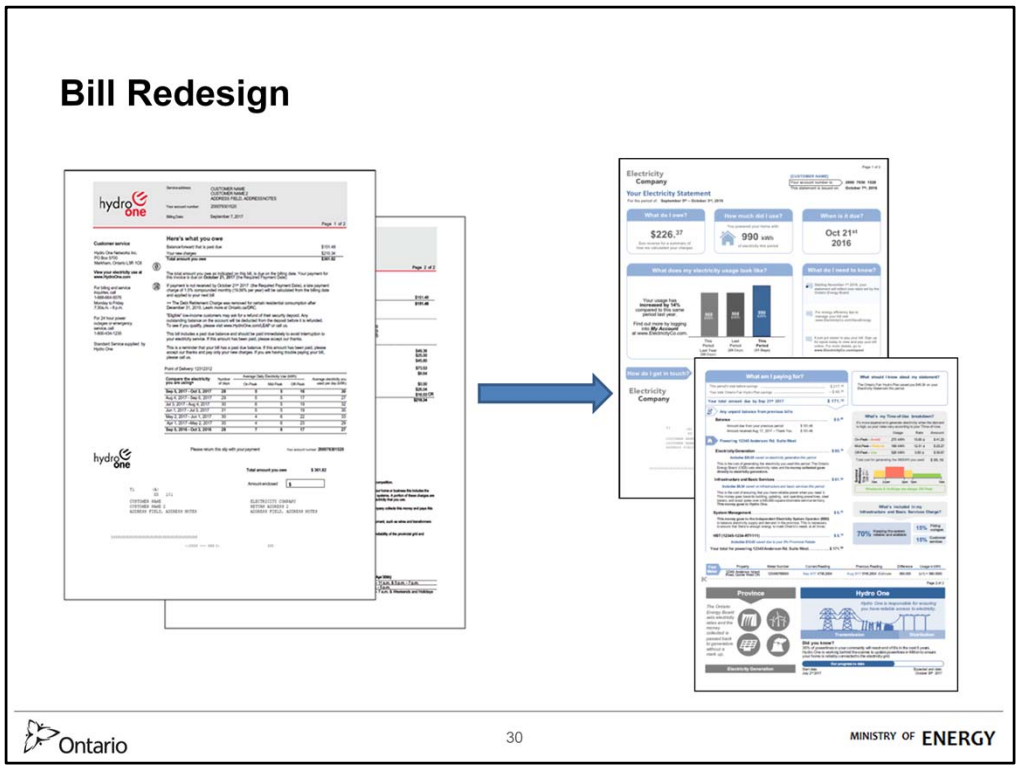
- The saveONenergy for Business Program, delivered by local distribution companies, offers a variety of financial incentives to distribution-connected business and industrial customers to increase energy efficiency and help manage their bills.

- The IESO holds annual Demand Response (DR) auctions which provide payment to successful participants that commit to reducing their consumption in response to system needs.
  - Participation in the DR Auction is open to new and existing DR participants in Ontario with peak load greater than 1 MW, including industrial consumers and aggregators.

- The government and the Ontario Energy Board (OEB) are considering changes to the way the Global Adjustment is charged to mid-sized commercial and industrial consumers, otherwise known as non-RPP Class B consumers.
  - For these consumers, the GA is a fixed charge that is the same regardless of the time that they consume electricity.

- Consultations will take place before any changes would be made.

Key Initiatives

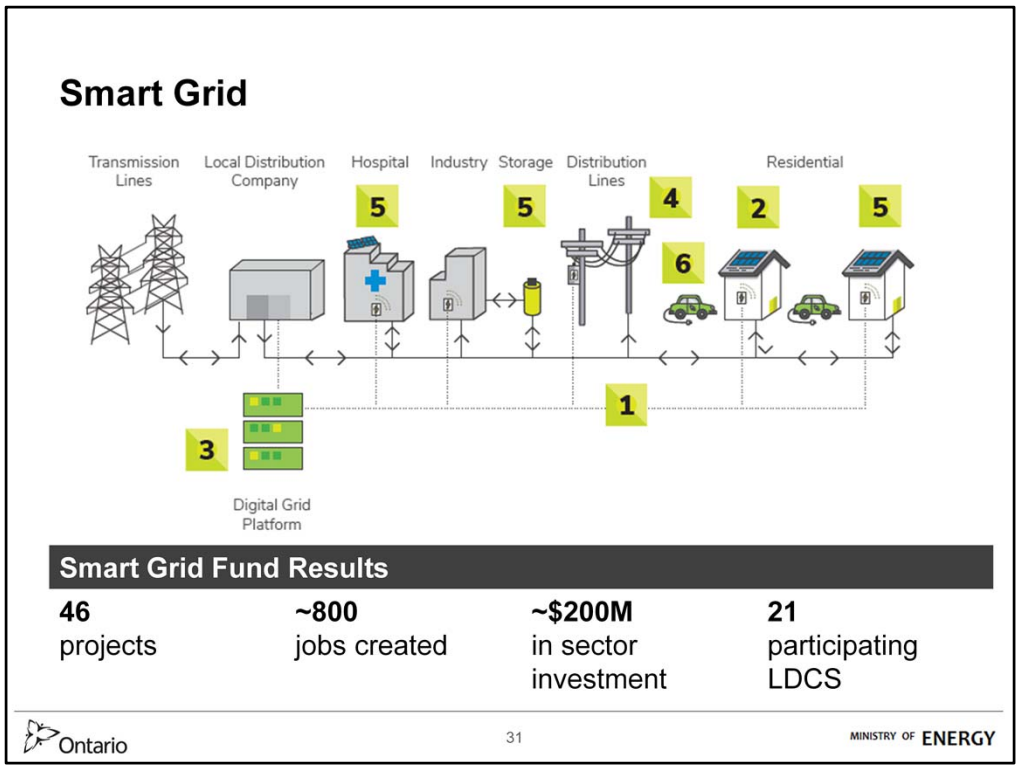


- Through the LTEP consultation process, the Ministry heard that customers find their current bills confusing and inaccessible. To address this, the LTEP committed to give Ontarians the information they said they want on the bill.

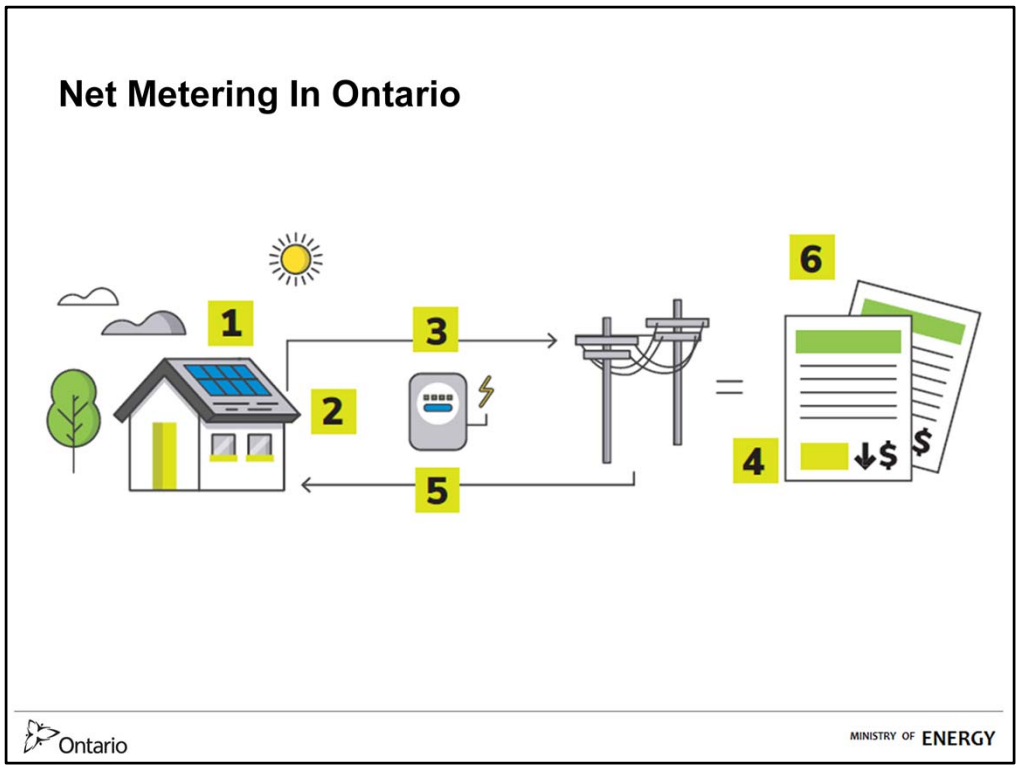
- Concurrently, Hydro One was investigating how behavioural science could help address this issue with its customers.

- Building on Hydro One's work, the Ministry launched the Bill Modernization Action Plan in the summer of 2017 with the aim of revising the regulatory framework on invoicing to improve the value of electricity bills for consumers.

- Informed by consumer research and engagement with Industry, the Ministry amended the regulatory framework for billing to do the following:
    - Use dynamic messaging to show each customer their savings under the Fair Hydro Plan
    - Provided increased flexibility to bill issuers to design electricity bills that are tailored to the needs of their specific customers.



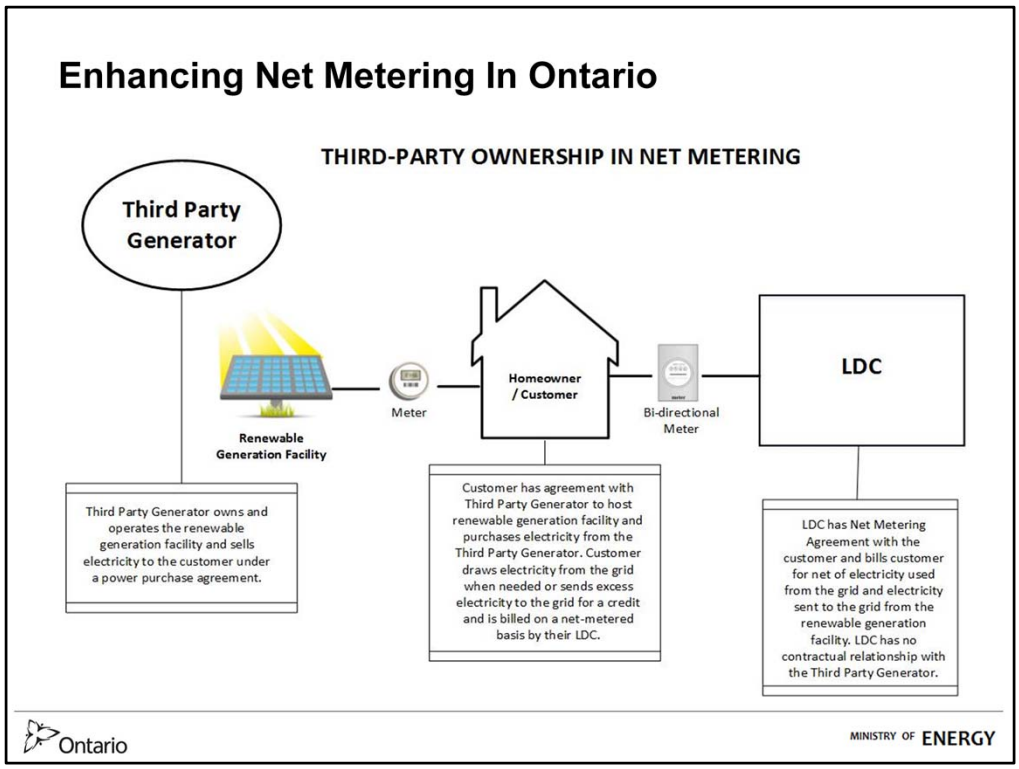
- A smart grid is a digital grid that uses sensors, communications infrastructure, and software.
- This digital grid platform can better integrate new technologies (like EVs and energy storage).
- It also generates the information needed so that utilities can run their systems more efficiently and the information customers need to make informed decisions about their energy use.
- The Smart Grid Fund is a key tool to support the modernization of Ontario's grids.
- The SGF addresses barriers to grid modernization by providing utilities much needed experience with new technologies.
- In supporting companies demonstrating grid modernizing solutions, it continues to promote Ontario's leadership in smart grid while promoting innovation, jobs, and growth.



- Net metering is a billing arrangement with a local distribution company – or LDC – that allows a customer to offset the electricity they buy from their LDC with electricity generated by their own renewable energy systems.
- Generally customers use rooftop solar for net metering, though any electricity generated from a renewable energy source is eligible.
- Net-metered customers self-consume the electricity they generate and send any excess electricity to the local grid for a credit on their bill, reducing their total bill charges. These credits can be carried over for up to 12 months for application on future bills.
- A net-metered customer is still able to draw power from the local distribution grid when their own demand is higher than what their system can produce.
- Net metering has been in place in Ontario since 2005, and as of the end of 2016, 983 net-metered systems had been installed in the province.
- Since 2005, customers have been required to own the renewable energy system used for net metering. This has meant that customers needed to have access to the required funds to purchase or finance the system in order to net meter.
- The Ministry of Energy has taken steps to enhance Ontario's net metering framework by enabling third parties to own and operate net-metered systems on behalf of the customer, giving customers new ways to participate in renewable energy generation (usually with lower up front costs), while also reducing their electricity bills.

- Steps have also been taken to ensure that Ontarians have access to robust consumer protections when participating in third party ownership net metering. The Ontario Energy Board has been given the authority to pass codes of conduct and license requirements for third party generators, similar to how they regulate energy retailers.

- The regulatory changes to enable third party ownership and the associated consumer protections have been passed and are slated to come into force on October 1, 2018.



- Third party ownership net metering, under the new regulation, will be similar to customer-owned net metering, in that the generation must be from a renewable energy source, must be located behind a customer's meter, and the customer will be billed on a net-metered basis, the same as with a customer-owned system.

- The main difference with this model of net metering is that a customer will be able to buy the renewable electricity from a renewable energy provider rather than purchase, own and operate the renewable generation system themselves. So rather than spending upwards of ten thousand dollars on a residential-size system, a homeowner could have a third party install a system and buy the electricity at a set price per kilowatt hour.

- The Third Party Generator, as defined in the new regulation, can install a system on a customer's premise and will sell the customer the electricity that is generated under a power purchase agreement. Similar to electricity from the grid, the renewable electricity from the third party generator would be metered and the customer would receive a monthly bill.

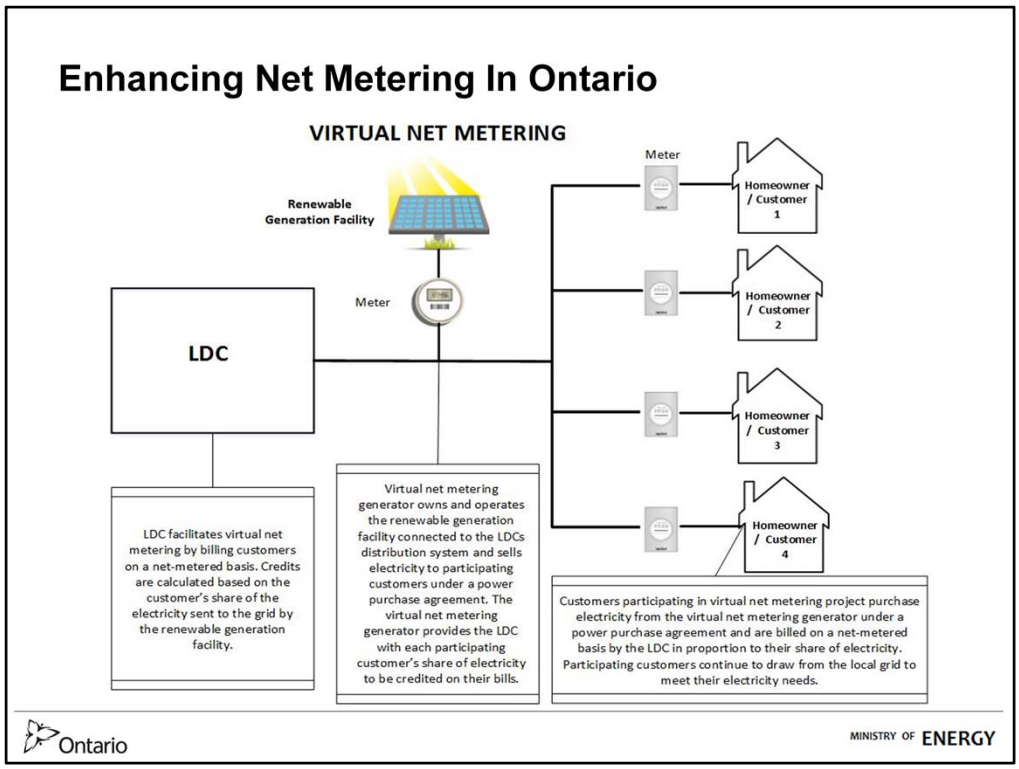
- The benefit of this type of arrangement is that a customer could get savings on their electricity bill by using lower cost electricity from the solar system, for example, without having to make the upfront investment to own the system. Any excess electricity from the solar system is sent to the grid by the customer and counted towards their net metering credits for billing by their LDC.

- This could make customer-sited, renewable distributed generation much more accessible to lower-income homeowners, or could allow businesses greater options in

how they finance renewable generation to offset their energy costs.

- Another benefit of allowing third party generators to operate within the net metering framework is that it provides opportunities for innovation.

- Renewable energy providers will be able to offer renewable generation and storage options to customers and offer services to optimize between the use of the generation, battery and grid energy to maximize savings to customers, or, in the future, to provide services to the grid – like helping to balance local supply and demand or reduce peak load.



- Virtual net metering can have many variations in ownership and participation, but the main concept is that the renewable generation facility is sized to meet the electricity needs of multiple customer loads, and is generally located off-site or in-front of the participating customers' meters.

- This graphic shows a very basic virtual net metering configuration, where the renewable generation is sending electricity to the LDC's grid, and the participating customers receive a credit on their electricity bill.

- In this case, the customers are represented as homeowners, but virtual net metering is ideal for apartment or condominium residents – any customers that can't host renewable generation due to lack of roof space or other reasons. In the case of a municipality, it could allow net metering of heritage buildings that aren't suited for installing renewable generation systems.

- Similar to third party ownership net metering, a virtual net metering customer would purchase electricity from the renewable generator under a power purchase agreement and receive credits on their bills from the LDC.

- With virtual net metering, however, there is no direct connection between the power produced and the customer's consumption. The customer is net metered for electricity generated by the facility, but this electricity could be used somewhere else on the grid. The customer continues to draw electricity from the local grid for their needs.

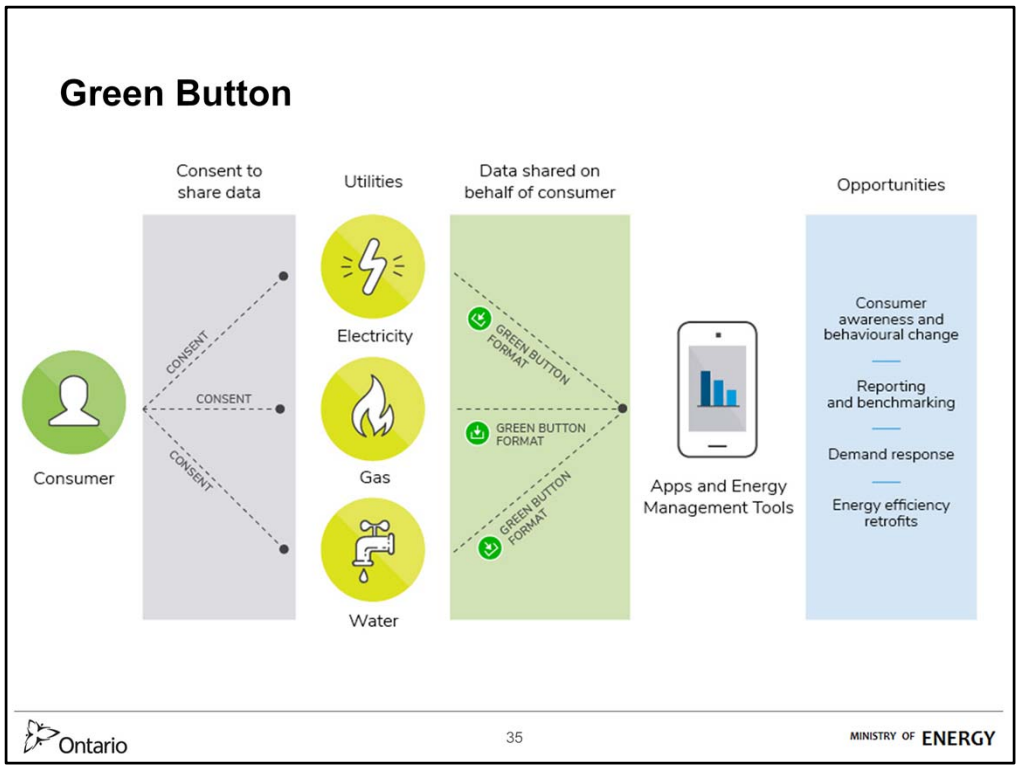
- Ontario is taking the approach of exploring virtual net metering through demonstration

projects to better understand the costs and benefits of allowing these kinds of arrangements. A number of U.S. states allow virtual net metering in the form of community net metering, and restrictions vary across jurisdictions.

- We hope to learn the best approach for the Ontario context to ensure these kinds of projects are providing benefits to customers and value to the electricity system, as well as challenging the sector to be innovative in how these models can be used.

- As you can tell, innovation is a key theme of Ontario's Long-Term Energy Plan. The electricity system and other energy markets are changing rapidly, and innovation in renewable energy integration is a key driver for these changes.

- Ontario is taking action to support innovation in renewable distributed generation integration.



•The 2017 LTEP stated that the government was committed to expanding Green Button province-wide, and intended to propose legislation that would, if passed, allow Ontario to require implementation by electricity and natural gas utilities.

•A regulatory proposal was posted from December 2017 to January 2018

- The Green Button data standard consists of Download My Data, or DMD, which can give households and businesses easy electronic access to data on their energy and water consumption, and Connect My Data, or CMD, which allows customers to authorize the automatic, secure transfer of their own data from their utility to 3rd party applications of their choice.

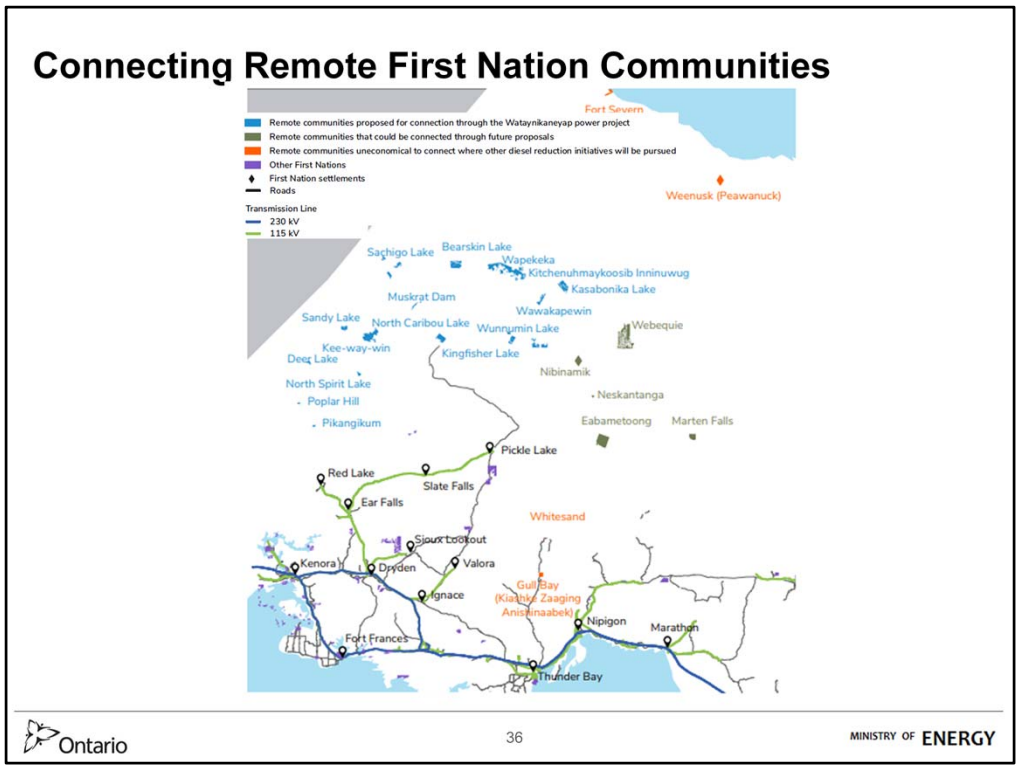
- With the passage of the Stronger, Fairer Ontario Act in December 2017, several amendments were made to the Green Energy Act, 2009, and the Ontario Energy Board Act, 1998 that enable the Ministry of Energy to bring forward regulation to require Green Button DMD and CMD across the province.

- To date, about 10 LDCs across Ontario have voluntarily implemented Green Button DMD for their residential and small business customers. Four LDCs have voluntarily implemented Green Button CMD as well.

- In 2016, the ministry conducted a cost-benefit analysis and consulted on a draft policy proposal to require utilities to implement Green Button.
    - The CBA concluded that for every dollar in costs associated with the province-

wide implementation of Green Button in the electricity and natural gas sectors , there would be over 4$ in total benefits.

- The Ministry of Energy is considering the feedback on the regulatory proposal submitted by stakeholders and has proposed to establish working groups to help develop implementation support documents. Subject to any further required government approvals, the proposed regulation could come into force in early 2019.



- Expanding transmission to remote First Nation communities in Northwestern Ontario to reduce reliance on diesel-powered generation is a priority in the LTEP. Those communities that are uneconomical to connect to the grid are in the planning and development stages of adding sustainable technologies to reduce their reliance on diesel.
- Twenty-five remote First Nation communities in the province's northwest rely on diesel fuel to power their communities. The Ministry recognizes the distinct challenges they face and, because of the high cost of diesel fuel, there is a good economic case to connect as many as 21 of those communities to Ontario's electricity grid.
- Connection to Ontario's low-carbon electricity grid will not only improve the quality of life of these communities and enable their economic development, but it will also reduce local pollution, greenhouse gas (GHG) emissions, and the environmental risks associated with transporting and storing diesel fuel.
- For these reasons, we have taken several steps to begin the connection of remote First Nation communities. These include:
    - Selecting Wataynikaneyap Power as the transmitter for connecting most of the remote First Nations;
    - Creating a mechanism for funding a portion of project costs; and
    - Advocating for a fair cost-sharing arrangement with the federal government that ensures the project is fully funded and can proceed to construction.

Grid connection is not currently feasible for four of the 25 remote First Nations in Ontario. Each of these communities has begun the planning and development work to add sustainable technologies that will reduce their reliance on diesel. Projects that reduce diesel reliance could include renewable microgrids, battery storage, and other innovative technologies that meet identified community needs.

THANK YOU