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Supply Mix Insights: Ontario's Energy Landscape

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Introduction and housekeeping

- Welcome!
- CIET introduction
- Housekeeping items
- Participant introductions

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Introduction

Elissa Williamson, P.Eng., CEM, CMVP, Senior Consultant at Econoler

Experienced energy management professional with over 15 years of energy and carbon management project experience focused in industrial settings. Well-versed in guiding large power users through the implementation and design of demand side management initiatives.

Agenda

- Supply mix: overview, capacity vs. output, transmission vs distribution
- Supply mix: generation types, benefits and limitations
- Energy/demand historical data and forecasts
- Historical emissions data and forecasts
- Ontario electrical grid emissions factors and how to use them

Supply mix overview

On average, only three per cent of Ontario's total greenhouse gas (GHG) emissions came from the Ontario electricity system.

In 2023,

- 87% renewable transmission output
- Ontario's renewable capacity
  - 73% renewable transmission connected
  - 91% renewable distribution connected

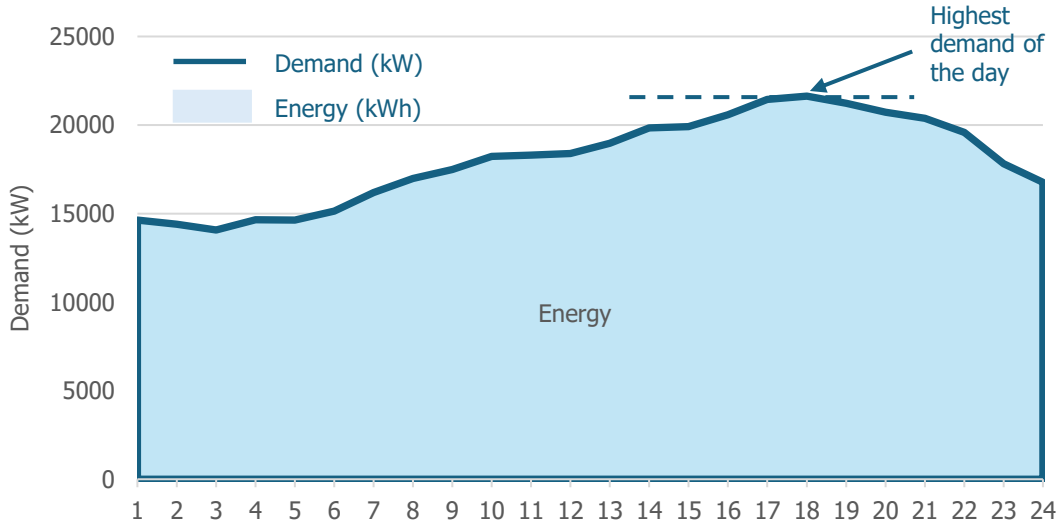
Source https://www.ieso.ca/en/Powering-Tomorrow/2021/Six-things-to-know-about-the-IESOs-study-on-phasing-out-gas-fired-generation-by-2030

Supply mix: energy versus demand

Energy versus demand

Energy

- Typically in kWh (or MWh)
- Refers to the total amount of energy used over a period of time (ie. the customer used 12 kWh)



Demand

- Typically in kW (or MW)
- Refers to the amount of power consumed at a point in time of time (ie. 12 watt light bulb or the industrial plant as a peak demand of 10 MW)

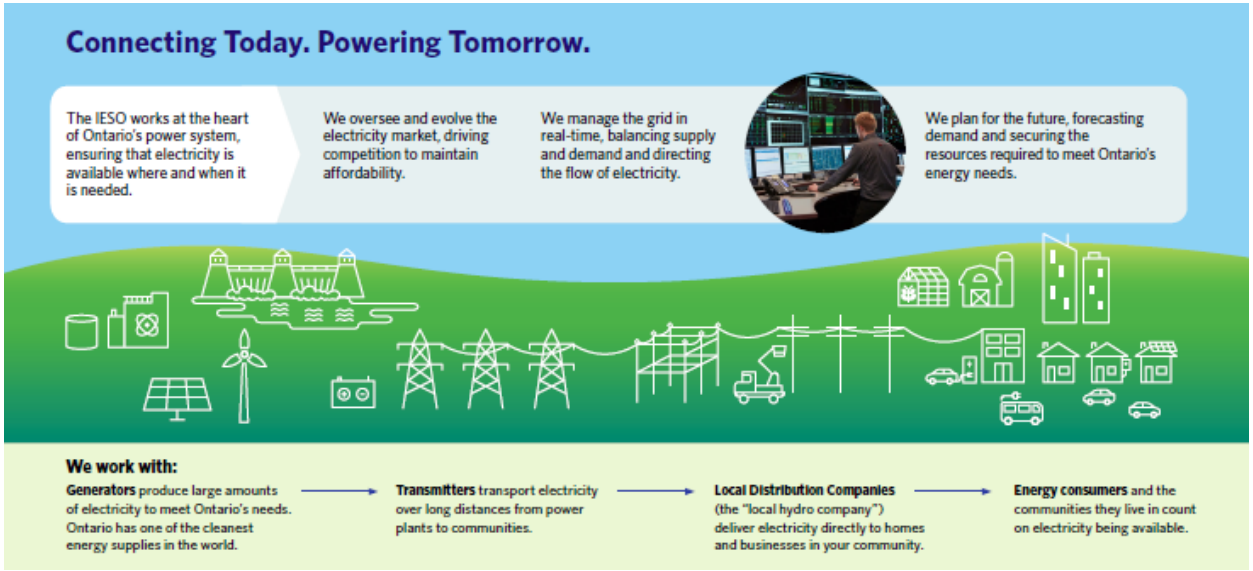
Supply mix: transmission versus distribution

Transmission

High-voltage grid connected >50kV (IESO controlled grid)

Distribution

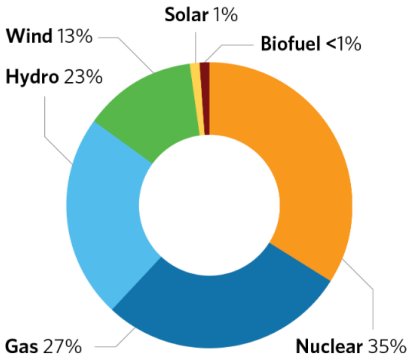
Low-voltage grid connected <50kV, local distribution company (LDC) controlled grid (embedded generation)



https://www.ieso.ca/-/media/Images/IESO/Learn/2022/about-the-ieso-infographic.ashx

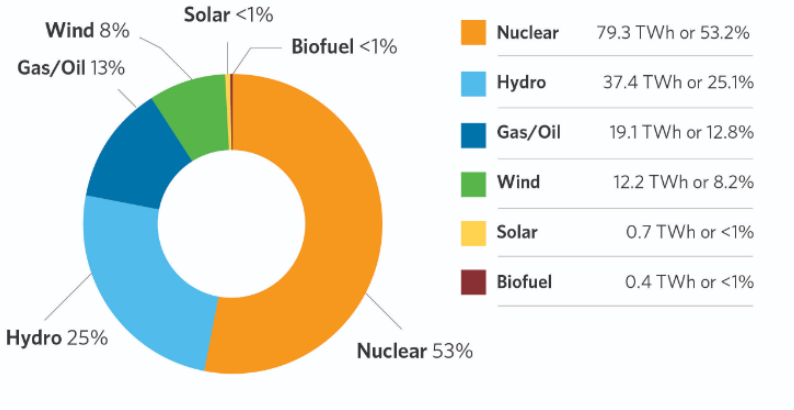
Supply mix: capacity versus output (2023)

Capacity: maximum amount that can be supplied (73% renewable)



Nuclear	13,214 MW or 35%
Gas/Oil	10,471 MW or 27%
Hydro	8,862 MW or 23%
Wind	4,943 MW or 13%
Solar	478 MW or 1%
Biofuel	296 MW or <1%

Output: what is generated (87% renewable)

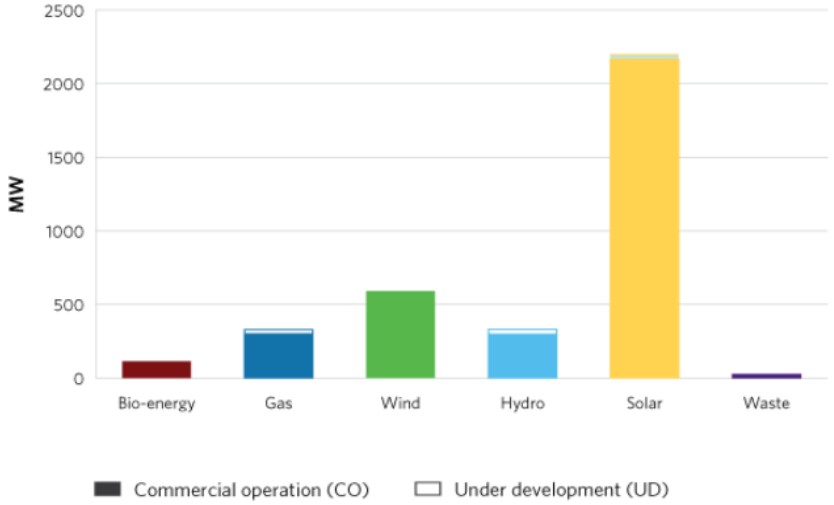


https://ieso.ca/Power-Data/Supply-Overview/Transmission-Connected-Generation

Distribution-connected electricity supply

Supply mix

- Supply mix typically refers to grid-connected generation (IESO controlled grid)
- Can also include a small amount of embedded generation (LDC connected) that participates in the IESO-administered market
- Distribution connected generation is typically excluded
  - Primarily solar (61%) versus gas generation representing (9%)



Source https://ieso.ca/Power-Data/Supply-Overview/Distribution-Connected-Generation

Historical generation type change milestones in Ontario

Timeline of events for ending coal-fired generation

2001 – Ontario announces it will explore alternative power sources to coal

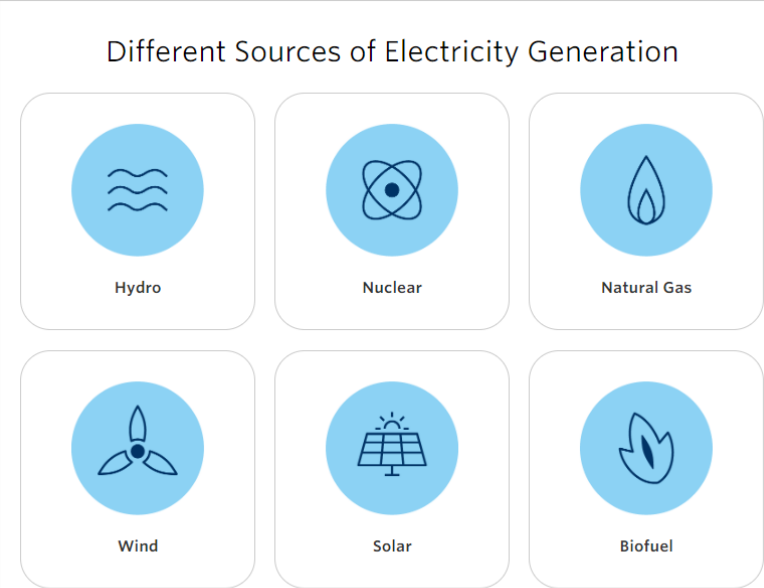
2005 – Lakeview generation station (GS) closes

2012 – Atikokan GS closes

2013 – Nanticoke GS and Lambton GS close

2014 – Thunder Bay GS closes (last coal GS)

2015 – Atikokan and Thunder Bay reopen, fueled by biomass

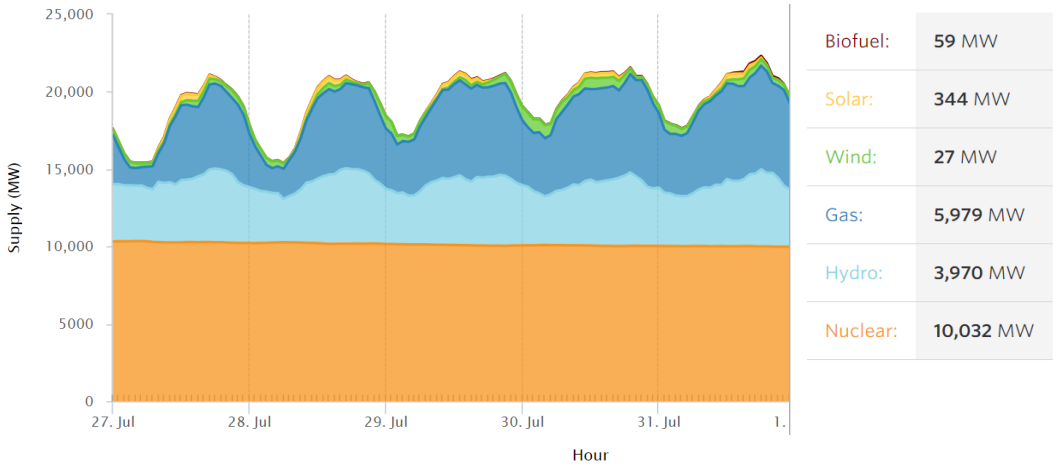


Source https://www.ieso.ca/Learn/Ontario-Electricity-Grid/Supply-Mix-and-Generation

Supply mix type sources in Ontario

Supply types

- **Baseload generation** Nuclear and run of the river hydro
- **Intermediate and peaking generation** This is natural gas plants and certain hydro dams
- **Variable but controllable generation** Solar and wind



Source https://www.ieso.ca/Power-Data
Data taken on August 1, 2024

Supply mix types (benefits and limitations)

Baseload generation

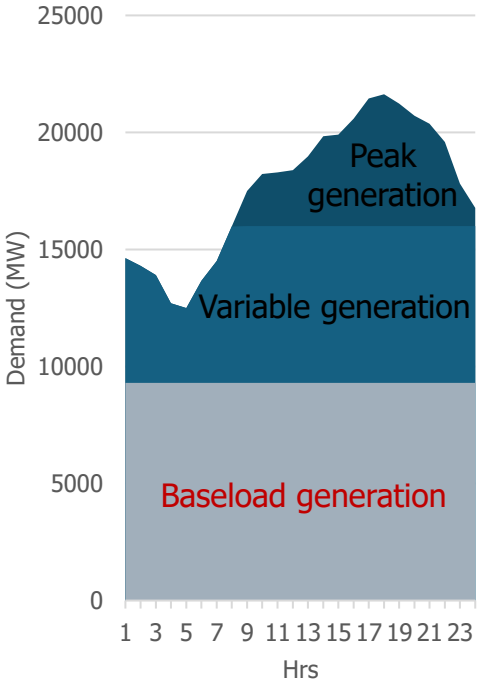
ie. nuclear and run of the river hydropower

Benefits

- Can generate a constant, steady supply of electricity 24/7
- Consistent and reliable
- Resources have long life

Limitations

- Can have long procurement and permitting timelines
- Can be expensive



Supply mix types (benefits and limitations) (Part 2)

Variable but Controllable Generation

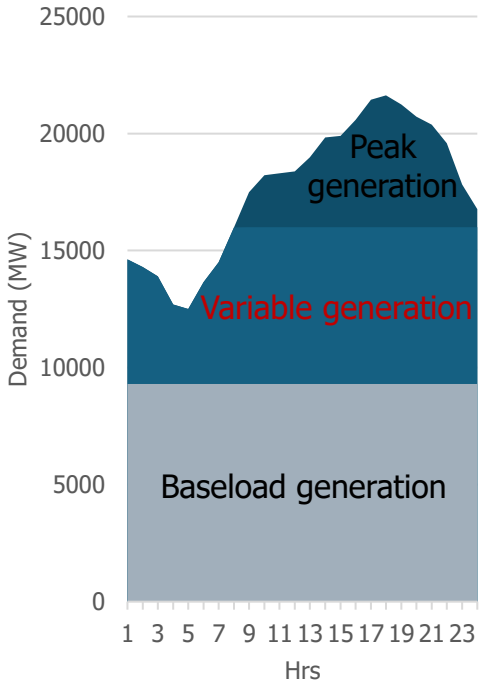
ie. solar and wind

Benefits

- Their operation is flexible

Limitations

- Generation is based on how sunny/windy it is
- Regional considerations



Supply mix types (benefits and limitations) (Part 3)

Intermediate and Peaking Generation

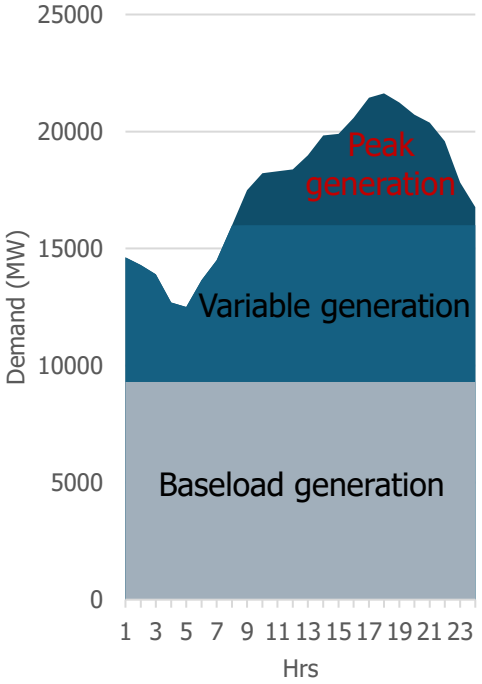
ie. natural gas plants and certain hydro dams

Benefits

- Can quickly adjust output to match fluctuations in demand

Limitations

- Natural gas plants are the single biggest source of air emissions currently on the Ontario grid

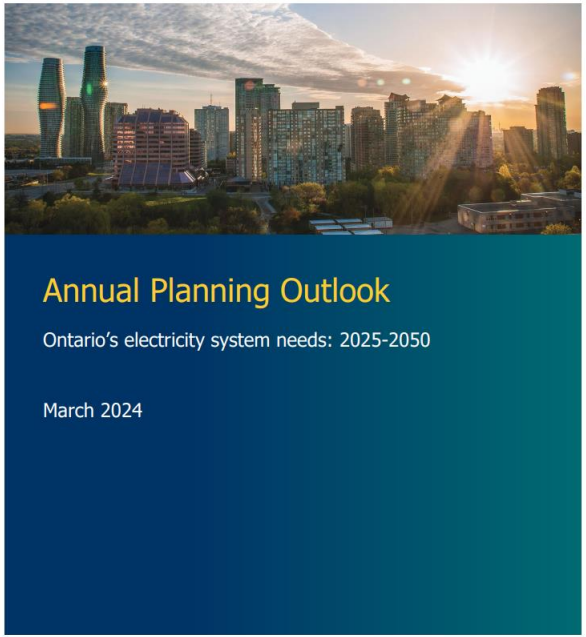


Historical energy and demand data

Annual Planning Outlook (APO)

Published annually by the Independent Electricity System Operator (IESO). The IESO is essentially "air traffic control" for the Ontario electrical grid. They operate the grid, ensuring that reliable and safe electricity is available to satisfy provincial needs 24/7.

- Historical energy demand (2014-2023) https://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook
- Data source: dispatch records

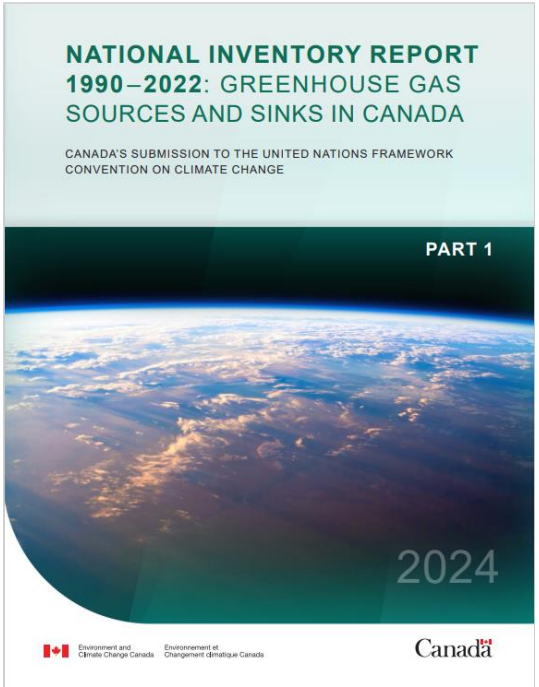


Historical energy and demand data (continued)

National Inventory Report (NIR)

The Government of Canada publishes Canada's official greenhouse gas (GHG) Inventory annually with Annex 13 containing electricity generation and GHG emissions details for Ontario.

- Historical energy data (1990-2022) in Table A13-7 https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory/C-Tables-Electricity-Canada-Provinces-Territories?lang=en
- Data source: Statistics Canada



Energy and demand forecasts

Annual Planning Outlook (APO)

This key document, published annually by the IESO provides a 20-year forecast for Ontario's electricity system, including energy and demand forecasts as well as an emissions outlook.

- The APO is based on the latest available economic data projections, committed policies and projects. The APO does not speculate on policy changes that are unconfirmed. This forecast is what is considered to be the most likely to transpire.

This document can provide a lot of insight to those trying to forecast peak demand periods and do budgetary forecasts.

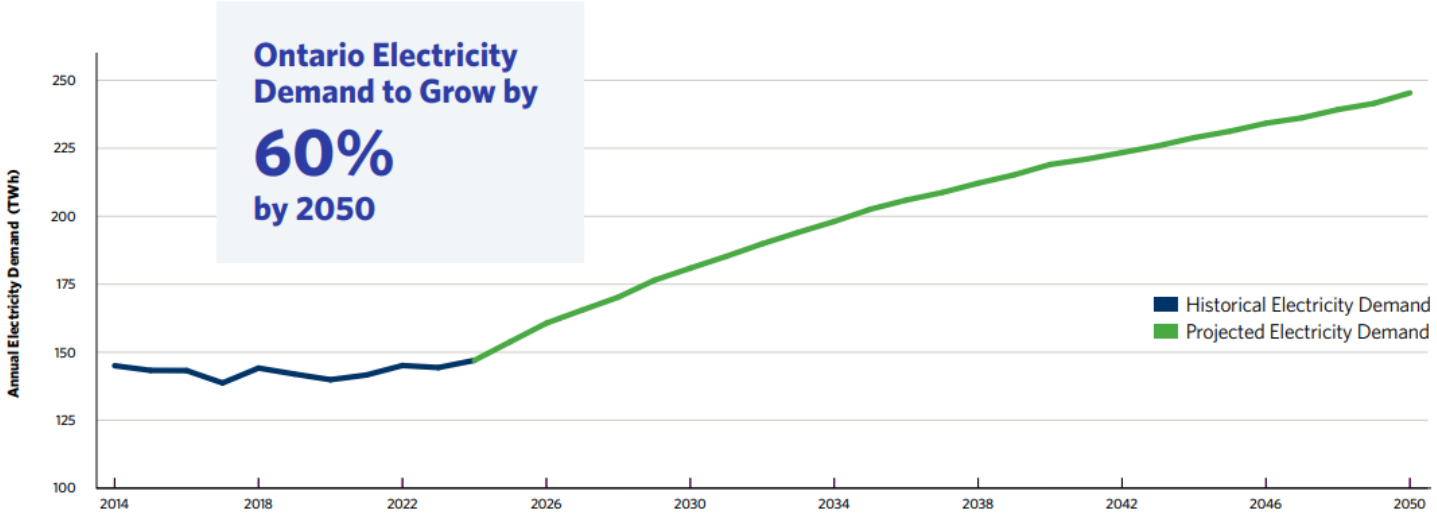
Energy and demand forecasts (continued, part 2)

Six Graphs and a Map: 2024 Annual Planning Outlook and Emissions Update

- The APO identifies system needs and planned actions
- The spring 2024 update provides updated emissions forecasts for the sector https://www.ieso.ca/Powering-Tomorrow/2024/Six-Graphs-and-a-Map-2024-Annual-Planning-Outlook-and-Emissions-Update
- Graphs are available in Excel format. To request a copy, email iesoCustomerRelations@ieso.ca

Energy and demand forecasts (continued, part 3)

Six Graphs and a Map: 2024 Annual Planning Outlook and Emissions Update



https://www.ieso.ca/Powering-Tomorrow/2024/Six-Graphs-and-a-Map-2024-Annual-Planning-Outlook-and-Emissions-Update

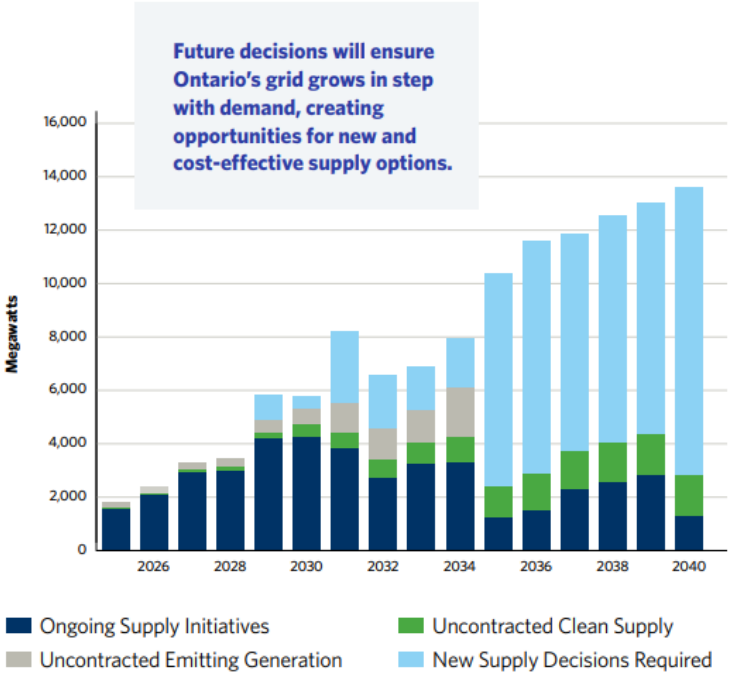
Energy and demand forecasts (continued, part 4)

Six Graphs and a Map: 2024 Annual Planning Outlook and Emissions Update

Highlights

- Ongoing supply initiatives
- Uncontracted supply
- New supply decisions required

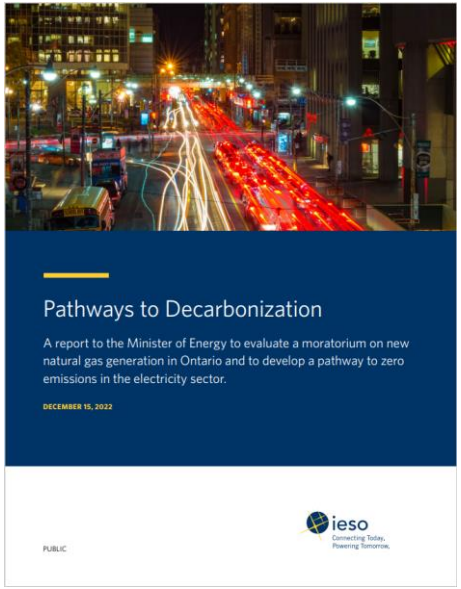
Source https://www.ieso.ca/Powering-Tomorrow/2024/Six-Graphs-and-a-Map-2024-Annual-Planning-Outlook-and-Emissions-Update



Energy and demand forecasts (continued, part 5)

Pathways to Decarbonization (IESO, Dec 2022)

- Presents a model of what energy/demand could look like under an aggressive transition to a net-zero emissions grid by 2050.
- Not a forecast but provides "a high-demand bookend that could be seen in an economy transitioning to societal decarbonization."



https://www.ieso.ca/en/Learn/The-Evolving-Grid/Pathways-to-Decarbonization

Historical emissions data

IESO – 2022 APO (2005-2022)

- Annual Planning Outlook (ieso.ca) https://www.ieso.ca/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook

National Inventory Report (NIR)

- Government of Canada publishes Canada's official greenhouse gas (GHG) Inventory annually with Annex 13 containing emissions details for Ontario ECCC Data Catalogue
- Data comes from Statistics Canada with most recent data available from 2 years prior to the published date (ie. up to 2022)

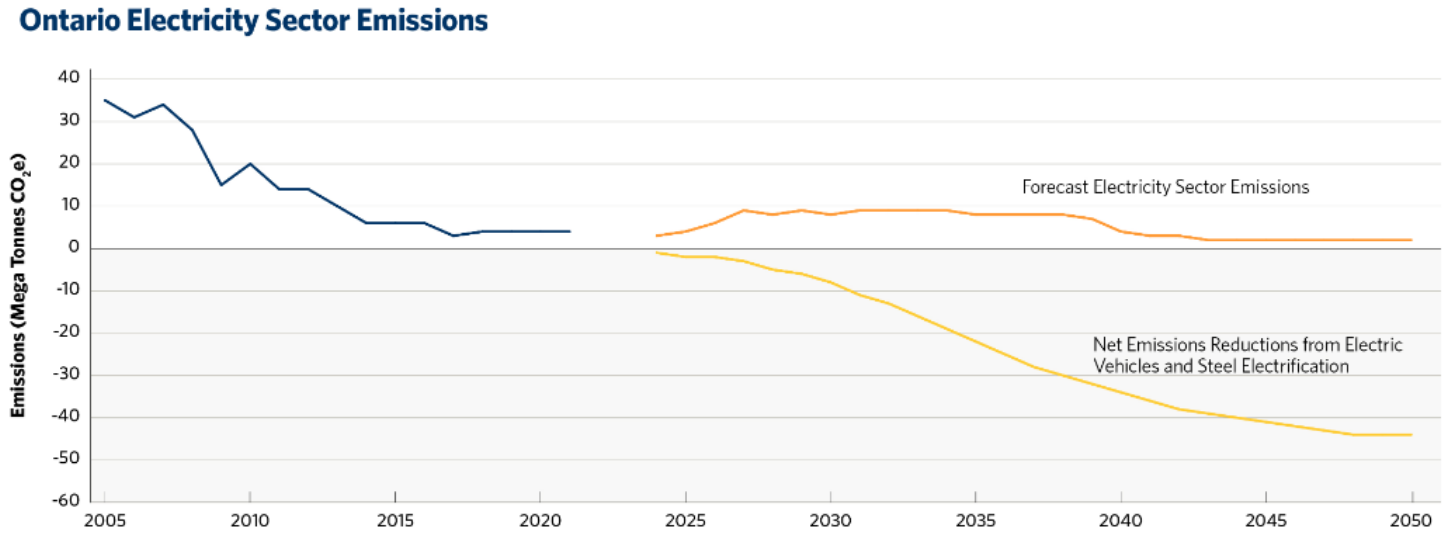
Emissions forecasts

IESO's Annual Planning Outlook (Spring 2024 Update)

- Six Graphs and a Map: 2024 Annual Planning Outlook and Emissions Update https://www.ieso.ca/Powering-Tomorrow/2024/Six-Graphs-and-a-Map-2024-Annual-Planning-Outlook-and-Emissions-Update
- The graphs produced show emissions from Ontario's electricity system starting to level out, while allowing for substantial emissions reduction from the transportation and steel manufacturing sectors.
- The forecast also show that as demand increases, the energy-intensity of the grid (g CO2e/kWh) will become less emissions-intensive.

Emissions forecasts (continued)

IESO's Annual Planning Outlook (Spring 2024 Update)

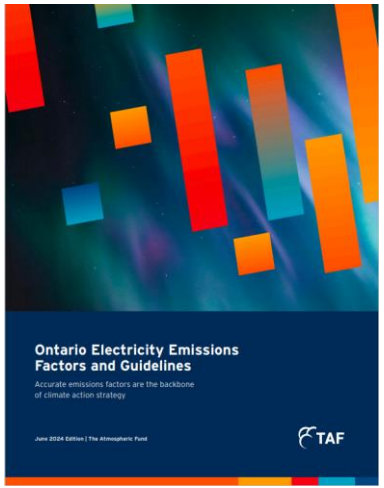


https://www.ieso.ca/Powering-Tomorrow/2024/Six-Graphs-and-a-Map-2024-Annual-Planning-Outlook-and-Emissions-Update

Emissions forecasts (continued…)

Toronto Atmospheric Fund (TAF)

- Regional climate agency that invests in low-carbon solutions for the GTA and Hamilton area
- Assesses available data from IESO, NIR and external resources and provides up to date recommendations on best emissions assumptions (Ontario Electricity Emissions Factors and Guidelines 2024 Edition)
- This report is a great resource for those trying to;
  - understand current or historical emissions
  - evaluate the emissions impacts of a project or change



Ontario electrical grid - emissions factors

Emissions factor - This is the greenhouse gas intensity of the grid, typically presented in g CO2eq/kWh.

TAF, 2024, Electricity Factors and Guidelines

- Uses best available data to provide estimated hourly, annual and forecasted emission factors.
- All data used is from NIR (emission factors) or IESO (supply/demand source: IESO 2024 APO) publicly available information.
- The IESO's Generator Output and Capability Report provides the most up-to-date data available to estimate emissions (data does not include distribution level generation or transmission connected sources <20MW). According to TAF, this accounts for 119MW of natural gas generation.

Ontario electrical grid - emissions factors (continued)

TAF, 2024, Electricity Factors and Guidelines

Emissions Factor		Methodology
Average	Annual	The total emissions from electricity production in Ontario divided by the total electricity produced in any given year.
	Hourly	The total emissions from electricity production in Ontario divided by the total electricity produced in a specific hour of the day, averaged over the year.
Limited Marginal	Peak/Off-Peak	The emissions generated based on the forecasted proportion of natural gas on the margin obtained from the IESO for 2024 and 2030.

TAF, June 2024, Ontario Electricity Emissions Factors and Guidelines., p.10

Marginal resource - refers to the emissions intensity of the generation resource used to respond to changes in demand (ie. last generation resource to be dispatched in order to satisfy the Ontario demand).

Ontario electrical grid - annual average emissions factor

Annual Average Emissions Factor (annual AEF)

The average annual amount of greenhouse gas emissions produced per unit of electricity consumed (gCO2eq/kWh).

- Calculated by taking the total amount of annual emissions produced divided by the total amount of electricity consumed
- Typically used to calculate emissions from electricity consumption
- Can be used to calculate emissions changes from a fuel switching project

Annual AEF (gCO_2eq/kWh): The total emissions from electricity production in Ontario (gCO2eq) divided by the total electricity produced (kWh) in any given year.

2023	67
2022	51
2021	44
2020	36
2019	29
2018	29
2017	18
2016	40
2015	46

TAF, June 2024, Ontario Electricity Emissions Factors and Guidelines., p.11

Ontario electrical grid - hourly average emissions factor

Hourly Average Emissions Factor (hourly AEF)

The average hourly amount of greenhouse gas emissions produced per unit of electricity consumed (gCO2eq/kWh).

- Hourly emissions produced divided by the total amount of electricity consumed over the same hour and averaged across the year
- Used when more granular data is required (ie. impact of projects that would have interactive effects such as an LED lighting project, which could impact the amount of cooling/heating required)

Hour	2023	2022	2021	2020	2019
1	38	25	19	15	14
2	34	23	19	14	13
3	34	24	20	15	13
4	37	26	23	18	15
5	43	30	27	21	17
6	51	37	32	25	21
7	58	43	36	29	25
8	64	49	41	32	28
9	69	52	44	35	30
10	72	55	47	38	32
11	73	57	49	41	33

TAF, June 2024, Ontario Electricity Emissions Factors and Guidelines., p.12

Ontario electrical grid - forecasted emissions factors

Toronto Atmospheric Fund (TAF)

- TAF, 2024 "While changes may result in material variations to the forecasts, the most up-to date and accurate information available is used to generate the projected factors in this guideline."
- TAF has used the IESO's 2024 APO The IESO's Annual Planning Outlook in Six Graphs
- Forecasted emissions factors are provided in full as a separate, downloadable data file 2024-2041

Forecasted AEFs (gCO_2eq/kWh)	
2024	71
2025	138
2026	145
2027	132
2028	133
2029	126
2030	126

TAF, June 2024, Ontario Electricity Emissions Factors and Guidelines., p.14

Ontario electrical grid - marginal emissions factors

Marginal Emissions Intensity – This refers to the amount of greenhouse gas emissions per unit of electricity (gCO2eq/kWh) of the marginal resource (typically natural gas).

Can be used to:

- forecast the impact of changes in electricity consumption during on-peak/off-peak times
- quantify the impact of projects involving load shifting, battery storage etc

Forecasted Peak/Off-Peak (gCO_2eq/kWh)

		2024	2030
Summer	On Peak	220	499
	Mid Peak	195	494
	Off Peak	95	359
Shoulder	Mid Peak	235	479
	Off Peak	107	387
Winter	On Peak	244	489
	Mid Peak	205	484
	Off Peak	100	434

TAF, June 2024, Ontario Electricity Emissions Factors and Guidelines., p.15

Stay connected with tools and resources

- Virtual one-on-one coaching: post-webinar support intake form for tailored support for organizations to manage energy resources effectively
- Monthly bulletin: sign up to receive monthly training updates on all Save on Energy training and support new tools and resources
- Live training calendar: visit this page to easily register for upcoming events and workshops
- Training and support webpage: visit this page to access all training and support materials

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References

Environment Canada. (2024). *National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.* National inventory report : greenhouse gas sources and sinks in Canada.: En81-4E-PDF - Government of Canada Publications - Canada.ca

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