

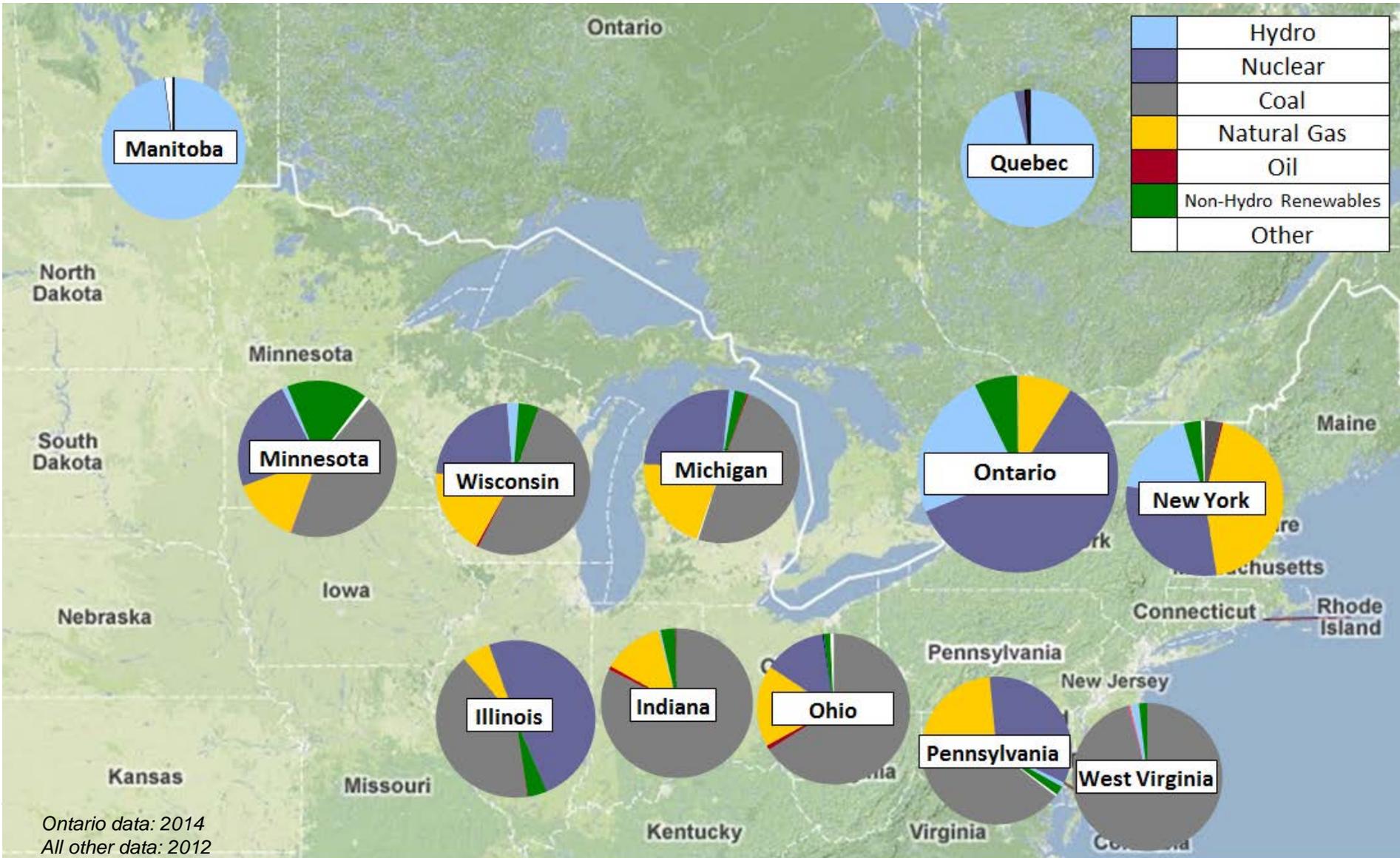
Coal Closure In Ontario

August 2015

Purpose

- Ontario has experience in phasing out coal-fired electricity generation.
- This deck provides insight into Ontario's experience through a thorough review of the following:
 - Ontario's decision to phase-out coal-fired generation;
 - How Ontario implemented the phase-out of coal; and
 - Results of phasing out coal-fired generation for Ontario.
- In April 2014, Ontario burned its last piece of coal to generate electricity, making it 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 and was the equivalent of taking up to 7 million cars off the road.

Ontario's Success Story



Chronology – Ontario's Case for Action

- From the 1910s-1950s, Ontario relied on hydroelectric stations to supply the province's power. Coal-fired generating stations were built to help power post-war industrialization.
 - From 1951 to 1985, six coal plants were built totalling about 10,000 MW.
- In 2003, coal-fired generation provided 25 per cent of Ontario's electricity.
- At that time, coal-fired electricity represented the largest single source of greenhouse gas emissions in Ontario.
- In 2003, Ontario committed to the phase-out of coal by 2007.
- A 2005 independent study confirmed the benefits of phasing out coal-fired electricity. The study found that the health, financial and environmental impacts of coal-fired electricity had an annual cost of \$4.4 billion (2004\$).

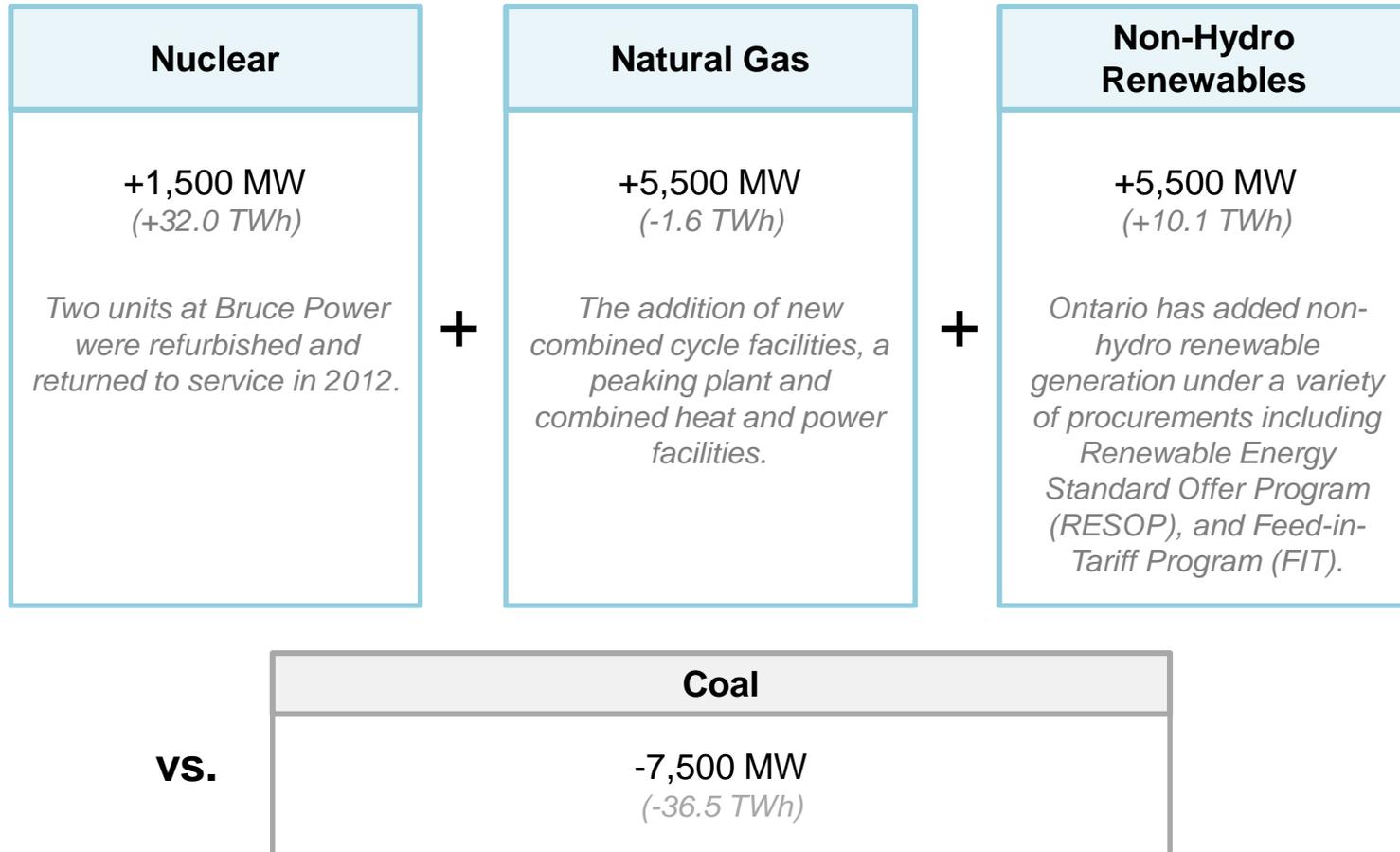
- Coal-fired generating stations (GS) in Ontario:
 - Nanticoke GS (4,000 MW)
 - Atikokan GS (230 MW)
 - Thunder Bay GS (325 MW)
 - Lambton GS (2,000 MW)
 - Lakeview GS (2,400 MW)
 - Hearn GS (1,200 MW)



*Ontario's largest former coal plant,
Nanticoke Generating Station*

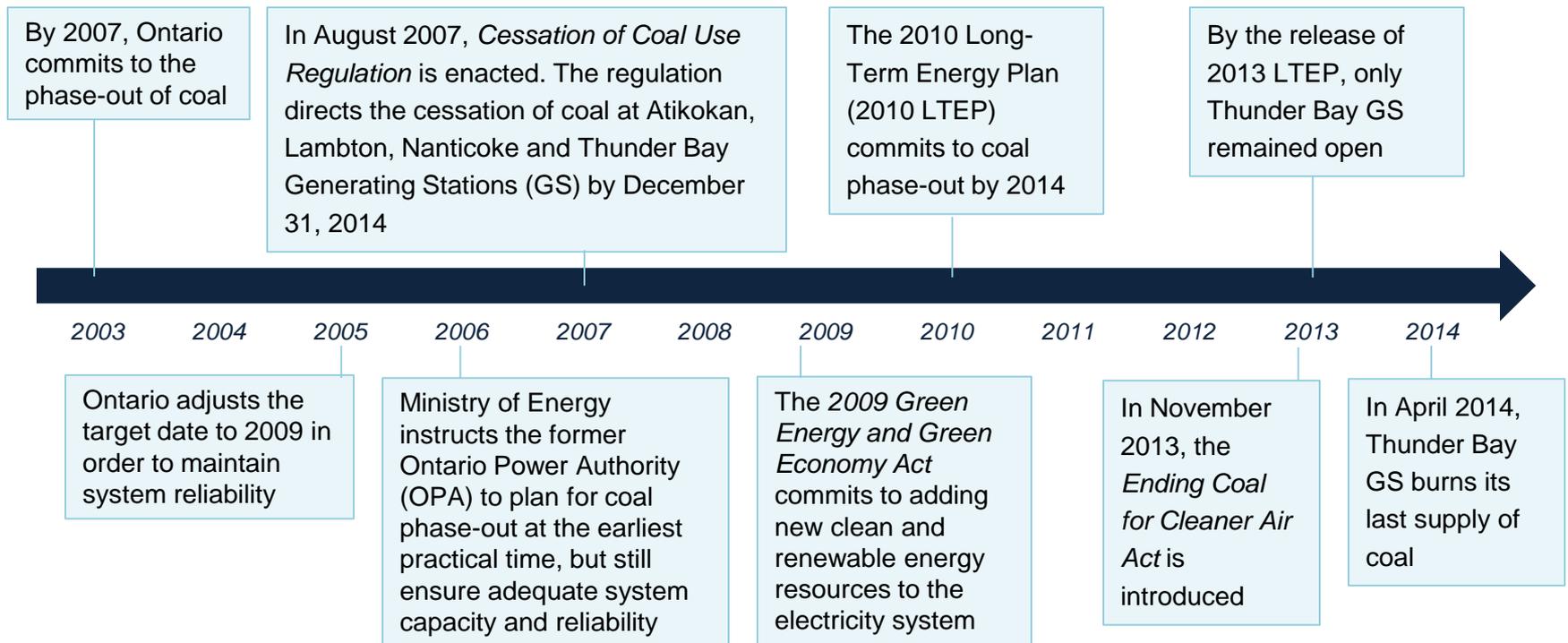
Ontario's Approach for Replacing Coal-Fired Capacity

- Ontario's approach to replace coal was to transition to a supply mix that included: nuclear, natural gas and non-hydro renewable sources (e.g., wind, solar, biomass).



Timeline of Events – Phase-out of Coal

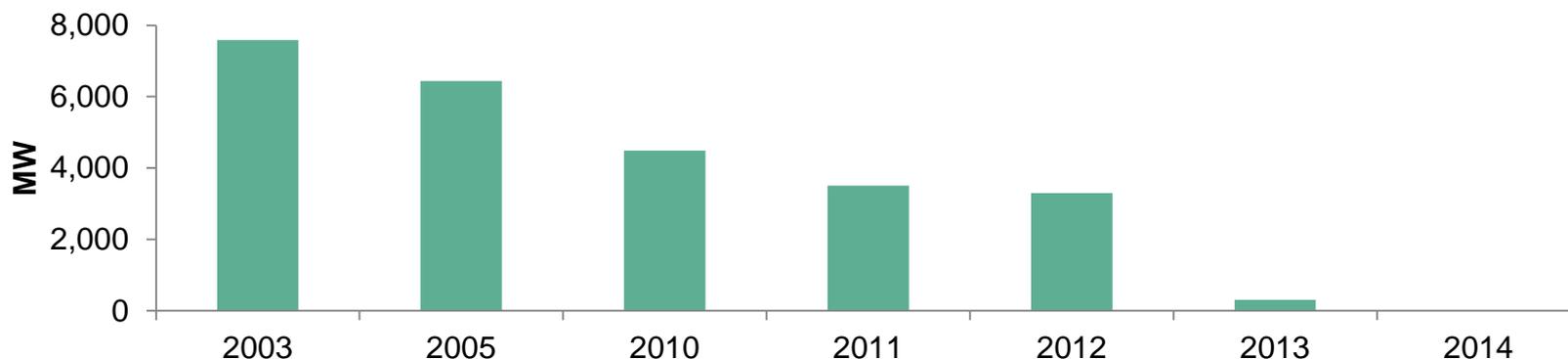
- Ontario took a phased approach to the elimination of coal to maintain system reliability. The timelines for coal phase-out were adjusted over time as necessary.



Timeline of Events – Coal Capacity Over Time

- Coal capacity was reduced in a staged approach from 2003-2014 to ensure system reliability and adequate capacity.

Total Coal-fired Capacity at Year End



Capacity at Year End	2003	2005	2010	2011	2012	2013	2014
Lakeview	1,150	-	-	-	-	-	-
Nanticoke	3,940	3,940	2,960	1,980	1,980	-	-
Lambton	1,980	1,980	1,010	1,010	1,010	-	-
Thunder Bay	306	306	306	306	306	306	(April)
Atikokan	211	211	211	211	-	-	-
Total	7,587	6,437	4,487	3,507	3,296	306	0

Note: Hearn GS closed in 1983

System Considerations

- The Independent Electricity System Operator (IESO) was responsible for ensuring system reliability and sustainability during and following coal phase-out.
- A number of gas generators were built to replace much of the coal capacity that was phased out; these new gas facilities were operated through 2-3 peak seasons (summer and winter) and had to demonstrate consistent reliable performance before IESO allowed the controlled shutdown of the coal-fired generating fleet.
- Bringing on large numbers of generators with a different fuel-type than coal posed new administrative and operational challenges for IESO to overcome:
 - Establishing new processes for reporting and monitoring;
 - Enhancing new focus on gas-electric coordination; and
 - Adapting to new operational characteristics such as ramp-up time
- Additional nuclear generation, along with greater amounts of wind and solar, increased the times and quantities where baseload supply (i.e., nuclear, hydroelectric, wind, solar) exceeded Ontario demand. This required IESO to develop new approaches for managing surplus generation.
- New approaches were also required to manage variable generation (i.e., wind and solar), including:
 - Increased visibility of current variable generation output;
 - Enhanced methods to forecast variable generation output; and
 - Processes to dispatch variable generation resources.

Technical Considerations

- OPG was responsible for ensuring the phase-out of coal-fired generation was completed safely and efficiently.
- OPG's goals in coal phase-out was to ensure it was done in a safe and environmentally responsible manner, while addressing system adequacy. In addition, OPG wanted to consume the last tonne of coal on the last day of operation.
- OPG's implementation plan was as follows:
 - OPG established a schedule for coal phase-out based on fuel type, fuel flexibility, emissions, unit condition, labour and location.
 - OPG's phase-out schedule was built with a staged approach to:
 - o Allow for flexibility in the event of a shift in supply/demand forecasts;
 - o Manage fuel supply; and
 - o Allow for effective labour management.
 - OPG allowed for approximately 18-months of lead time to reduce scope and scale of operations.
 - OPG optimized coal inventories by developing a strategy on how to bid coal-fired electricity into the market. This strategy allowed for an increased/decreased rate of coal consumption to draw down the coal inventory in the lead up to closure dates.
 - OPG established a multi-disciplinary senior team consisting of Station Operations, Fuel Supply, Energy Planning & Forecasting and Market Operations.
- OPG's lessons learned were:
 - Obtain agreement(s) with labour unions, ensuring operating staff are available on final day of operation;
 - Maximize the value of coal inventory and coal contracts to ensure no fuel was remaining on the last day of operation; and
 - Incorporate flexibility into the plan.

Legislation

- Both the provincial and federal governments have enacted regulations to enable the phase-out of coal in Ontario.
- ***Ontario's Cessation of Coal Use Regulation (August 2007)***
 - On August 24, 2007, the coal-closure regulation (O. Reg 496/07) under the *Environmental Protection Act* (EPA) was enacted. The regulation orders the cessation of coal-use at the remaining four coal-fired plants by December 31, 2014.
- ***Federal Coal Emission Regulation (August 2011)***
 - On September 5, 2012, the federal government announced final regulations designed to reduce emissions from coal-fired electricity facilities.
 - The *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations* made under the *1999 Canadian Environmental Protection Act* will apply performance standards to new coal-fired electricity generation units and coal-fired units that have reached the end of their economic life (considered 50 years).
- ***Ontario's Ending Coal for Cleaner Air Act (November 2013)***
 - On November 25, 2015, legislation was introduced to ensure that once coal-fired generating stations stop operating by the end of 2014, coal would never be used again to generate electricity in Ontario.
 - The government's term ended before the bill was passed. The bill was re-introduced in 2014, and has received its second reading.

Results of Coal Phase-Out Initiative

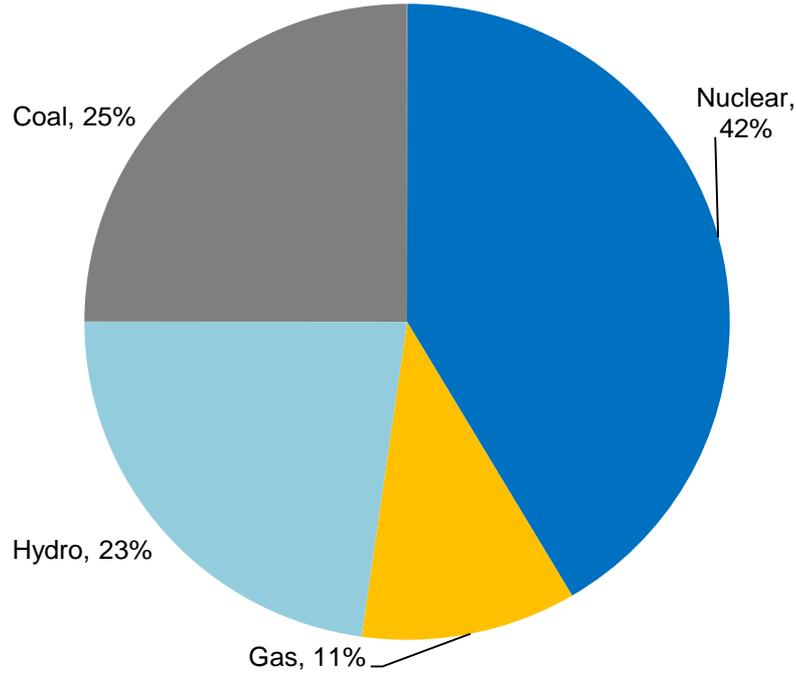
Summary of Results

- As a result of the phase-out of coal-fired electricity generation, Ontario accomplished the following:
 - Ontario has transformed its energy supply mix which has helped to decrease GHG, nitrogen and sulfur oxide emissions.
- By converting two generating stations from coal to biomass, Ontario was able to maintain local economic development and jobs, and build new research capacity in the area of biomass (i.e., established a biomass research centre).
- Coal phase-out contributed to the development and growth of renewable energy sector in Ontario. More than 30 solar and wind manufacturing companies are operating in Ontario and continue to be leaders in the development of the renewable energy industry in Canada.

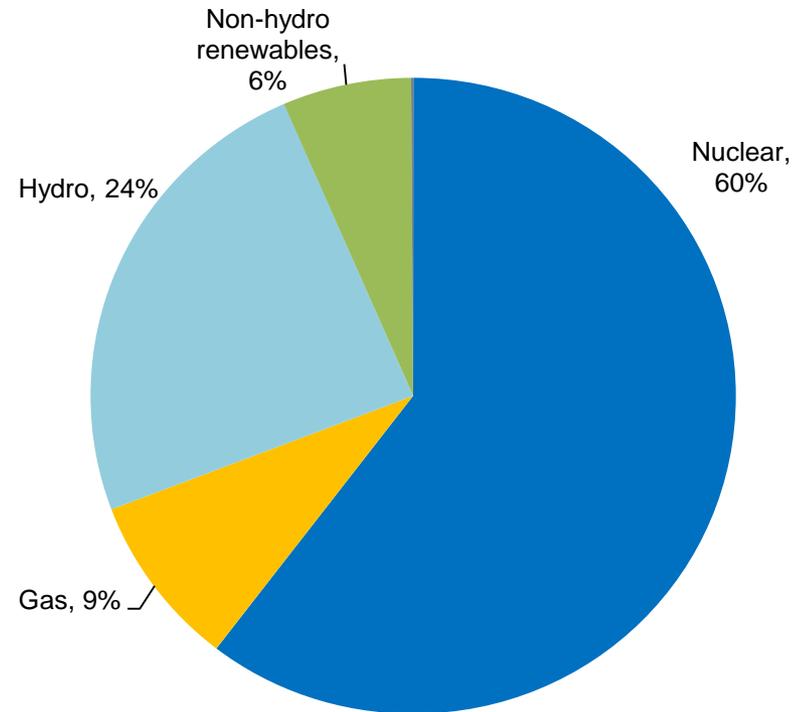
Ontario's Current Electricity Supply Mix

- Today, Ontario has a diverse supply mix without coal:

2003 Electricity Generation

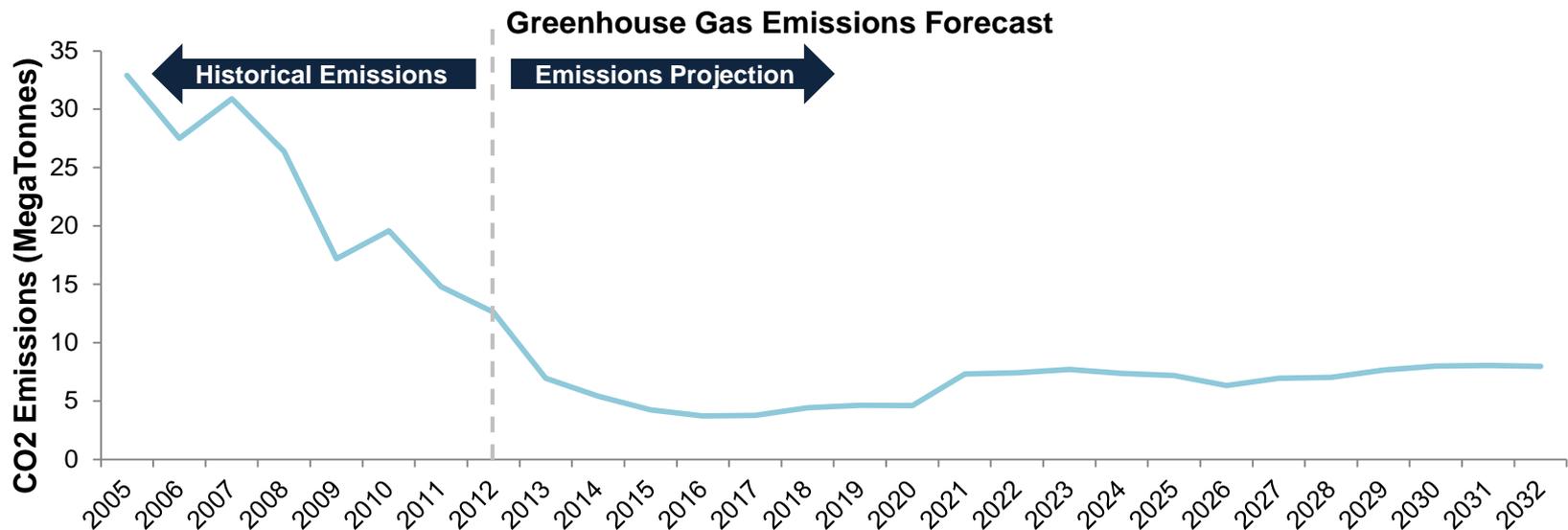


2014 Electricity Generation



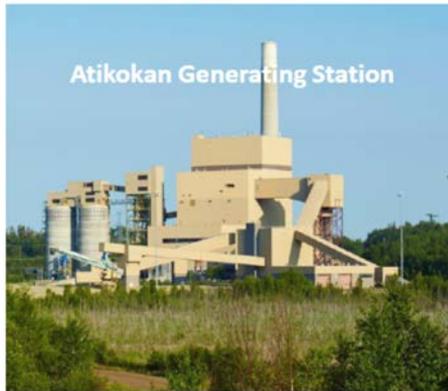
Updated Greenhouse Gas Emissions Forecast

- Since 2003, greenhouse gas emissions in the electricity sector have been reduced by nearly 90 per cent.
- Air emissions from Ontario's electricity sector are expected to remain at historically low levels, although there may be variations in future emissions attributable to changes in demand, the use of natural gas, clean imports and demand response.
- The associated cost of emissions reductions have been incurred by Ontario electricity consumers, through the replacement of coal with clean sources of supply. Rate mitigation programs are available to residents, businesses and industrial customers. See Appendix.



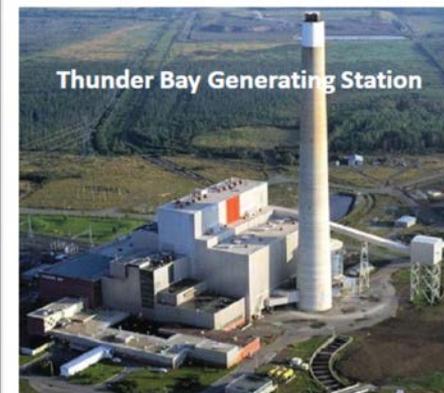
Conversion of Two Coal-fired Stations to Biomass

- Ontario's successful conversion projects provide valuable research and development opportunities. The conversion of Thunder Bay GS to advanced biomass is the first of its kind – putting Ontario and OPG at the leading edge of biomass research globally.



- Ontario successfully completed the conversion of the Atikokan GS from coal to biomass. It is now the largest 100 per cent biomass facility in North America.
- The 205 MW plant is expected to generate 150 million kilowatt hours of renewable power, enough to power 15,000 homes each year.
- The two-year conversion project was completed on time and on budget.

- Thunder Bay GS stopped running on coal in April 2014. The 153 MW station now uses advanced biomass as fuel.
- Advanced biomass has similar handling and storage characteristics to coal. It produces about 75 per cent less nitrogen oxide than coal, and has virtually no sulphur dioxide. It can also be stored outdoors.
- The conversion project was completed under budget and ahead of schedule.



Growth in the Renewable Energy Sector

- Ontario has firmly established itself as a North American leader in renewable energy. More than 30 solar and wind manufacturing companies are operating in Ontario and continue to be leaders in the development of the renewable energy industry in Canada.
- Ontario's *2009 Green Energy Act* (GEA) was introduced to expand renewable energy generation, encourage energy conservation and promote the creation of clean energy jobs.
- As part of the GEA, the Feed-in Tariff (FIT) program was launched in September 2009.
- Renewable energy procurement programs in Ontario:
 - 2004 – Renewable Energy Supply I Request for Proposals (RFP);
 - 2005 – Renewable Energy Supply II RFP;
 - 2006 – Renewable Energy Standard Offer Program;
 - 2008 – Renewable Energy Supply III RFP;
 - 2008 – Combined Heat and Power III RFP;
 - 2009 – Hydroelectric Contract Initiative;
 - 2009 – Feed-In Tariff Program, including microFIT program;
 - 2013 – Hydroelectric Standard Offer Program; and
 - 2014 – Large Renewable Procurement.

Growth in the Renewable Energy Sector (cont'd)

- Ontario has more than 14,800 MW of wind, solar, bioenergy, and hydroelectric energy online, and almost 3,000 MW of renewable energy projects contracted and under development.
- As stated in Ontario's 2013 LTEP, 20,000 MW of renewable energy will be online by 2025, representing about half of Ontario's installed capacity.
- Ontario has strong potential to provide Ontario-manufactured solar photovoltaic modules, wind turbines and related components, as well as Ontario's leading expertise, to external markets.

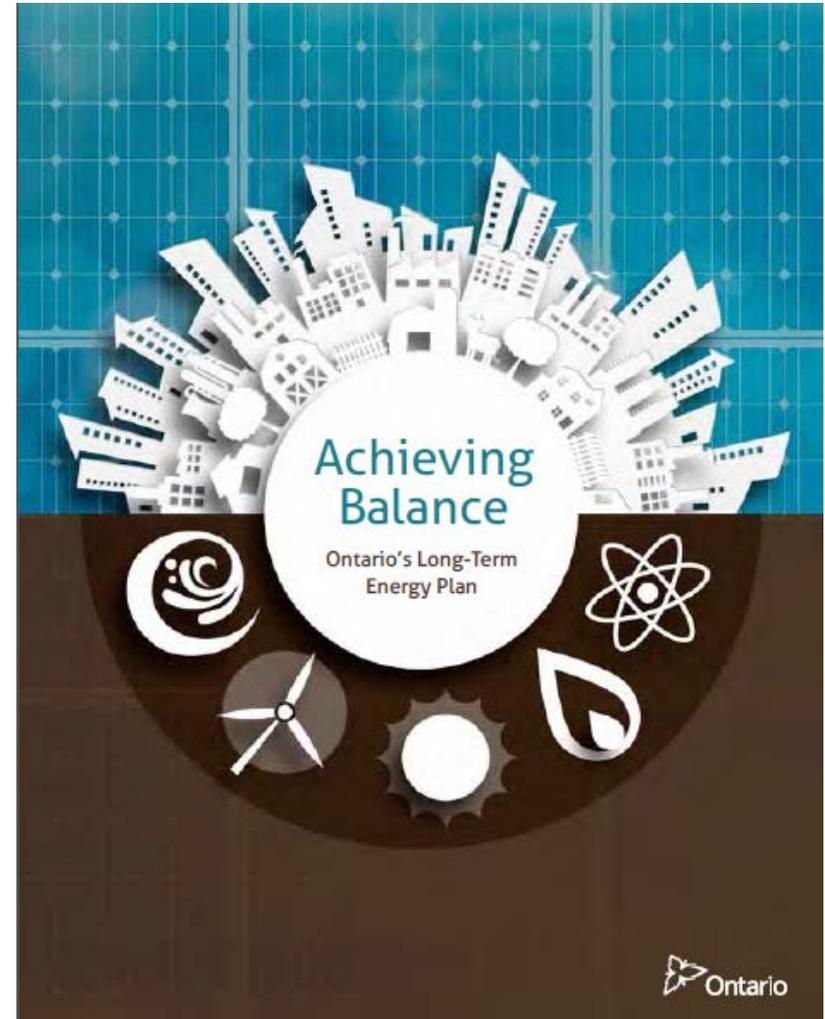
Ontario's Lessons Learned

- Develop a long-term, coordinated plan including the conversion of existing infrastructure, and overall supply-mix changes:
 - Keep the plan flexible to ensure system reliability in the event of a shift in supply/demand forecasts; and
- It is important to maintain a diverse supply mix.
- Communication planning is critical to anticipate and address issues from the public and stakeholders (e.g., price impact, system reliability and adequacy concerns).
- Collaborate with key stakeholders (i.e., generators and system operator).
- System operator needs to learn to adapt and manage a changing system.
 - IESO developed new approaches to monitor and operate different forms of generation.

Appendix

Overview of 2013 LTEP

- In December 2013, Ontario released the 2013 Long-Term Energy Plan (2013 LTEP).
- The plan is designed to balance five principles:
 - Cost-effectiveness;
 - Reliability;
 - Clean Energy;
 - Community engagement; and
 - Conservation and demand management before building new generation.
- The 2013 LTEP was developed through comprehensive consultation and engagement.
 - Sessions were held online and around the province with municipalities, Aboriginal communities, stakeholders and the public.

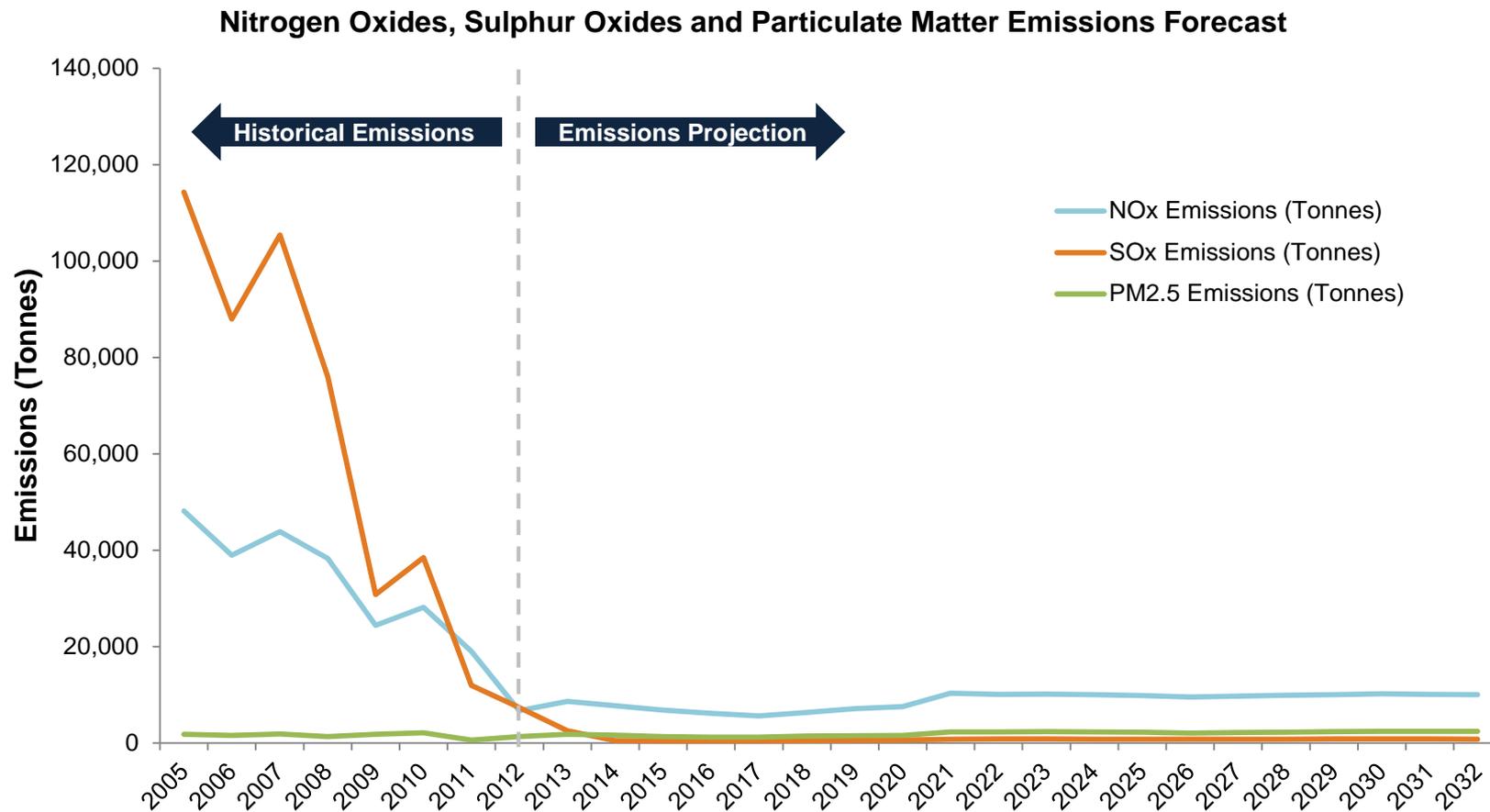


Ontario Biomass Expertise

- The province, through Ontario Power Generation (OPG), has converted two former coal-fired electricity generating stations to biomass.
- In September 2014, Atikokan Generating Station was converted to use biomass. At 205 MW, it is the largest capacity 100 per cent biomass fueled power plant in North America. Wood-pellet biomass was chosen because the energy content is very similar to lignite coal. The station's fuel is supplied locally through Rentech Inc. and Resolute Forest Products, located in Northern Ontario.
- In February 2015, one 153 MW unit Thunder Bay Generating Station was converted to use advanced biomass. Advanced biomass has favourable handling and storage properties, along with a higher energy density. The station also houses OPG's Bioenergy Learning Research Centre.
- These conversion projects provide valuable research and development opportunities. The conversion of Thunder Bay Generation Station is the first of its kind – putting Ontario and OPG at the leading edge of biomass research globally.
- There is potential for OPG to partner with other jurisdictions looking to convert coal facilities to cleaner fuel types or build advanced biomass generating stations.

Other Emissions

- Since 2003, the emissions of sulphur dioxide coming from coal-fired generation in the electricity sector have dropped by 93 per cent. There has also been a 90 per cent reduction in nitrogen oxides.



2003 Coal Fleet Details

Generating Station	Number of Units	Fuel Type	Delivery Type	Location
Atikokan	1	Lignite	Rail	Northwestern Ontario
Thunder Bay	2	Lignite / Northern Powder River Basin Blend	Rail/Vessel	Northwestern Ontario
Lambton	4	2 Units (with Scrubbers) – High Sulfur Coal 2 Units – Low Sulfur Coal	Vessel	Southern Ontario
Nanticoke	8	Southern Powder River Basin / Low Sulfur Blend	Vessel	Southern Ontario
Lakeview	4	Low Sulfur Coal	Vessel	Southern Ontario

- The schedule for phase-out was as follows:
 - Four Lakeview Units
 - Two Lambton Units (with low sulfur coal)
 - Four Nanticoke Units
 - Four Nanticoke Units
 - Two Lambton Units (with high sulfur coal) and 1 Atikokan Unit
 - Two Thunder Bay Units