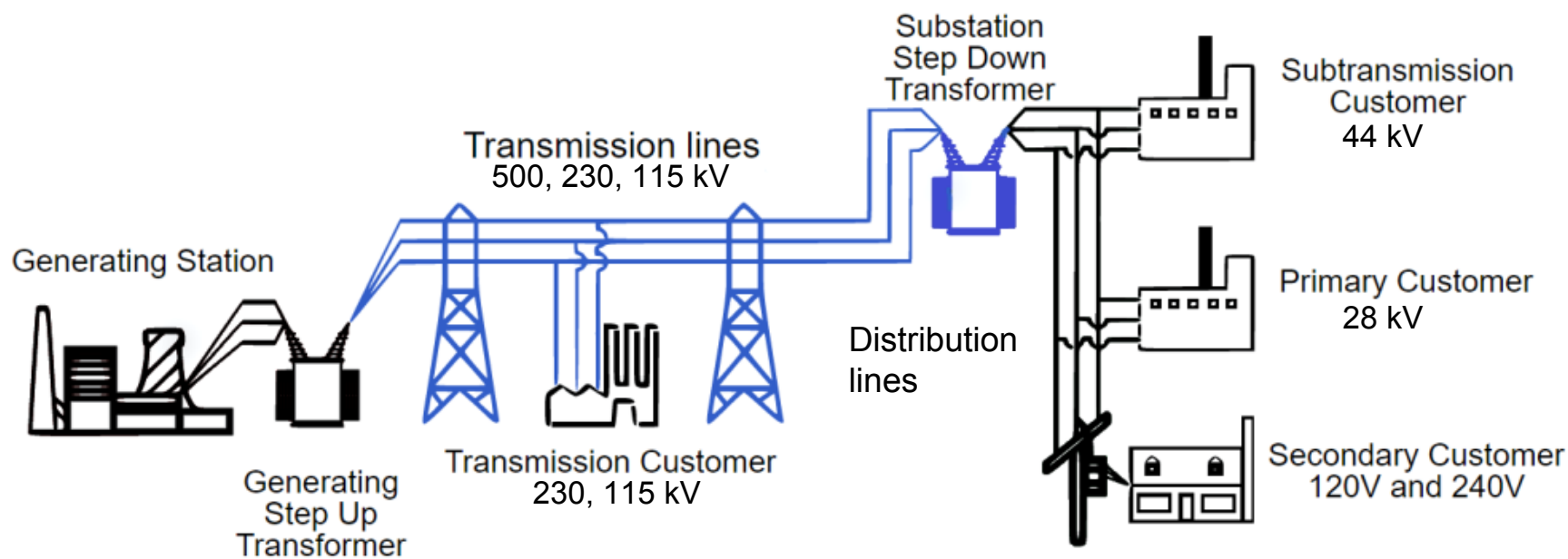

Transmission Overview

Transition 2018
Foundation Briefing
Working Draft

CONFIDENTIAL DRAFT

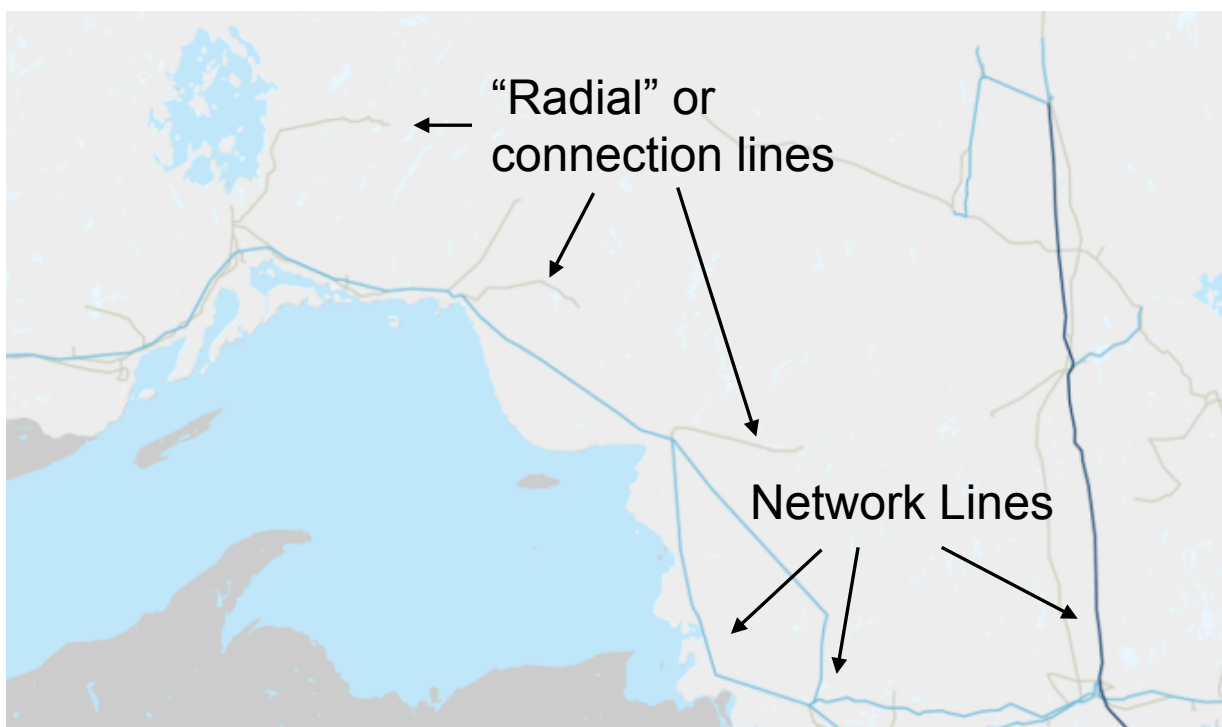
Transmission Overview



- Electricity is transmitted around the province on high-voltage transmission lines.
- Transformers “step up” or “step down” the voltage to a higher or lower level.

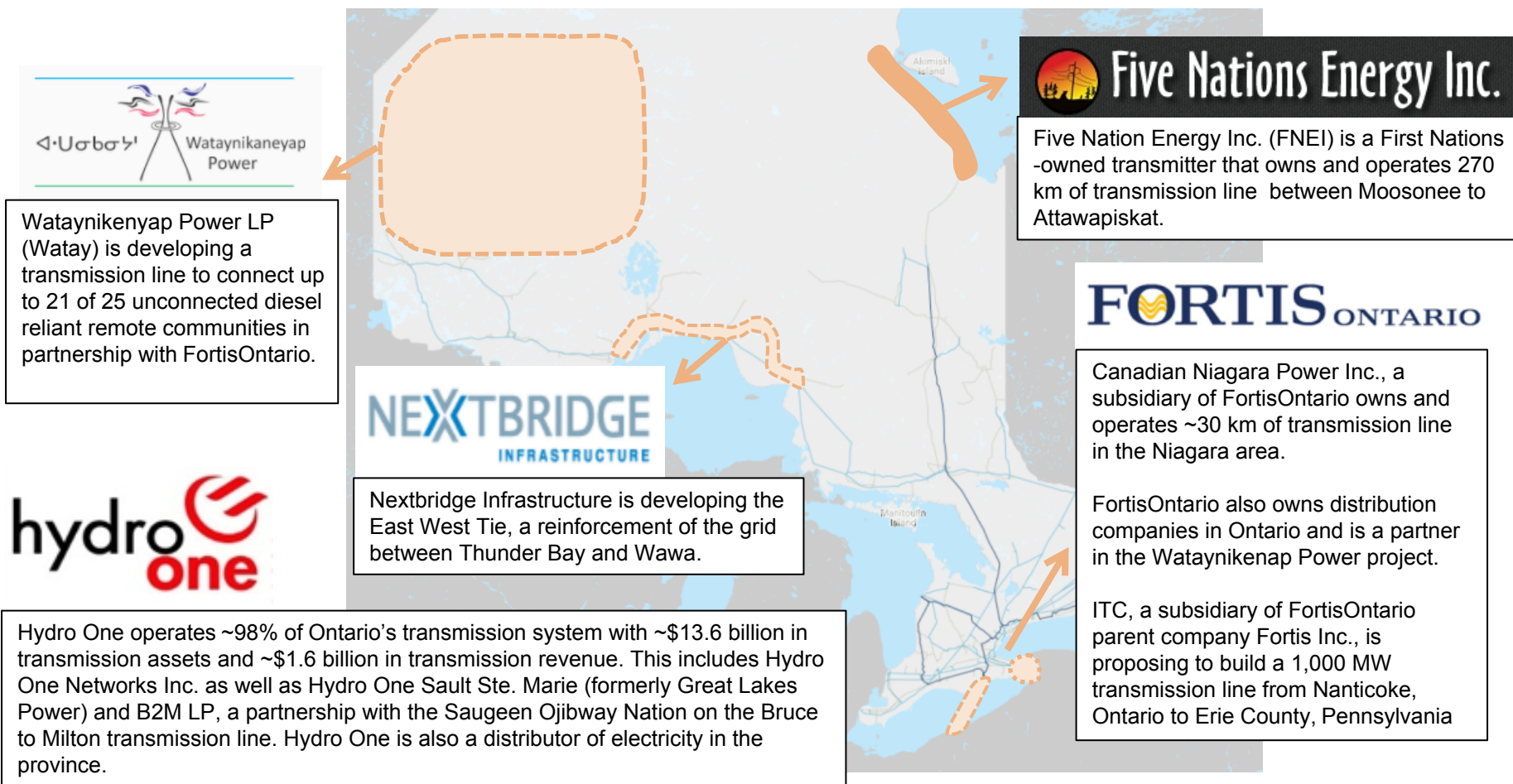
Network vs. Connection Lines

- High voltage (i.e. 230 kV, 500 kV) **network lines** connect different regions of the province together, and have benefit for all customers in Ontario.
- Lower voltage (i.e. 115 kV) “**radial**” or **connection lines** provide a connection between a network line/station and particular load or generation customers.



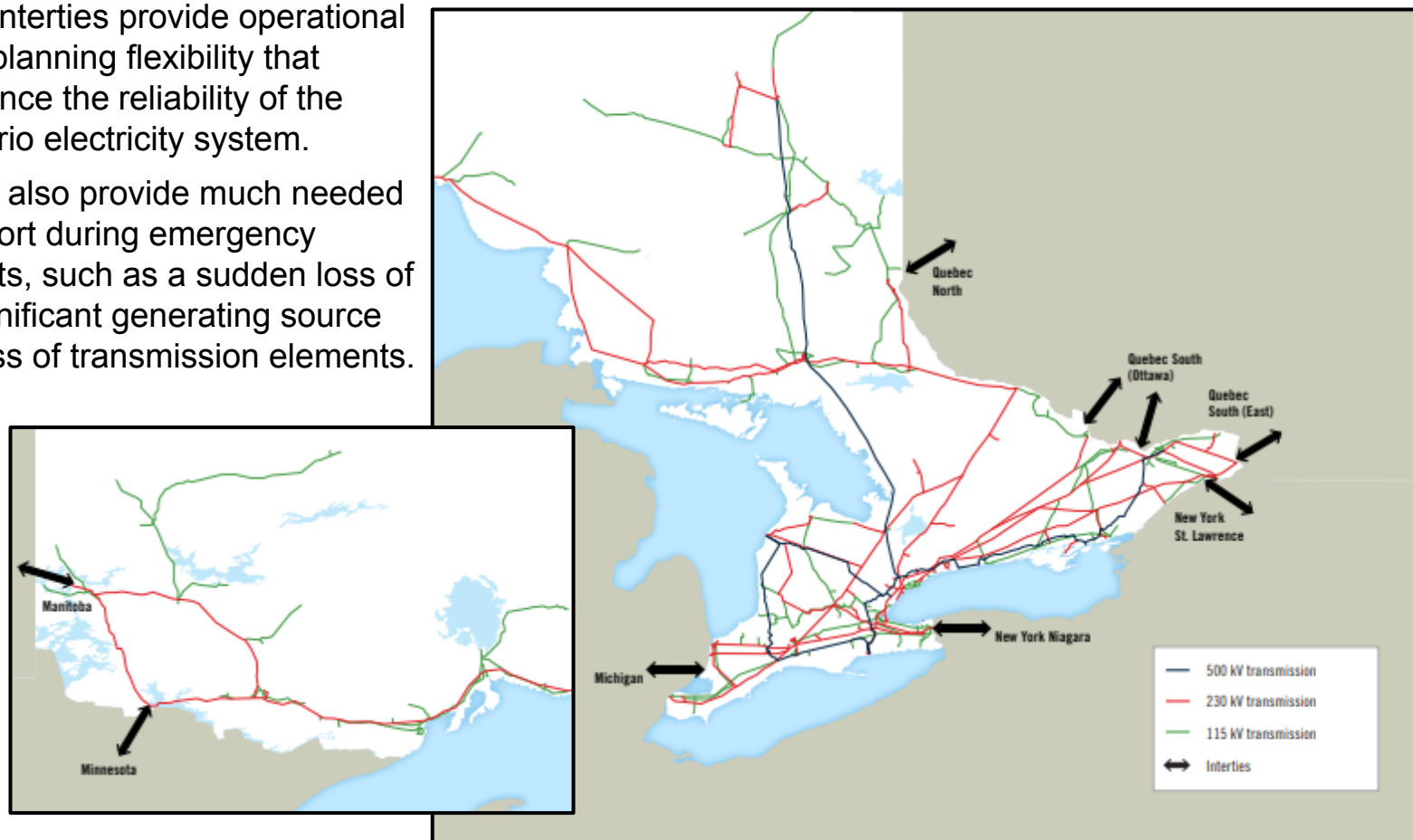
Transmitters in Ontario

- Ontario has approximately 30,000 km of transmission lines and over 300 transformer stations and switching stations, 98% of which is owned and operated by Hydro One.



Transmission Interconnections (Interties)

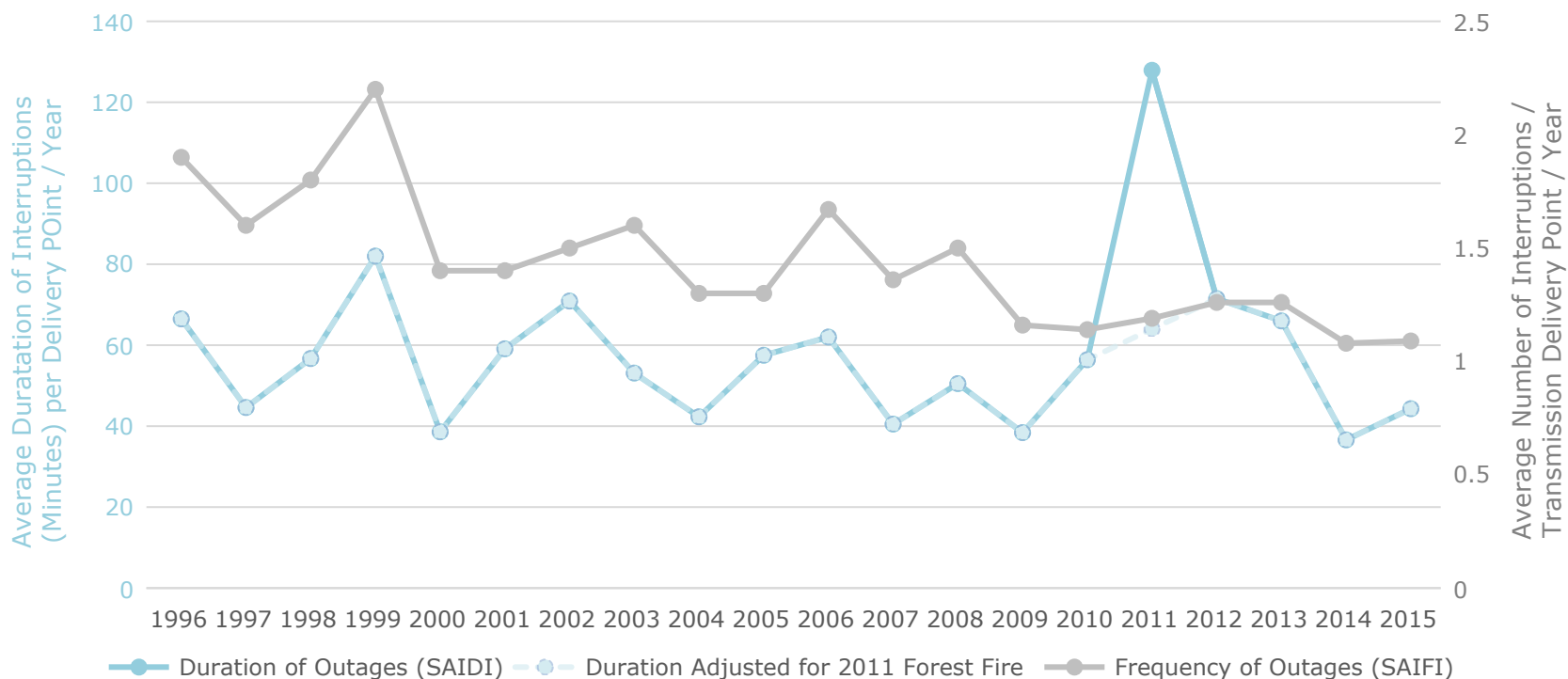
- Ontario is electrically interconnected with Manitoba, Minnesota, Michigan, New York and Quebec across 26 interties, enabling electricity trade between and beyond these jurisdictions.
- The interties provide operational and planning flexibility that enhance the reliability of the Ontario electricity system.
- They also provide much needed support during emergency events, such as a sudden loss of a significant generating source or loss of transmission elements.



Transmission System Reliability

- Transmission reliability has been relatively stable over the last 20 years.

Frequency and Duration of Interruptions on Hydro One's Transmission System



Sources: 1996-2005 Data based on data included in Hydro One's 2007 transmission rate application: See pages 19 and 20 of the following pdf: 2006-2015 Data based on Hydro One's 2017/18 Rate Application, 2003 excludes the impact of the 2003 blackout, 2006 excludes the impact of the Caledonia event in 2006, 2013 excludes the impact of GTA flooding.

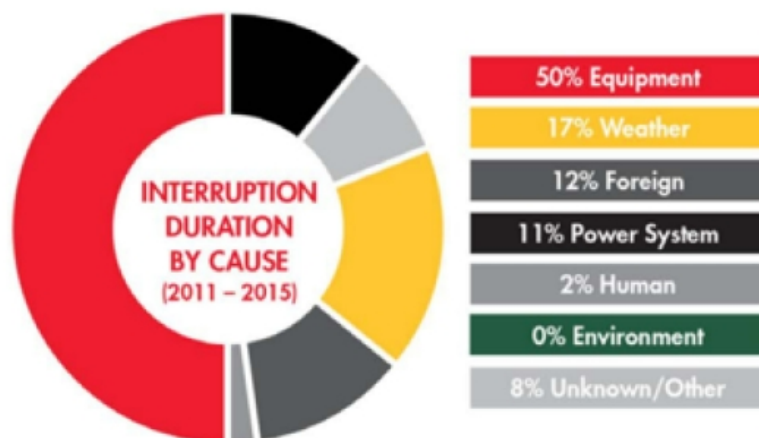
Cause of Interruptions

- A lack of redundancy drives increased duration of outages on Hydro One's single-circuit system, which primarily services Northern Ontario.

MULTI-CIRCUIT SYSTEM (SAIDI)

KEY FACTS:

- ~70% of delivery points • ~85% of total load
- Located primarily in Southern Ontario



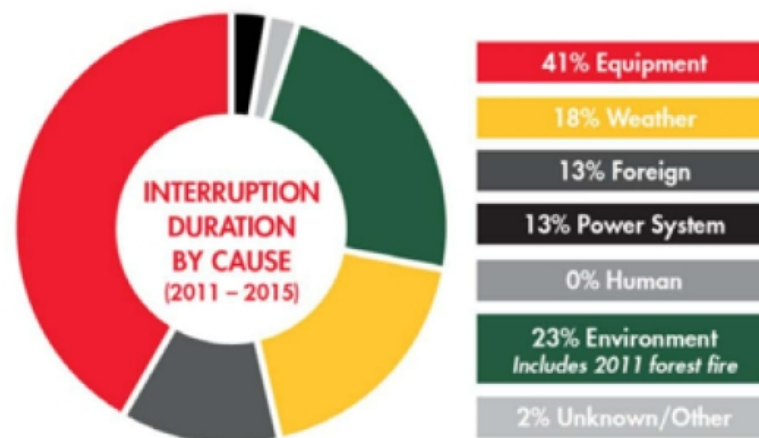
Average interruption duration per delivery point: **10 mins**

Duration of interruptions limited by redundancy in the multi-circuit network

SINGLE-CIRCUIT SYSTEM (SAIDI)¹

KEY FACTS:

- ~30% of delivery points • ~15% of total load
- Located primarily in Northern Ontario



Average interruption duration per delivery point: **211 mins**

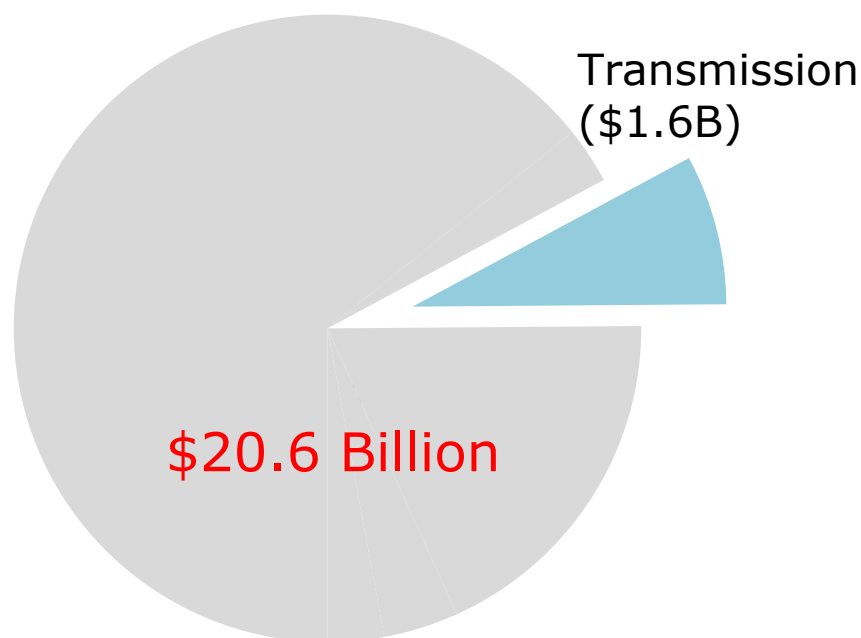
Lack of redundancy drives increased duration of interruptions

Transmission Costs

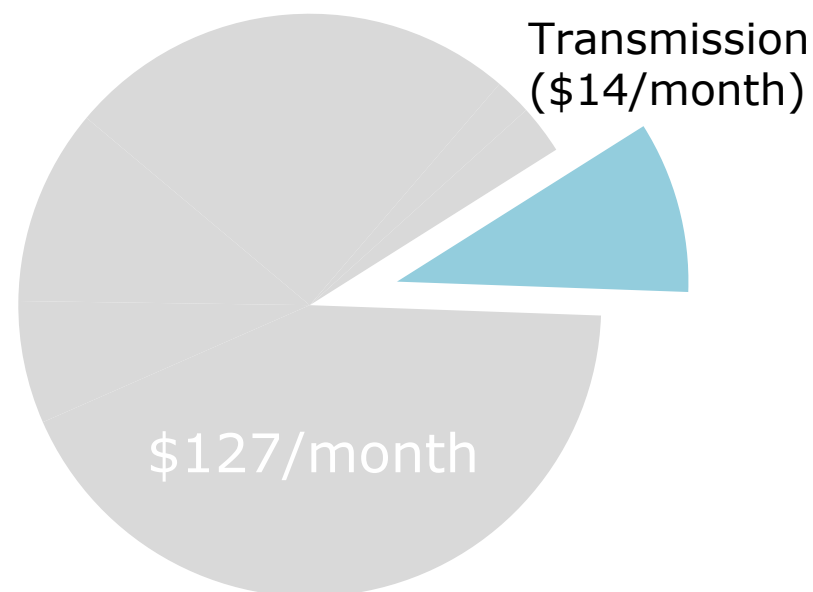
Costs of the Transmission System

- Total transmission costs of \$1.6 billion out of total system costs of **\$20.6 billion** translates to a monthly cost of \$14 per month on a typical residential customer bill.

Transmission portion of Total System Cost



Typical Transmission portion of Monthly Residential Customer Bill*



* Includes the impact of the Ontario Fair Hydro Plan Act.

How Is Transmission Paid For?

- For new transmission assets that benefit the entire system, costs are recoverable from electricity ratepayers once the OEB deems them to be “used and useful.” Then, the costs of the equipment are recovered from customers over time through transmission rates.
- Transmission assets required to connect individual generator or load customers are funded by the customers themselves through a combination of upfront capital contributions and the transmission rates they pay on their bills over time. This is consistent with the “beneficiary pays” principle: infrastructure that only benefits certain customers are not applied to rates paid by all ratepayers. This is an important principle because it helps to keep electricity rates from increasing, which benefits families and businesses across the province.
- Licensed transmitters apply to the Ontario Energy Board for approval of transmission rates on a regular basis to recover the costs of their capital investments, operational/maintenance costs, and a rate of return on equity.

TRANSMISSION RATES [table to be filled in]

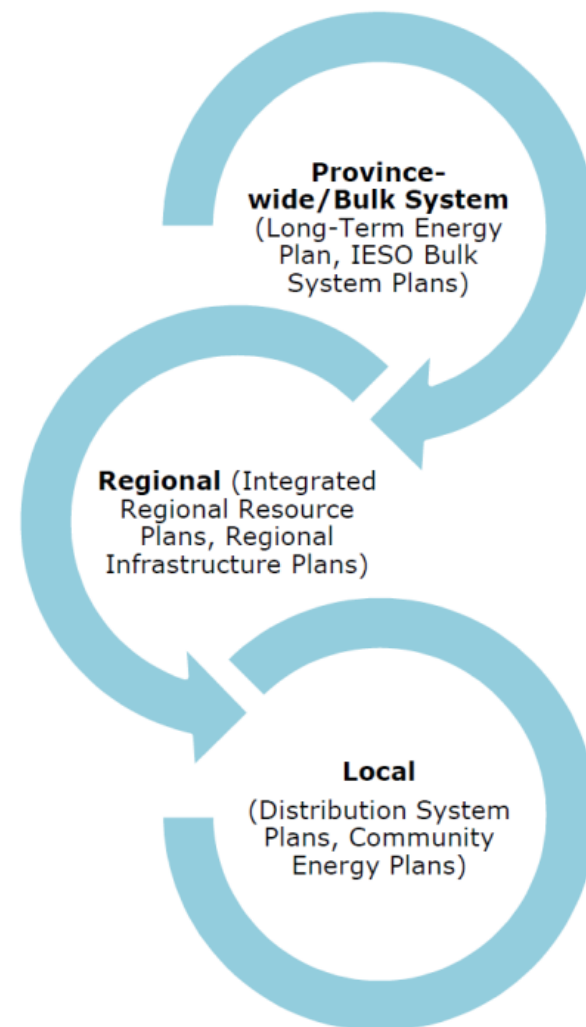
	2015	2016	2017	2018
Annual Revenue Requirement (All Transmitters)	\$1.57 B	\$1.56 B	\$1.52 B	1.6 B
Transmission Rates				
Percentage Change				

Transmission Planning and Project Development

Levels of Planning

The IESO plans for the resources needed to meet Ontario's future electricity needs. Electricity planning happens at the provincial, regional and local level.

- **Province-wide or bulk planning** looks at the 230 kV and 500 kV transmission and generation system in Ontario. Bulk planning is conducted through the IESO and through the Ministry's Long-Term Energy Plan.
- **Regional planning** is focused on the 115 kV and 230 kV system. The IESO looks at each region's unique needs and considers conservation, generation, transmission and distribution, and innovative resources to meet these needs. The IESO works with transmitters, the local distribution companies (LDCs), municipalities and Indigenous communities as well as individuals and business groups.
- **Local planning** includes distribution system plans prepared by LDCs and Community Energy Plans prepared by municipalities and Indigenous communities. Ontario's Municipal Energy Plan program and the IESO's Aboriginal Community Energy Plan (ACEP) program both support the efforts of municipalities and Indigenous communities.



Planning Standards in Ontario

- When conducting planning, the IESO and transmitters consider North America-wide and Ontario specific reliability standards.
- After the 2003 blackout, a Canada-U.S. Task Force was formed to identify the causes of the power outage and seek recommendations to help prevent future outages. Their final report identified 46 specific technical and policy recommendations on minimizing or preventing future blackouts. The top recommendation stressed the creation of mandatory, enforceable reliability standards with penalties for non-compliance.
- Today, the North American Electric Reliability Corporation (NERC) defines the reliability requirements for planning and operating the interconnected North American bulk electric system. The IESO is a member of NERC, representing Ontario's interests in the development of standards affecting all jurisdictions across Canada and the U.S. The IESO is also a member of the Northeast Power Coordinating Council (NPCC), which is responsible for promoting and improving the reliability of the interconnected bulk power system in the northeast of North America.
- NERC and NPCC standards include a wide array of standards from personnel credentials and training, to physical and cybersecurity and vegetation management.
- The IESO's Market Rules define the roles and obligations of the IESO and all market participants who own or operate elements and facilities that form part of the IESO-controlled grid. Included in the obligations of market participants is the requirement to comply with applicable reliability standards, including NERC, NPCC and Ontario-specific standards.
- The IESO administers the Ontario Reliability Compliance Program (ORCP) and works closely with market participants to ensure that they understand and follow their reliability obligations.

Regulation and Key Approvals

POLICY



Ministry of Energy

- Develops, analyzes and monitors transmission policy and oversees transmission planning activities by the IESO.
- Cabinet has the authority to pass an Order-in-Council naming a transmission project a priority. This designation means that the Ontario Energy Board must consider the transmission project to be needed when deliberating on Leave to Construct.
- Works with other ministries to ensure the Crown's legal duty to consult is met where Aboriginal or treaty rights may be adversely affected by a Crown action.

PLANNING



- Operates the transmission system and generation wholesale market.
- Enforces mandatory bulk system reliability standards.
- Plans for adequate and reliable electricity resources of the province.
- Conducts regional and bulk system planning with the support of transmitters.
- Currently developing a competitive transmitter selection process for new projects.

APPROVALS

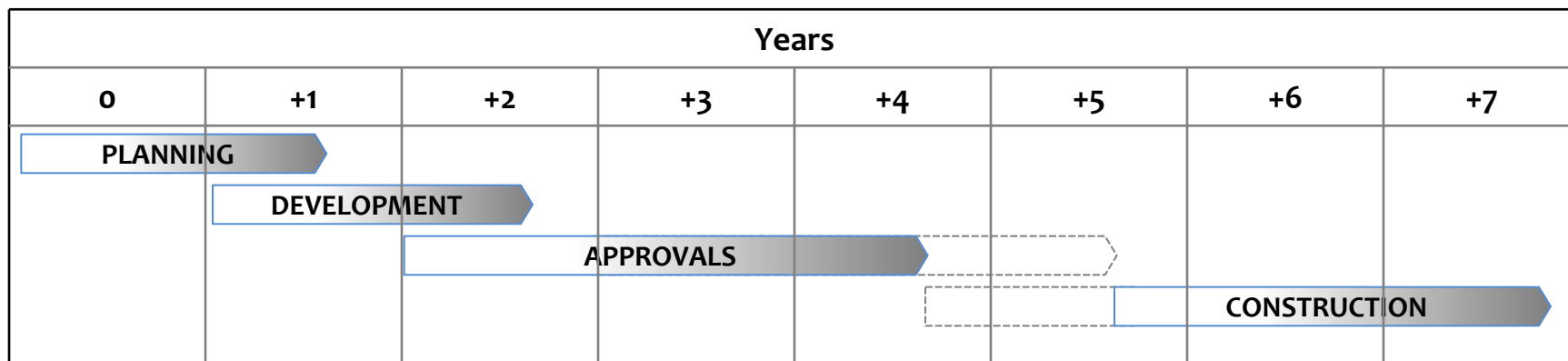


Ministry of Environment
and Climate Change

Other Approvals

- **Ontario Energy Board (OEB)** approves transmission rates and Leave to Construct transmission projects. "Leave to Construct" reviews the technical and economic aspects of new transmission project applications submitted by transmitters and determines whether the proposed project is economically prudent and in the public interest. Grants right to expropriate land for transmission projects.
- **The Ontario Ministry of the Environment and Climate Change (MOECC)** reviews the environmental impact of transmission projects through the Environmental Assessment process. The EA review also considers the need and alternatives to the project.
- **Other Approvals** – Ontario and/or Federal Environmental Assessment, Niagara Escarpment Commission Development Permit, or Ministry of Natural Resources and Forestry approvals or consultations may be necessary for some projects (e.g., those crossing waterways and/or the escarpment). NEB

Illustrative Transmission Development Timeline



Planning	Development	Approvals	Construction
- Need identification - Alternative analysis - System studies - Policy alignment - Project scoping	- Transmitter selection - Aboriginal engagement - Public consultations - Engineering & costing - Routing and siting analysis	- Environmental assessment - Leave to Construct - Other approvals - Cost recovery mechanism - Indigenous Consultation	- Procurement - Expropriation - Construction - Commissioning

Legend

IESO	Ministry	OEB	Proponent
------	----------	-----	-----------

Key Bulk System Projects

East-West Tie

Area: Northwest/Northeast

Description: new double circuit 230kV line between Wawa and Thunder Bay

Est. Cost: \$777M for the line and \$147M in station work

Exp. In-Service: 2020

Proponent: NextBridge Infrastructure / Hydro One



JOHN SOPINSKI/THE GLOBE AND MAIL, SOURCE: HYDRO ONE; NEXTBRIDGE INFRASTRUCTURE

Rationale: The East-West Tie expansion would reinforce the network between Wawa and Thunder Bay to ensure adequate supply in the Northwest.

Status: In 2016, the Province designated the East-West Tie as a priority project. NextBridge submitted a Leave to Construct application in 2017 with a \$777M cost estimate. Hydro One also submitted a Leave to Construct for a competing project, which would save approximately \$120M in capital costs. Potential savings are due to the project's shorter route which makes use of Hydro One's pre-existing right-of-way which traverses Pukaskwa National Park.

The Leave to Construct process for both proposals is currently ongoing.

Northwest Bulk Transmission Line

Area: Thunder Bay to Dryden

Description: New 230 kV transmission line from Thunder Bay to Atikokan (Phase 1) and Atikokan to Dryden (Phase 2)

Est. Cost: Phase 1: \$300-400M; Phase 2: \$150-200M

Exp. In-Service: Phase 1: 2024+; Phase 2: 2034

Proponent: Hydro One



Rationale: Demand west of Thunder Bay is projected to increase, but is uncertain. A new transmission line would increase supply and reliability to the area.

Status: The IESO's current demand assumptions for the northwest are lower than previous estimates. As a result, the IESO recommends proceeding with development work on the line, but not committing to construction of the project at this time. Development work was assigned to Hydro One.

Next Steps: IESO will issue an updated project scoping letter to Hydro One to proceed with development work and to pursue a phased approach to the project in either Q2 or Q3 2018. The Ministry intends to delegate procedural aspects of the Duty to Consult to Hydro One.

Niagara Reinforcement Project

Area: Southwestern Ontario

Description: Line Upgrade (from 115 to 230 kV)

Est. Cost: ~\$130 M

Planned In-Service: 2006

Proponent: Hydro One

Rationale: The Project would ease transmission congestion in the area by enabling about 700 MW to flow out of the area and into southern Ontario.



Status: The Project was stopped in 2006 when protests related to the development of the nearby Douglas Creek Estates (DCE) housing subdivision in Caledonia escalated. Six Nations of the Grand River entered into negotiations with both the Ministry of Energy and Hydro One since 2016 to complete the line. SNEC and Hydro One reached an agreement that would involve SNEC purchasing up to 25% ownership in the line through a partnership arrangement.

Next Steps: Continued discussions with Six Nations are necessary in order to reach an agreement to complete the line.

Clarington Transformer Station

Area: Greater Toronto Area

Description: New 500/230kV autotransformer station

Est. Cost: \$281M

Exp. In-Service: Q2 2018

Proponent: Hydro One

Rationale: Clarington TS, a new is needed to accommodate the closure of Pickering Nuclear Generating Station and to enhance the reliability of supply to the eastern Greater Toronto Area as the population and demand for electricity in this area continues to grow.

Status: Project approved under the Class Environmental Assessment, subject to several conditions. Construction has begun and continues. Project is on schedule for Q2 2018 in-service.



Hawthorne to Merivale

Area: Ottawa

Description: 230 kV Conductor Upgrade

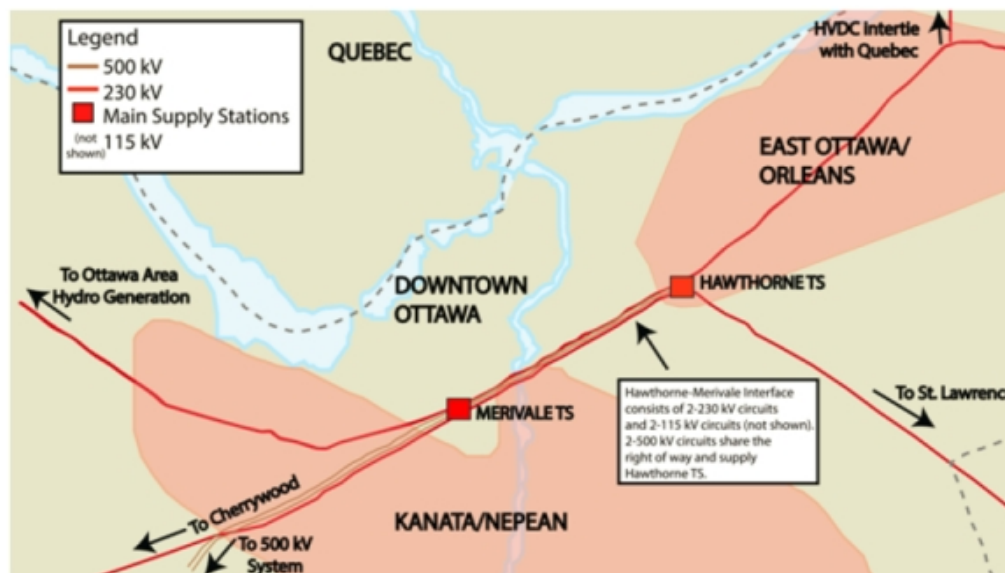
Est. Cost: ~\$20M

Exp. In-Service: 2020

Proponent: Hydro One

Rationale: The 230 kV circuits between the Hawthorne and Merivale transformer stations require upgrades to their capability to serve growth in western Ottawa and optimize the use of its interties with Québec.

Status: This project is being developed by Hydro One and is expected to be in service in 2020.



Greater Toronto Area West Bulk Reinforcement

Area: Greater Toronto Area West

Description: TBD

Est. Cost: TBD

Exp. In-Service: as early as 2020

Proponent: TBD



Rationale: Growth in demand, the eventual retirement of the Pickering Nuclear Generating Station and new renewable generation all impact the bulk transmission system in the western section of the Greater Toronto Area (GTA).

Status: The IESO is studying the need for and timing of reinforcements to the transmission system in the region. Transmission solutions being investigated include building new transmission lines along the existing Parkway Belt West transmission corridor and expanding station facilities at the existing Milton switching station.

Lake Erie Connector

Area: Inter-jurisdictional

Description: 1,000 MW High Voltage Direct Current transmission cable under Lake Erie, running from Nanticoke, Ontario to Erie County, Pennsylvania

Est. Cost: ~\$1 billion USD

Exp. In-Service: 2020/2021

Proponent: ITC Lake Erie Connector LLC, a Fortis Company



Rationale: The line would provide a new direct link between Ontario electricity markets and markets in 13 states in the Eastern U.S. Generators and electricity traders who would transmit electricity and related products over the line would pay the entire cost of the project. Under this merchant funding model, the costs of the project would not impact the transmission rates paid by Ontario ratepayers.

Status: The project has approval from the U.S. Department of Energy, Canada's Governor in Council, the National Energy Board, the Pennsylvania Department of Environmental Protection, and the U.S. Army Corps of Engineers. Remaining milestones in the project include completing project cost refinements and securing favorable transmission service agreements with prospective counterparties. ITC is interested in Ontario Power Generation (OPG) being an anchor customer for the line. However, at this time, the two parties appear to disagree over the line's anticipated value to OPG.

Key Regional Projects

Remote Community Connections

Area: Far North

Description: A new 230KV line to Pickle Lake (Phase 1), and new 115kV and 44 kV lines to connect 16 diesel-reliant First Nations communities (Phase 2) to the provincial grid.

Est. Capital Cost: ~\$1.6B

Exp. In-Service: Pikangikum: Late 2018; Most community connections between 2020 and 2024

Proponent: Wataynikenyap Power LP (Watay)

Rationale: IESO analysis indicates an economic case for grid connection of up to 21 of 25 diesel reliant remote communities.



Status: Federal **government committed \$1.6 billion in funding** in March 2018 to connect 16 First Nations to the provincial power grid. This includes up to \$60.2M for the early connection of Pikangikum, expected to be complete in late 2018.

Next Steps: Watay to submit Leave to Construct application in mid-2018. A decision on an amended Environmental Assessment is expected from MOECC in mid-2018. Regulatory amendments are needed to enable connections. Other options are being explored for First Nations that are not economic to connect to the grid.

SECTR Line and Station

Area: Southwestern Ontario

Description: New 230 kV transformer station and line

Est. Cost: \$77M for a new 230 kV line and new Leamington TS

Exp. In-Service: June 2018 and December 2021

Proponent: Hydro One

Stage: Leave to Construct approved; cost responsibility pending



Rationale: The Supply to Essex Country Transmission Reinforcement (SECTR) project has both system benefits (network) and benefits to specific customers (LDCs, expansion of greenhouse sector).

Status: Hydro One is proceeding with construction of the Leamington SECTR project with an expected in-service date of June 2018. The OEB initiated a review to determine cost responsibility and the Board has issued a proposal. Subject to OEB approval, a capital contribution is expected from customers (e.g. greenhouse growers), with the remaining costs of the project expected to be recovered through rates.

Based on an increase in load forecast determined in October 2017, Hydro One is also proceeding with upgrades to the related Kingsville TS project, with the first upgrades completed in June 2018 and continuing to December 2021. The total estimated cost for the Kingsville TS upgrades is \$27M.