

Inter-jurisdictional Overview

Presentation for the Minister of Energy

March 6, 2017

Purpose

- To provide an overview of IESO's interaction with neighbouring jurisdictions, with a focus on market and reliability activities

Agenda

1. Inter-jurisdictional Overview
2. How We Work Together
3. Trading Across the Interties
4. Market Development and Comparisons

Benefits of An Interconnected Grid

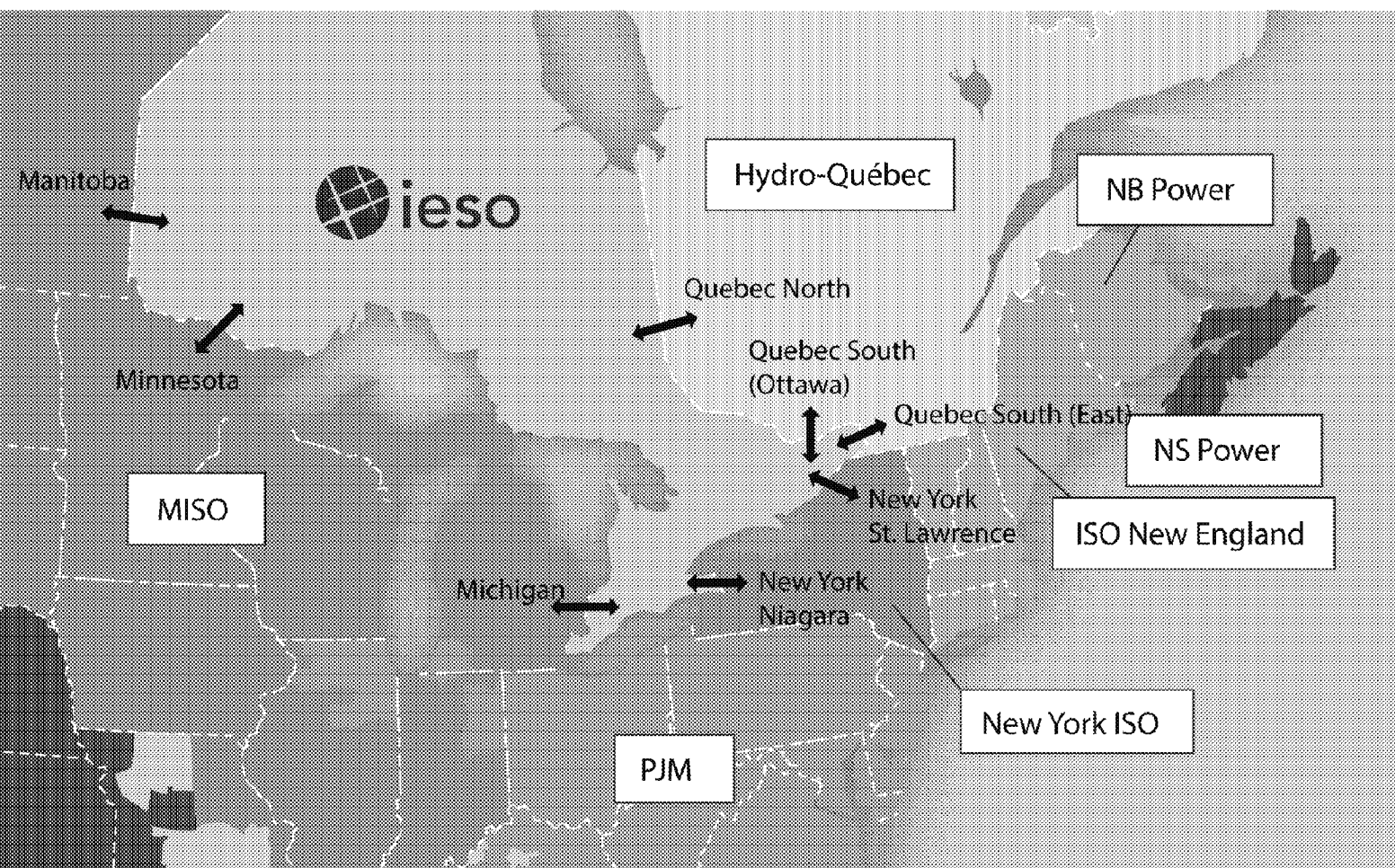
- ***Economic:*** Energy and capacity trade utilizes a diverse range of resources over a much greater geographic area, thereby lowering the cost of producing energy and capacity trade between jurisdictions, system operators have put operating agreements in place to formalize common operating practices
- ***Reliability:*** connection to large, stable, continental power system enhances the reliability of electricity delivery in Ontario – exporting power when there's surplus energy and importing power when there's a shortfall

Types of Neighbours

- Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) (e.g., NYISO)
 - Various resources (generation, loads, imports and exports) compete in a bid- and offer -based market to determine the most efficient and economic dispatch schedules for internal resources and interties transactions
 - Electricity market actions support system reliability, efficiency, transparent and open access, and fosters innovation
- Vertically integrated utilities: (e.g., Hydro Quebec)
 - Sell or buy power into or out of the IESO's or other entity's electricity market
 - All the generation is usually owned by one entity and that entity is responsible for serving all load in the jurisdiction

Inter-jurisdictional Overview

IESO's Neighbours



In 2016

- 99% of Ontario exports destined for the U.S., with the most frequent destination being MISO (10.6 TWh)
- 94% of imports originate from Canada (Manitoba and Quebec)

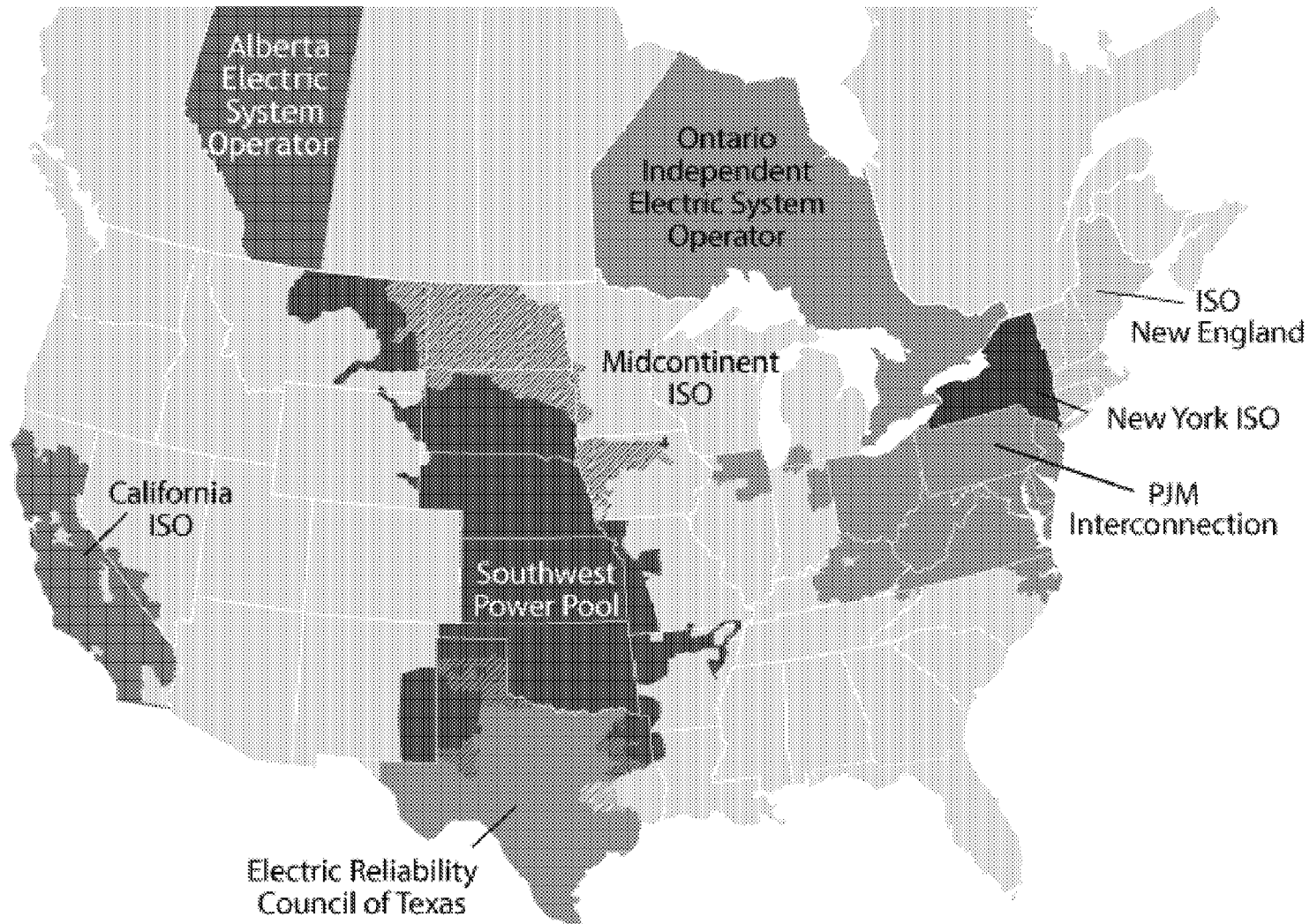
How We Work Together

Coordination

- IESO is a member of the ISO/RTO Council (IRC), made up of North America's nine Independent System Operators
- The IRC promotes:
 - reliability, efficiency, transparent and open access to markets, and fosters innovation
 - common positions on electricity policy and sharing best practices in the context of North American electricity markets
- IESO participates in IRC committees including regulatory affairs, communications, operations, markets, IT and communications

How We Work Together

North American ISOs and RTOs



How We Work Together

Coordination

- All system operators, whether or not an ISO or RTO, perform key reliability roles, including the roles of Reliability Coordinator, Balancing Authority and Transmission Operator
 - IESO participates in the Northeast Power Coordinating Council (NPCC) Task Forces and Committees
 - IESO participates in North American Electric Reliability Corporation (NERC) Committees and Standards Drafting Teams
- IESO has Interconnection Agreements with neighbouring entities
 - Stipulate emergency and normal operating protocols, planning and IT activities established through joint committees

Reliability Standards

- Reliability standards create an obligation to coordinate operating plans and real-time events
 - Daily operating plans
 - Coordinate outages to key transmission and generation facilities
 - Forecasts of electricity demand and weather
 - Coordination of hourly import and export schedules
 - Simultaneous activation of operating reserve following a major loss of supply
 - E.g. between IESO, Maritimes, NYISO, PJM and ISO-NE
 - Emergency energy and restoration support

How We Work Together

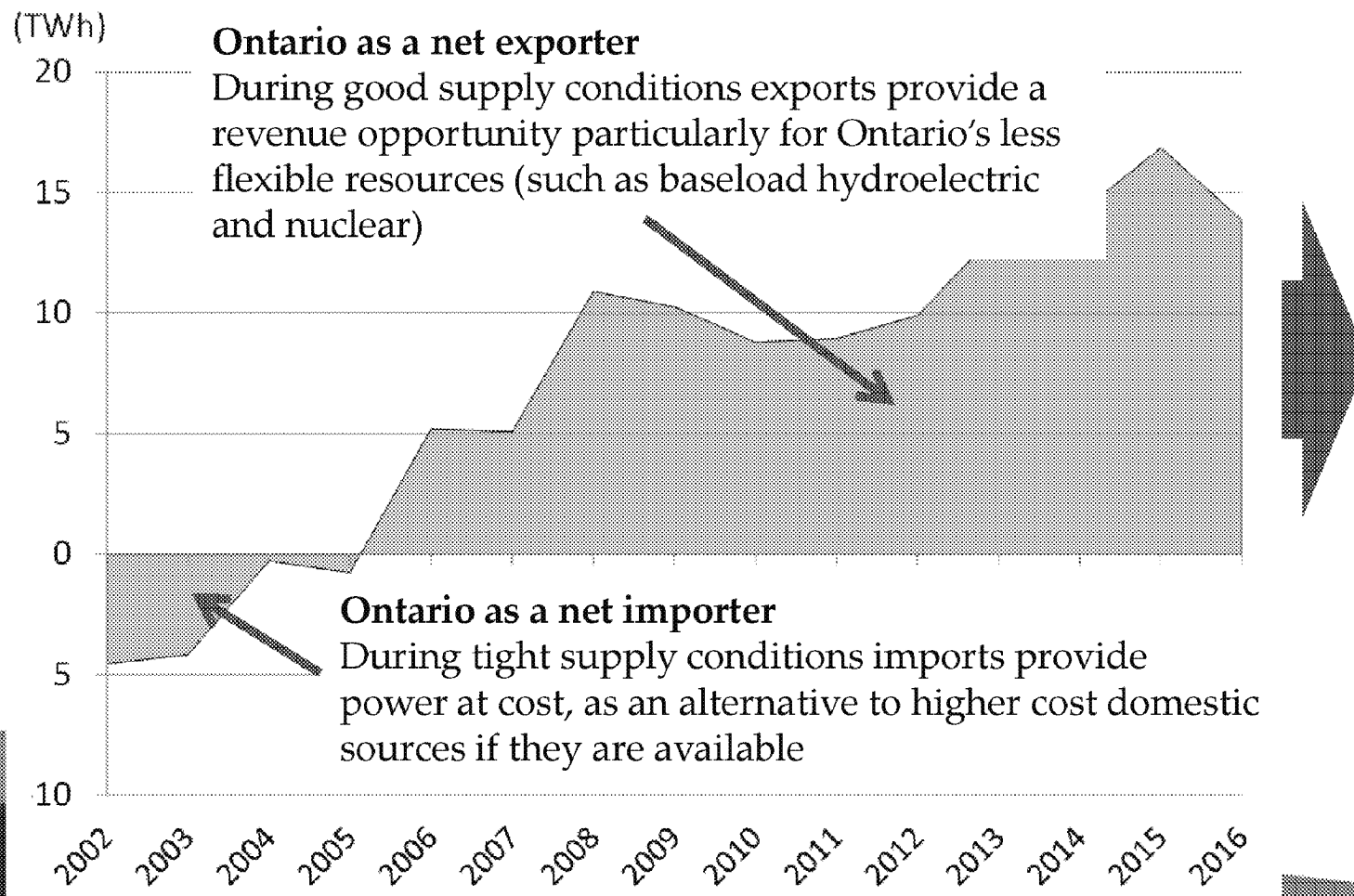
Daily Communications

- Control Room to Control Room:
 - Over 20,000 data points exchanged (two-way) every few seconds with neighbouring areas
 - Over 3000 phone calls per month for market and reliability matters (1/6 of all control room calls)
 - Manage over 60,000 proposed or actual import/export transactions per month

Trading Across the Interties

Energy Trade Overview

- Ontario trades energy extensively with its neighbours and has benefited from being both a net exporter and a net importer in recent years.



Nuclear refurbishment and changing market conditions could result in a reversal of recent trends. Regardless, energy trade will play an essential role in maintaining reliability and managing costs

Trading Across the Interties

Energy Trade and Operating Reserve

Energy and Operating Reserve:

- Hourly intertie transactions, i.e. imports to and exports from Ontario, provide important balancing function during times of surplus or shortfall
- Competing transactions are scheduled between markets or Hydro-Quebec based on the most economic outcome (higher priced exports and lower priced imports are selected first)
- Wheel-through transactions can be scheduled across multiple markets (e.g., PJM to IESO via NYISO, or Quebec to PJM via IESO and MISO)
- Imports can displace higher cost domestic resources
- In competition with internal resources, operating reserve may be acquired economically from our neighbors (e.g. Hydro Quebec's Outaouais HVDC intertie)
- Exports pay a series of costs (export fee of \$1.85/MWh and uplifts of about \$2-4/MWh) as well as indirect benefits such as reducing curtailments

Trading Across the Interties

Capacity Trade

- Capacity trade is a well-established feature of many North American markets for its efficiency benefits
 - Over time, capacity trade can avoid or defer the need to build new resources that might only be required for a short period of time, and it also can provide bridging revenues for domestic assets that are not needed today, but might be required in the future
- The IESO Capacity Export pilot project successfully enabled Ontario's first capacity export to New York in 2016
 - Required negotiating operating agreement with the NY-ISO that governs the energy associated with a capacity export
 - IESO considering other markets depending on market participant interest (e.g. Quebec, Mid West, PJM)
- Lessons learned from pilot project will inform Market Renewal and the development of a capacity auction including capacity imports

Market Development

Market Development

- Many market developments are in response to dealing with the change in supply mix and the growth of renewable and intermittent generation
- The IESO's Market Renewal project includes moving to more frequent scheduling on a 15 minute basis consistent with our US counterparts to provide greater operational flexibility
- Potential to explore opportunities to use interties to provide operating reserve with neighbouring US markets
- Working with ITC and PJM to get ready to put in place operating protocols to enable a direct connection to PJM, the largest North American market

Market Development

Comparison of North American Markets

- At a high level, with the exception of capacity markets, there are broad similarities in how ISOs organize their markets
- Each ISO tailors its implementation details to its specific operating and transmission parameters

	PJM	NYISO	MISO	SPP	ERCOT	CAISO	ISO-NE
Single Schedule (Real-Time)	✓	✓	✓	✓	✓	✓	✓
Real-Time Commitment	✓	✓	✓	✓	✓	✓	✓
Day-Ahead Market	✓	✓	✓	✓	✓	✓	✓
Capacity Market	✓	✓	✓	✓			✓

Energy Trade – Recent Developments

- Market and system operators across the world looking for ways to fully optimize the potential of intertie transactions
 - In Europe, for example, national markets have begun to implement “market coupling”, where transactions are scheduled automatically across market borders.
 - Some US markets such as New England are considering full tie optimization to improve and coordinate real-time energy dispatch to minimize production costs across multiple markets
 - In California a new market has been created, the Energy Imbalance Market (EIM). This balancing market enables real-time economic re-dispatch of available resources across multiple systems, automatically adjusting intertie schedules based on market conditions
- One of the objectives of the Market Renewal project is to maximize the value provided by interties

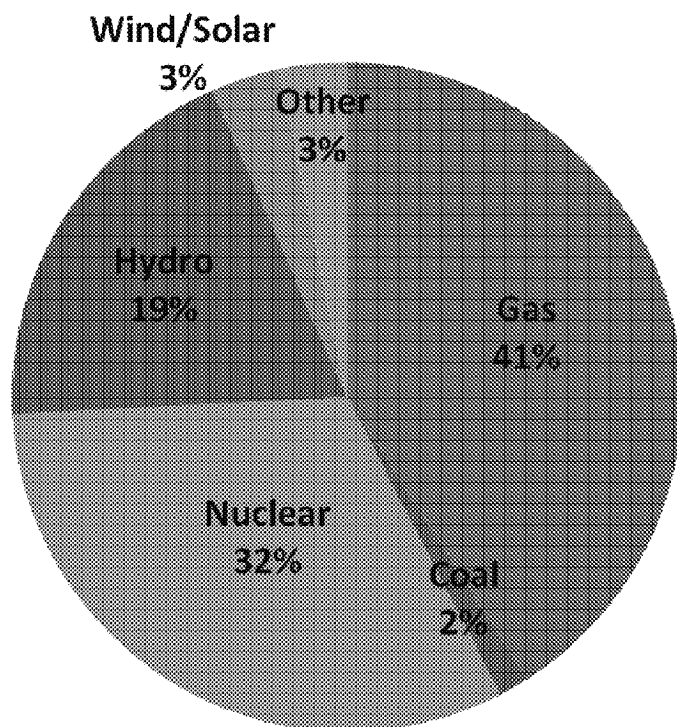
Summary

- An interconnected grid provides **economic benefits** by allowing the IESO to leverage a larger number of resources to compete to provide the lowest cost energy and capacity for ratepayers
- An interconnected grid provides **reliability benefits** by allowing the IESO to export power when there is surplus energy and import power when there is a shortfall
- The IESO closely coordinates with its neighbours, from thousands of monthly phone calls to sharing of best practices through various working groups and committees
- Looking ahead, other jurisdictions provide valuable insights the IESO can learn from, especially as it moves forward with Market Renewal

APPENDIX

Factsheet: New York

2015 Supply Mix



- 2016 Exports to NY = 8.2 TWh
- 2016 Imports from NY = 0.3 TWh

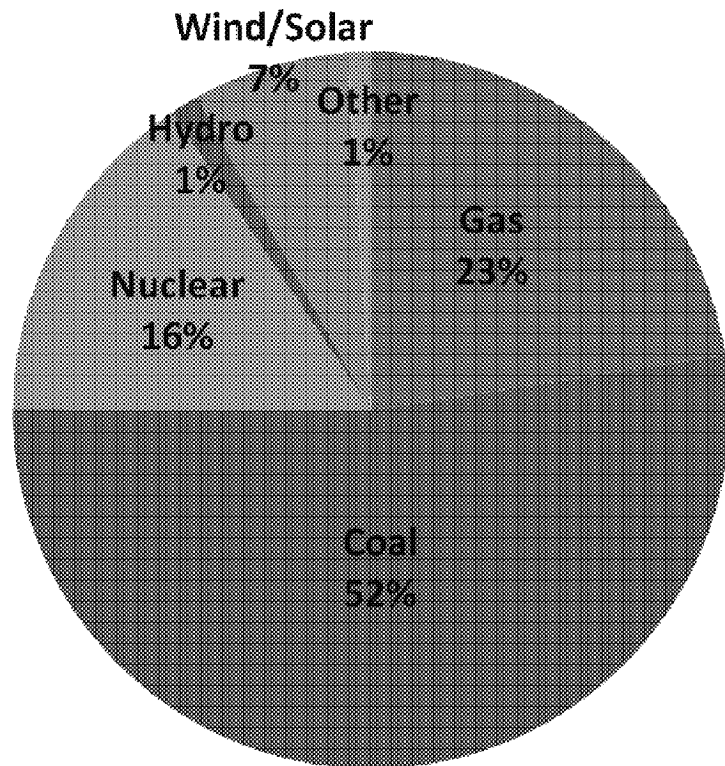
Recent Developments

- 2016 first Ontario capacity export to NY = 89MW
- New York participates in the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade program
- Clean Energy Standard (CES) has a goal of 50% renewables by 2030
- Reforming the Energy Vision (REV) initiative aims to increase the penetration and coordination of distributed energy resources and turn consumers into active participants in the power system

Factsheet: MISO

includes Michigan, Minnesota and Manitoba

2015 Supply Mix



- 2016 Exports to MISO = 9.6 TWh
- 2016 Imports from MISO = 0.2 TWh

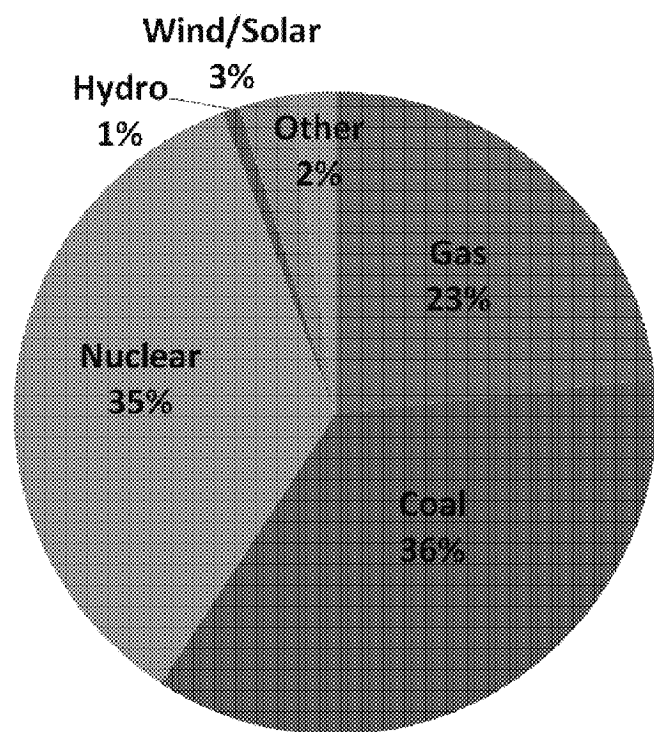
Recent Developments

- The expansion of the market to include the creation of MISO-South market in 2013 extends the MISO footprint from Manitoba all the way to the Gulf of Mexico
- The MISO-North market has a capacity of 129 GW, of which more than half is coal. Wind portion grew from 2% in 2006 to 11% in 2015

Factsheet: PJM

includes Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

2015 Supply Mix



- 2016 Exports to PJM: 2.6 TWh
- 2016 Imports from PJM: 0.1 TWh

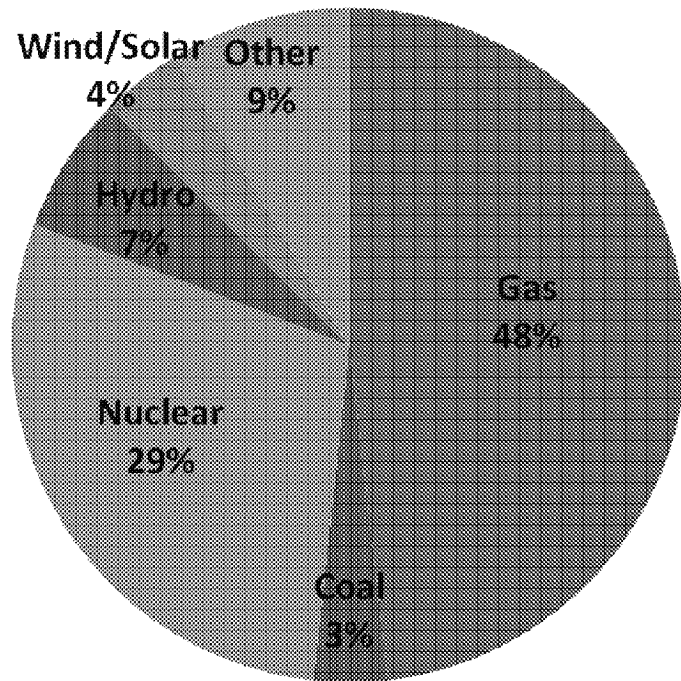
Recent Developments

- ITC's Lake Erie Connector will be the first direct connection from Ontario to PJM, the largest organized electricity market in North America
- The generating fleet in PJM is in the midst of a substantial shift as coal plants retire and new gas-fired capacity enters
- About 11,600 MW of resources are enrolled in PJM's load management programs (as of Sep 2015)

ISO-New England

includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont

2015 Supply Mix



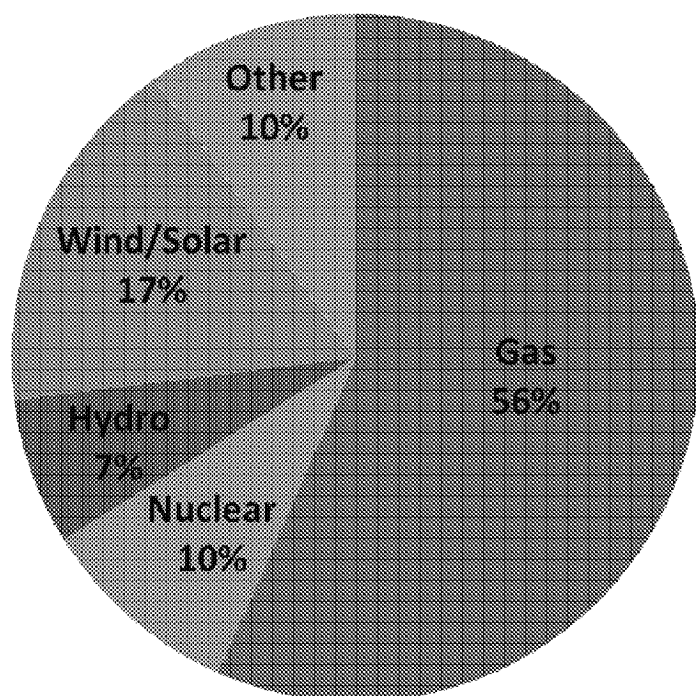
- 2016 Exports to ISO-NE = 1.4 TWh
- 2016 Imports from ISO-NE = 0.0 TWh

Recent Developments

- New England is heavily dependent on gas-fired generation, accounting for more than 40% of installed capacity mix
- Due to large fleet of gas-fired capacity, wholesale power prices are highly correlated to natural gas prices
- All 6 New England states participate in the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade program

California

2015 Supply Mix



Recent Developments

- Due to the large number of renewable resources, CAISO has implemented an energy imbalance market to better manage operability challenges from highly variable resources – often referred to as the “Duck Curve”
- California pursuing aggressive environmental targets including 50% of retail electricity from renewables by 2030 and GHG emissions reduction to 1990 levels and increased energy storage
- Introduced a market based ramping product to ensure flexible resources are available when needed
- Introduced a demand response auction in 2015