Overview of the IESO Administered Markets

IESO Training

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AN IESO MARKETPLACE TRAINING PUBLICATION

This guide has been prepared to assist in the IESO training of Market Participants and has been compiled from extracts from the market rules or documents posted on the web site of Ontario's Independent Electricity System Operator. Users of this guide are reminded that they remain responsible for complying with all of their obligations under the market rules and associated policies, standards and procedures relating to the subject matter of this guide, even if such obligations are not specifically referred to herein. While every effort has been made to ensure the provisions of this guide are accurate and up to date, users must be aware that the specific provisions of the market rules or particular document shall govern.

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1. Introduction

This overview provides an introduction to Ontario's IESO Administered Markets, including discussions of:

- The history of the electricity industry in Ontario
- The electricity market in Ontario
- The roles of the IESO and Market Participants in the markets
- The IESO controlled grid
- The day-ahead and real-time energy markets
- Financial aspects of the markets

For more in-depth information, please refer to the to the Market Rules and Market Manuals and to the materials available in the Marketplace Training section of the IESO website.

2. Ontario's Electricity Market

Ontario's electricity market opened on May 1, 2002, moving the basis of electricity supply in the province from a vertically integrated utility to a competitive electricity market.

- The **wholesale** price of electricity is determined through competitive processes. The wholesale price applies to most consumers using more than 250,000 kilowatt-hours per year.
- Prices for certain classes of retail consumers are regulated. The Regulated Price Plan (RPP) took effect April 1, 2005 and is administered by the Ontario Energy Board. Currently, RPP rates apply to residential customers, qualifying farms, and customers who consume less than 250,000 kilowatt-hours per year.

Historically, the former Ontario Hydro was largely responsible for producing electricity in Ontario, while Hydro One and municipally-owned utilities distributed power to consumers.

The Ontario Electricity Act of 1998 re-organized Ontario Hydro into four successor organizations. As of April 1, 1999, the following came into existence:

2.1 Two commercial companies:

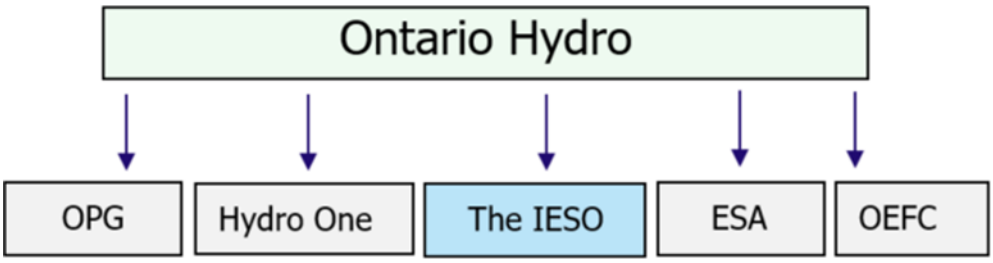
- **Ontario Power Generation Inc. (OPG)** - generates electricity and competes with other electricity suppliers in the market *(To view the OPG website please click here:* https://www.opg.com*)*
- **Hydro One** - transmits and distributes electricity *(To view the Hydro One website please click here:* https://www.hydroone.com*)*

2.2 Two not-for-profit entities:

- The **Independent Electricity System Operator (IESO)** – oversees the electricity markets to promote fair competition, and ensures the reliability of the electrical system *(To view the IESO website please click here:* https://www.ieso.ca*)*. The IESO merged with the Ontario Power Authority (OPA) in January 2015. The OPA, which was not one of the original successor companies, was created in 2004 to ensure long term adequacy in Ontario by assessing future supply needs and by procuring new supply, transmission and demand management as required. The IESO now fulfills this role.
- **The Electrical Safety Authority (ESA)** - promotes and enforces electrical safety through administration and enforcement of electrical safety regulations, by providing education programs, and by monitoring for unsafe electrical products *(To view the ESA website please click here:* https://www.esasafe.com*)*.

2.3 One crown agency:

- **The Ontario Electricity Financial Corporation (OEFC)** - responsible for servicing and paying down the 'stranded debt' of the former Ontario Hydro, that is, the debt in excess of the debt assigned to the other successor organizations (website: http://www.oefc.on.ca)



3. The Role of Ontario's IESO

3.1 What is Ontario's IESO?

The IESO is a non-profit, regulated corporation without share capital. The Ontario Energy Board (OEB) regulates the IESO, and the Ontario government appoints its directors.

3.2 The IESO has two distinct roles

3.2.1 Overseeing and Running the IESO Administered Markets

The IESO administers the Market Rules which govern the operation of the electricity market. The IESO monitors market activity to ensure compliance with these rules and to promote fair market competition.

The IESO itself does not buy or sell electricity. It administers the electricity market by authorizing Market Participants, publishing system forecasts and market information, determining schedules and prices, producing statements and invoices, and performing financial settlement transactions for the markets.

The IESO also runs the energy market. Based on bids and offers from consumers and suppliers active in the market and by giving consideration to the ability of the transmission system to move energy around the province, the IESO determines the amount of energy to be consumed or supplied by these participants, and the locational prices for that energy. Loads not active in the market, but directly connected to the high voltage system, pay a uniform load-weighted average price for their energy.

3.2.2 Ensuring the Reliability of the Integrated Power System

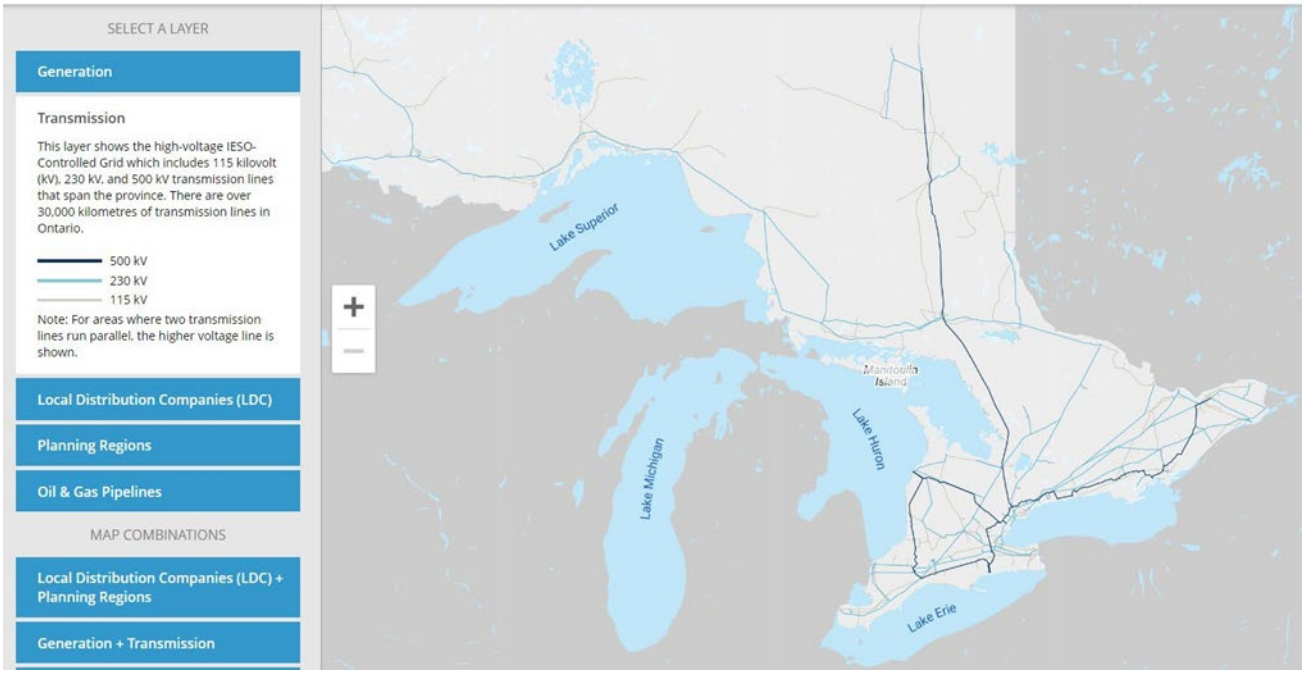
The IESO and all Market Participants are jointly responsible for ensuring the reliability of the power system.

From its system control centre, the IESO manages the power system. We ensure that the operation of the system adheres to reliability standards set by standards authorities such as the North American Reliability Council (NERC) and the Northeast Power Coordinating Council (NPCC). In addition, the IESO provides input to both of these reliability organizations to ensure that appropriate reliability standards are set.

The IESO gathers real-time information on voltage levels, power flows, and equipment status. Trained and certified IESO staff monitor this information and manage the security and adequacy of the power system 24 hours a day, every day of the year.

4. Ontario's Physical Power System

This physical power system is made up of a network that transmits electricity from suppliers (e.g., generators) to consumers (loads). To explore more of Ontario's physical power system, please see the IESO's Interactive Ontario Electricity System Map.



4.1 Ontario's Transmission System

Electric power is transmitted across the province on approximately 30,000 kilometres of high-voltage transmission lines. Hydro One owns and operates most of the transmission system. Transformers are used to link electric power from the high-voltage lines to low-voltage lines. Hydro One, several municipally owned utilities, and private companies then distribute the electric power at lower voltages to end-use consumers.

High-voltage lines also interconnect with lines from Manitoba, Quebec, New York, Michigan and Minnesota. These interconnection lines (or interties) allow electricity to be imported into and exported out of Ontario.

Ontario currently has the installed capacity to generate more than 35,000 megawatts of electric power. Available capacity changes throughout the day and year according to how many plants are in maintenance outage or have been temporarily derated. Ontario Power Generation Inc. (OPG) is the largest provider of generating capacity to the Ontario market. OPG's generating plants include nuclear, hydroelectric, biomass, oil and natural gas-fired stations. In addition, a growing number of independently owned suppliers provide power to the system.

5. The IESO Controlled Grid

The portion of the Ontario transmission system that is controlled by the IESO is called the 'IESO controlled grid'. It includes all transmission lines greater than 50 kiloVolts. These are not the lines that go directly into your home. They are the high voltage transmission lines that provide wholesale electricity to large industrial consumers, and to distributors who then provide electricity at the retail level.

The IESO is responsible for balancing the supply and demand of energy on the grid so that supply always adequately satisfies demand.

5.1 Energy Supply

Energy is provided to the market by generators located within Ontario and by imports from neighbouring jurisdictions.

5.2 Energy Demand

Consumers of energy in Ontario are referred to as loads. There is also demand from neighbouring jurisdictions for energy produced in Ontario in the form of exports. The electricity market considers both the requirements of loads within Ontario and those of energy exports when determining schedules and prices.

5.3 Measuring the Flow of Energy

Meters are used to measure the flow of energy at any point where energy flows into or out of the IESO controlled grid. These meters must accuracy requirements and be capable of measuring energy at specific time intervals. The resulting meter readings are the basis of settling energy charges and revenues in the wholesale market.

6. Participating in the IESO-administered Market

6.1 The IESO-Administered Markets, Services and Auctions

6.1.1 Energy Markets

The energy market serves as a platform for balancing supply and demand of electricity in Ontario.

The IESO operates both a day-ahead and real-time market. Most supply is scheduled day-ahead at day-ahead prices. Real-time serves as a balancing market where deviations from day-ahead schedules are settled at real-time prices.

6.1.2 Ancillary Services

Contracted ancillary services help ensure the reliable operation of the power system. Ancillary services make up a relatively small component of all power system costs but play a critical role for the power system.

6.1.3 Operating Reserve Markets

Operating reserve is stand-by power or demand reduction that can be called on with short notice to deal with an unexpected imbalance between supply and demand. The IESO ensures that additional supplies of energy are available should an unanticipated event take place.

6.1.4 Capacity Auction

The capacity auction is a competitive procurement mechanism which serves to secure the capacity needed to meet Ontario's short-term resource adequacy needs.

6.1.5 Transmission Rights Auction

Registered Market Participants can bid to export energy from Ontario, or offer to import energy to Ontario. Sometimes, the quantities of bids and offers exceed the ability of the interties to actually move that energy. This causes what is called 'congestion' on the intertie. Congestion leads to higher prices (if the intertie is export congested) or lower prices (if the intertie is import congested). Transmission rights allow participants to receive a payment based on this congestion. This helps importers and exporters reduce the price risk associated with trading between Ontario and jurisdictions outside of Ontario. The Transmission Rights Auction is settled in the **Financial Market.**

6.2 Becoming a Market Participant

In order to participate in any of Ontario's IESO Administered Markets, a company must first apply to the IESO and pay an application fee. When the company has met all the requirements, the IESO will authorize them as a 'Market Participant'.

Market Participants with physical connections to the grid must also register their facilities and resources with the IESO, and are required to have registered interval meters to measure energy flows into or out of the IESO controlled grid. In addition, participants must obtain appropriate licenses from the Ontario Energy Board. For more details, please refer to Overview of the Connection Process (ieso.ca)

As a condition of authorization, Market Participants must meet credit, or 'prudential', requirements. Through this process, participants expected to be net debtors to the market (i.e., their purchases exceed their sales) are required to post an amount of money with the IESO. The IESO can then call upon these funds if the Market Participant fails to pay their invoice. This ensures that other Market Participants will not suffer undue losses.

The amount of prudential support provided by a Market Participant is based on their activities in the market – so the amount required will not be the same for all Market Participants. For more details, please refer to MM5.4.

For additional information on the authorization process, refer to MM1.3 section 8.1.2.

6.3 Types of Market Participants

There are different ways to classify the types of companies that participate in the IESO Administered Markets. One classification is based on the company's physical assets. Some companies have their own equipment that produces or uses electricity; some companies participate in the market without actually producing or using electricity.

Companies with physical assets may be connected directly to the IESO-controlled grid, or they may be 'embedded'. Embedded companies are connected to a distributor's lines, which are themselves connected to the IESO controlled grid.

A Market Participant may play more than one role in the market. For example, a Market Participant could be both a generator and an energy trader.

Participants with physical facilities (may be directly connected to the IESO-controlled grid or may be embedded)	Participants without physical facilities
• Transmitters (all transmitters are directly connected) • Distributors • Loads (consumers) • Generators • Energy Storage • Capacity Auction (with Facilities)	• Energy Traders • Financial Market Participants (TRA) • Retailers • Wholesalers • Capacity Auction (without Facilities) • Virtual Traders

6.4 Physically Connected Market Participants

While many companies may choose to participate in the IESO administered markets, any company with equipment directly connected to the IESO controlled grid to convey electricity into, through or out of the grid must become a Market Participant.

Market Participants who are connected to the grid can be further classified according to their interaction with the IESO. Some resources are capable of responding to dispatch instructions sent as often as every five-minutes to help the IESO balance supply and demand. Others are non-dispatchable. How they are classified on this measure effects how a resource interacts with the market and how they operate in real-time. For example, a dispatchable generator must submit offers to the market in order to operate. If they are scheduled to generate, they will receive dispatch instructions in real-time which tell them how much energy to produce and when. They will then be paid a price based on its location on the grid. Other resources aren't capable of responding to dispatch instructions. These will be registered as non-dispatchable. If a load, for example, is non-dispatchable, it does not enter bids to buy energy. Instead, it simply consumes as it wishes. It is then settled based on a uniform, province-wide price.

6.4.1 Transmitters

Transmitters are Market Participants who own the equipment that makes up the IESO controlled grid. Transmitters do not buy or sell energy; rather, they add value by building and maintaining the grid that connects suppliers and wholesale loads throughout the province.

Transmitters are compensated by an Ontario Energy Board (OEB) approved uplift (overhead) charge applied to all electricity purchased through the IESO Administered Market. Hydro One is an example of a transmitter.

6.4.2 Distributors

The term 'distributor' refers to a local distribution company (LDC). An LDC takes electricity from the IESO-controlled grid and provides it to retail consumers. Distributors add value by delivering electricity directly to retail consumers, at the appropriate voltage for their needs. Distributors are compensated by regulated payments made to them by their customers.

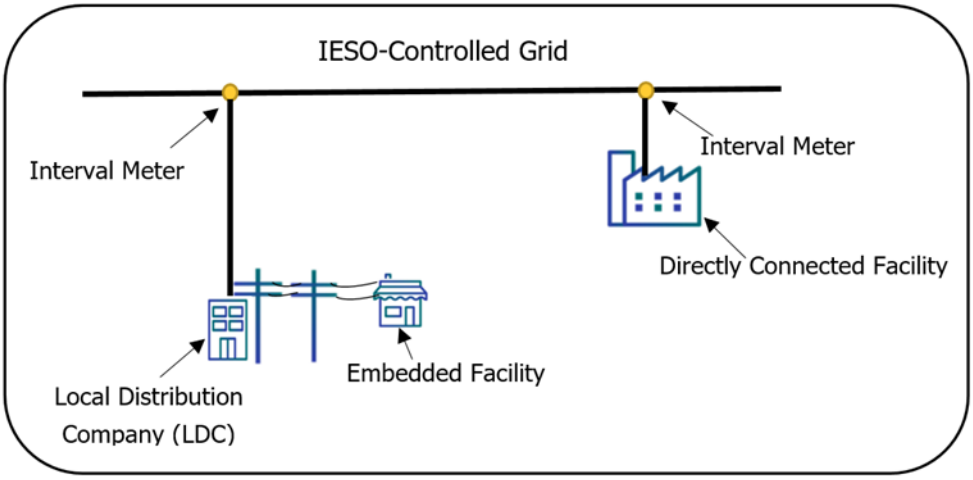
The OEB is responsible for licenses and regulations related to distributors.

Embedded Facilities

Embedded facilities are not connected directly to the IESO-controlled grid. Instead, they are connected to a distributor, who, in turn, is connected to the grid.

Rules regarding embedded consumers vary according to the volume of electricity consumed.

Electricity consumers using less than 250,000 kWh per year and qualifying farms pay set rates for the electricity they consume. The OEB reviews these rates and may change them from time to time. Consumers with 'smart meters' pay set rates depending on the time of day. See the Ontario Energy Board web site for details.



Large volume embedded facilities have a choice as to how they interact with the wholesale electricity market. They may deal with the distributor to buy or sell electricity, or they may choose to become a market participant. If the embedded facility becomes a market participant, it may buy or sell energy through the real-time markets.

6.4.3 Generators

Dispatchable Generators

Dispatchable generators must be able to adjust the amount of their energy supply in response to instructions from the IESO. These instructions are called 'dispatch' instructions, and the generators are considered 'dispatchable'.

The IESO can issue dispatch instructions to a generator for each 5-minute interval of the day. Dispatchable generators must be equipped to receive and respond to dispatch instructions from the IESO 24 hours a day, 365 days a year.

The dispatch instructions to reach a specific level of generation are based partly upon the generator's offers to sell electricity at specific prices relative to the bids and offers from other facilities. Also system constraints such as limits, losses as well as resource constraints are considered when dispatching a resource.

For example, a generator may agree to sell 50 megawatts of energy if the market price is $22/MWh or higher, but may not wish to sell if the market price is lower than $22. If there is price for energy priced at $22 or more at the generators' location, the generator will receive dispatch instructions from the IESO telling it the amount to generate. If the price for energy is priced below $22 at the generators location, the IESO will not dispatch the generator to produce electricity. The dispatch instructions also take into account the facility's ability to adjust its generation levels referred to as ramp rates.

Most of the energy supply in Ontario is provided by dispatchable generators.

Non-Dispatchable Generators

Non-dispatchable generators do not submit offers to provide energy; instead, they submit estimates or forecasts or schedules of energy production.

There are two types of non-dispatchable generators - self-scheduling and intermittent:

An example of a self-scheduling generator is a hydro-electric generator situated on a small river with no ability to store the water. This generator might not always be able to increase or decrease energy output in response to the IESO's dispatch instructions. This type of generator would register as self-scheduling. Self-scheduling generators submit schedules to the IESO indicating the amount of energy they will be providing for each hour of the day. Self-scheduling generators are restricted by size - in order to be classified as self- scheduling, a generator must be rated between 1 and 10 megawatts. ('Cogeneration' facilities are producers of another form of energy, such as steam, with electricity as a by-product. They may be self-scheduling even if they exceed 10 megawatts.) Intermittent generators operate intermittently as a result of factors outside the operators' control. As a result, they have even less ability to know in advance the amount of energy they will generate than self-schedulers do. Intermittent generators enter forecasts that estimate the energy they will provide and predict when they will be producing. Intermittent generators include run-of-the-river hydro-electric facilities.

6.4.4 Loads

Dispatchable Loads

As with dispatchable generators, dispatchable loads must be able to adjust their power consumption in response to instructions from the IESO. These instructions are called 'dispatch' instructions, and the loads are considered 'dispatchable'. The IESO can issue dispatch instructions to dispatchable loads for each 5-minute interval of the day, so they must be equipped to receive and respond to dispatch instructions from the IESO 24 hours a day, 365 days a year[1]. (Dispatchable loads account for only a small portion of the energy consumed in Ontario at this time.)

[1] Unless they receive a Market Rule Exemption. Please see the Exemptions page of the IESO website.

The dispatch instructions to reach a specific level of consumption are based primarily on the load's bids to purchase electricity at specific prices relative to the bids and offers from other facilities. For example, a load may submit a bid to purchase 20 megawatts of energy if the price is $25/megawatt or below, but may not wish to purchase if the price is higher than $25. If there is available energy that costs $25 or less, the load will receive dispatch instructions from the IESO telling it how much energy to withdraw from the grid. If the only available energy costs more than $25, the IESO will send dispatch instructions telling the load not to withdraw the 20 megawatts from the grid. The dispatch instructions must also take into account losses, binding constraints and the facility's ability to adjust its energy consumption levels.

Non-Dispatchable Loads

Non-dispatchable loads consume electricity in much the same way as you do at home. They simply draw electricity from the IESO-controlled grid as needed for their equipment. They agree to pay the wholesale market price for electricity at the time of consumption, regardless of what that price might be. Wholesale prices for non-dispatchable loads are set on an hourly basis.

A distributor is another example of a non-dispatchable load. Non-dispatchable loads account for most of the energy consumed in Ontario.

Price Responsive Loads

A PRL can be thought of as occupying a middle ground between dispatchable and non-dispatchable loads. Like a dispatchable load, a PRL is able to bid into the Day-Ahead Market (DAM). If it is economic, it receives a DAM schedule, locking in its day-ahead locational marginal price for its scheduled quantity. Post-DAM, a PRL is treated much like a non-dispatchable load. Its bid is no longer considered, meaning that like a non-dispatchable load its real-time consumption is forecast by the IESO for scheduling and pricing purposes. In real-time, it is free to consume as it wishes. However, like a dispatchable load, differences between its real-time operations and its day-ahead schedule are settled at its real-time locational marginal prices. If their real-time consumption deviates from their day-ahead scheduled quantity, they will either be:

- Charged at the real-time LMP for additional consumption, or
- Paid at the real-time LMP for the part of their day-ahead schedule that they did not consume

The PRL classification is available to wholesale loads including Demand Response (DR). MPs who can satisfy a capacity obligation by registering their physical hourly DR resource as a PRL.

6.4.5 Energy Storage

Energy storage can provide a reliable and flexible form of electricity supply. Storage can withdraw energy from the grid during off-peak hours and inject energy into the grid when it is needed most. Storage is particularly useful in supporting the wide-scale integration of renewable resources, like wind and solar, because it can help smooth out changes in energy output caused by unpredictable weather.

6.4.6 Capacity Auction Participant with a Physical Facility

Capacity Auction Participant with a physical facility can take part in the Capacity Auction, to compete to make their capacity available and receive capacity availability payments based on the auction clearing price and their obligation megawatts during the availability window.

6.5 Market Participants without Physical Facilities

Some companies participate in Ontario's IESO-administered markets without having physical facilities that supply or consume electricity. These companies may participate in both the day-ahead and real-time markets and the financial markets.

6.5.1 Energy Traders

The IESO-controlled grid is connected to five neighbouring jurisdictions with intertie transmission lines. These lines allow Ontario to import and export energy. Intertie traders can use the wholesale market to import into (i.e., sell) or export (i.e., buy) from Ontario. They participate in the interjurisdictional trading in the hopes of finding an arbitrage opportunity based on the difference between the Ontario electricity price and the electricity price in the other jurisdictions: Quebec, Manitoba, Michigan, Minnesota or New York.

6.5.2 Virtual Traders

Virtual Traders only participate in the Day Ahead Market (DAM) with bids or offers for energy similar to physical resources. However, unlike physical resources, virtual traders do not require actual delivery or consumption of energy in the real-time market. Virtual Traders predict if the price of energy determined during the DAM within a trading zone, for a specific hour, is likely to be higher or lower than the real-time price for that hour. As with interjurisdictional trade they participate in the market in the hopes of finding an arbitrage opportunity based on the difference between the DAM price and the real-time price.

6.5.3 Wholesalers and Retailers

Wholesalers buy energy on the wholesale market, and sell energy and services to other market participants; retailers sell energy and services to consumers at the retail level (that is, they may sell to non-market participants). Both wholesalers and retailers are re-selling electricity rather than producing electricity themselves. They may also act as importers or exporters. Importers bring energy products into Ontario from one of the five neighbouring jurisdictions: Quebec, Manitoba, Michigan, Minnesota and New York. Exporters export electricity from Ontario into these neighbouring jurisdictions.

6.5.4 Capacity Auction Participants without a Physical Facility

A Capacity Auction Participant is a market participant that can take part in the Capacity Auction where non-committed demand response, embedded generation, embedded storage and import resources compete to make their capacity available and receive capacity availability payments based on the auction clearing price and their obligation megawatts during the availability widow.

6.6 Financial Markets

Market participants may also participate in the IESO-administered financial markets. These markets do not affect the actual delivery of electricity. The financial markets allow market participants to reduce price risks. They involve the transfer of funds only; they do not involve the transfer of energy.

At this time, the transmission rights auction is the only IESO-administered financial market.

6.6.1 Transmission Rights (TR) Auction

Prices in Ontario may be different from prices in other jurisdictions. The use of Transmission Rights, or TRs, allows importers and exporters to reduce the price risk associated with trading between Ontario and jurisdictions outside of Ontario.

7. The Energy and Operating Reserve Markets

Ontario's IESO continually balances generation (supply) and load (consumption).

7.1 Supplying Energy to the Ontario Market

Energy is supplied by generators in Ontario and by imports into Ontario from neighbouring jurisdictions. As we have seen, dispatchable generators submit offers to supply energy, and self-scheduling and intermittent generators submit schedules and forecasts.

Facilities in neighbouring jurisdictions are not under the control of Ontario's IESO, but their energy offers must be taken into account when prices and dispatch instructions are set. The actual generators in other jurisdictions do not have to be registered with the IESO. Instead, the IESO has set up injection 'boundary entities' to enable importers to submit offers into the IESO-administered market. Boundary entities are not actual physical facilities. They are created so that the IESO system can consider and schedule energy imports.

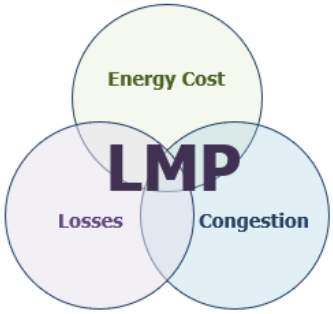
7.2 Consuming Energy in the Ontario Market

Energy is consumed by loads and by exports from Ontario to neighbouring jurisdictions. Non-dispatchable loads draw electricity as they need it; dispatchable loads submit bids to buy energy; price responsive loads, as discussed above, do both. Similar to energy imports, withdrawal 'boundary entities' have been set up by Ontario's IESO to enable exporters to submit bids to export energy, and to allow the IESO system to schedule exports.

7.3 Determining the Price for Energy

The competitive wholesale price for electricity is based on bids and offers into the market from dispatchable facilities, Price Responsive Loads (DAM only) and boundary entities, and on supply and demand from non-dispatchable facilities.

Locational Marginal Prices (LMPs) are paid or charged to dispatchable, self-scheduling and intermittent resources. It also underlies pricing for non-dispatchable loads and for intertie transactions. LMP pricing is a method of determining prices in which market clearing prices represent the cost of energy at physical locations on the transmission system where energy is injected by suppliers or withdrawn by consumers. Each locational marginal price includes the cost of the energy or operating reserve and the cost of delivering it. Delivery costs can differ between locations due to losses and congestion a central point on the grid to the pricing location**.**



Locational Marginal Prices for internal Ontario pricing nodes are comprised of three components:

- The Reference Bus Price
- Loss Component
- Congestion Component

LMP = Reference Price + Cost of Losses + Cost of Congestion

7.4 Two-Settlement System

The Ontario market is settled using a two-settlement system for both energy and operating reserve (OR). This design encourages greater and more efficient market participation. The two-settlement system allows the real-time market to function as a balancing market to reconcile DAM settlement amounts for energy and operating reserve with real-time market results. For this reason, there will be an LMP for Day-Ahead and LMP for Real-Time. The Day-Ahead Market (DAM) and the Real-Time Market (RTM) are settlement using a **Two-Settlement Process**.

DAM Settlement	Real-Time Balancing Settlement
• Paid or charge the day-ahead market schedule quantity for energy and operating reserve at the applicable day-ahead market locational marginal price on an hourly basis	• Balance any deviations between the day-ahead market and the real-time market • Paid or charged at the applicable real-time market locational marginal price if the actual energy consumed or produced, or operating reserve offered, differs from the day-ahead market-scheduled quantity on a 5-min interval basis

The two-settlement process can be represented by the simplified formula below:

Day-Ahead		Real-Time (Balancing)
$Q_{DA} \times LMP_{DA}$	+	$(Q_{RT} - Q_{DA}) \times LMP_{RT}$

The first settlement or the day-ahead settlement is the settlement amounts of energy and operating reserve that can be calculated on the basis of settlement data from the DAM calculation engine. It is calculated by using the day-ahead market scheduled quantity (Q_{DA}) and multiplying it by the day-ahead market locational marginal price (LMP_{DA}). The second settlement or the real-time balancing settlement is the settlement amount that is calculated on the basis of settlement data from the DAM calculation engine reconciled with the real-time market results. It is calculated by the real-time market actual quantity (Q_{RT}) less the day-ahead market scheduled quantity (Q_{DA}) multiplied by the real-time market locational marginal price (LMP_{RT}).

7.5 Determining Dispatch Instructions

The IESO can issue dispatch instructions to each dispatchable facility in Ontario for each five-minute interval of every day. Dispatch instructions specify the required amount of energy that is to be injected or withdrawn by the end of each interval.

As previously discussed, these specified amounts are mostly determined by the facility's bids or offers:

- In most cases, a generator is sent dispatch instructions to inject energy into the IESO-controlled grid whenever the LMP for a given interval is equal to or exceeds the price offered by the generator for that interval.
- In most cases, a dispatchable load is sent dispatch instructions to withdraw energy from the IESO-controlled grid whenever the LMP for a given interval is equal to or less than the price bid by the load for that interval.

Dispatch instructions cannot always follow this. If the resource is needed to operate in a specific way in order to manage a system issue, dispatch instructions may be different from what we would expect if we just considered bids and offers.

7.6 Constraints and Transmission Limits

In order to preserve the integrity of the power grid, the IESO's dispatch instructions take all constraints on the transmission lines into account. When there are constraints on the lines (congestion, binding constraints), actual dispatch instructions may be different from what we would expect. As an example, on a very hot day with little wind the limit on the transmission lines will drop. Constraints due to congestion and/or losses can cause differences in Locational Marginal Prices in the various nodes.

7.7 Intertie Zone Prices

Interconnection lines (or interties) allow electricity to be imported into and exported out of Ontario. Congestion can also occur on these intertie lines. Separate intertie zone prices are necessary at each of the intertie zones to account for price differences in the neighbouring jurisdictions resulting from constraints on the interties.

7.8 The Operating Reserve (OR) Market

There may be occasions when the balance between generation and load is affected by an unanticipated event, such as equipment failure or emergency. Spare capacity that can be called upon on short notice is required to restore the balance in the case of such an event. This spare capacity is called operating reserve.

Ontario's IESO administers an Operating Reserve (OR) Market to provide a market- based way for the IESO to quickly procure and schedule OR. This provides the IESO with the ability to activate OR if the need arises. OR can then be utilized for a short period of time until requirements can again be supplied from normal dispatch. There are three (3) OR products:

- 10-minute synchronized reserve (also called 10-minute spinning)
- 10-minute non-synchronized reserve (also called 10-minute non-spinning)
- 30-minute reserve (synchronized or non-synchronized)

7.9 Payments in the Operating Reserve Market

As with the price for electricity, there is a DAM price and a Real-Time price for OR. An OR price is determined for each of the three operating reserve products. The quantity of operating reserve scheduled day-ahead will be multiplied by the day-ahead operating reserve locational marginal price to determine day-ahead settlement. Real-time settlement will be the difference between the real-time scheduled operating reserve quantity and the day-ahead scheduled quantity times the real-time operating reserve five-minute locational marginal price.

The IESO considers the offers in order of increasing price, then selects the necessary resources to meet its requirements. Operating reserve offers are essentially stand-by offers. For operating reserve that is actually used, the suppliers are paid for the energy provided.

Day-Ahead		**Real-Time (Balancing)**
$Q_{DA} \times OR\_LMP_{DA}$	+	$(Q_{RT} - Q_{DA}) \times OR\_LMP_{RT}$

- Q_{DA} = day-ahead market operating reserve scheduled quantities
- OR_LMP_{DA} = day-ahead market locational market price of OR (hourly)
- Q_{RT} = real-time market actual operating reserve quantities
- OR_LMP_{RT} = real-time market locational marginal price of OR (5-minute)

7.10 Who Can Offer into the Operating Reserve Market?

10 Minute Synchronized	10 Minute Non-Synchronized	30 Minute
Dispatchable Generators Dispatchable Loads Energy Storage	Dispatchable Generators Dispatchable Loads Boundary Entities Energy Storage	Dispatchable Generators Dispatchable Loads Energy Storage

8. Day-Ahead Market (DAM)

The Day-Ahead Market (DAM) for electricity is a market where dispatchable, self-scheduling and intermittent market participants must submit bids and offers a day in advance of operations in order to secure a schedule and price for the following day. The DAM is a standard component of electricity markets in North America. In the DAM most of the supply is scheduled and the real-time market is used to balance any deviations that occur between day-ahead and real-time.

8.1 Key Benefits of the DAM

The DAM provides the following benefits to Ontario's electricity market:

- Greater financial certainty to market participants which helps them better manage their risks.
- Greater operational certainty which helps the IESO maintain a reliable supply of electricity at reduced cost.
- Increased competition, incentivizing market participants to offer and bid their resources at more competitive prices.
- A better alignment of schedules and prices, enabled by the single schedule market design, eliminating costly design-driven out-of-market payments.

8.2 Financially binding schedules

A DAM for energy and operating reserve encourages greater and more efficient market participation because DAM schedules are financially binding. That is, it provides market participants with an opportunity to lock in a day-ahead price for their day-ahead schedules. Market participants can adjust their real-time production or consumption in response to real-time price signals. They are then settled at real-time prices for differences between their DAM schedules and real-time operations.

8.3 DAM Calculation Engine

The DAM calculation engine will run on the pre-dispatch day, which is the day before the dispatch day. The engine will use several dispatch data parameters, including daily and hourly dispatch data, submitted by market participants to produce schedules and locational marginal prices for every hour of the dispatch day.

8.4 Market Power Mitigation (MPM)

Market Power Mitigation refers to actions taken to prevent market participants from exercising market power.

Before-the-fact or 'ex-ante' mitigation will be applied within the day-ahead market calculation engine to hinder the exercise of market power from significantly impacting day-ahead prices and schedules. This assessment is conducted by the day-ahead market calculation engine using a conduct and impact methodology by assessing the following:

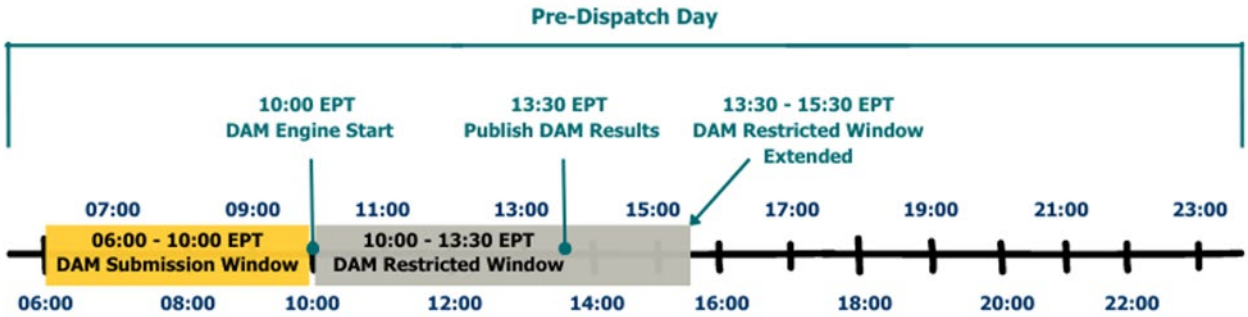
1. Did any resources have market power?
2. Did any of these resources submit dispatch data at prices significantly above their relevant reference level value?
3. Were market prices significantly higher using the too-high prices than would have been the case if reference level values were used instead?

If the answer to all three questions is 'yes', the relevant resources' dispatch data will be replaced in the day-ahead market calculation engine with the relevant reference level values to determine DAM prices and schedules.

8.5 Day-Ahead Market Timeline

The DAM will operate in Eastern Prevailing Time (EPT). On each pre-dispatch day, market participants will submit dispatch data for dispatchable loads, dispatchable, self-scheduling and intermittent generation facilities, PRLs, virtual traders, energy storage resources, and importers and exporters. These submissions will occur during the DAM submission window between 06:00 EPT and 10:00 EPT. The DAM submission window will close at 10:00 EPT and the DAM calculation engine will start running.

From 10:00 EPT to 13:30 EPT, with limited exceptions, market participants will not be allowed to revise their dispatch data submissions for the next dispatch day. This DAM restricted window will allow sufficient time for the calculation of schedules and prices to be completed. IESO approval will be required for any new submissions or revisions to dispatch data for the next dispatch day within the restricted window. Such requests will only be approved in the rare case of an IESO tool failure that prevents the IESO from receiving dispatch data submissions.



By approximately 13:30 EPT, hourly schedules, commitments, and locational marginal prices will be produced for the 24 hours of the next dispatch day as an output of the DAM. Results will be published in the form of reports. For a full list of DAM reports, please refer to Market Manual 4.2, Section 7.1.

Note: While the DAM itself operates on EPT, all inputs to and outcomes of the DAM will remain in Eastern Standard Time (EST) year-round.

The **DAM restricted window may be extended to 15:30 EPT** if there is a delay in publishing the resource schedules and day-ahead market prices. If results are not available to be published by 15:30 EPT, a DAM failure will be declared and no DAM results will be published for the relevant dispatch day.

9. Ancillary Services

Ancillary services are services required to maintain the reliability of the IESO-controlled grid, including:

- **Certified Black Start Facilities:** Facilities providing this service help system reliability by being able to restart their generator without an outside source of power following a blackout event.
- **Regulation Service:** Referred to as frequency regulation, this service acts to match total system generation to total system load on a moment-to-moment basis and helps correct variations in power system frequency.
- **Reactive Support and Voltage Control Service:** To maintain acceptable reactive power and voltage levels on the grid, reactive support and voltage control (RSVC) service are required. Reactive power moves active power through the transmission and distribution system from generators to the end customer. Due to the nature of the transmission system, reactive power needs are very localized and cannot be provided over far distances.
- **Reliability Must-Run:** Reliability must-run (RMR) contracts are used to ensure the reliability of the IESO-controlled grid. An RMR contract allows the IESO to call on the counterparty to produce electricity if it is needed to maintain the reliability of the electricity system. RMR contracts obligate the market participant to offer into the IESO-administered markets the specified amount of energy and/or operating reserve in a commercially reasonable manner and in accordance with stated performance standards.

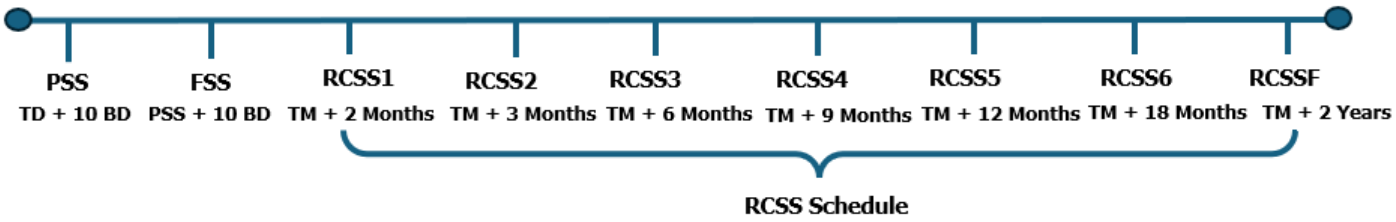
10. Financial Settlements for Market Transactions

Participants in the day-ahead and real-time markets receive payments or invoices directly from the IESO for energy sold or purchased. In addition, other charges are included in the invoices:

- Charges for transmission and distribution of energy (set by the Ontario Energy Board).
- 'Uplift' or overhead charges to cover costs incurred to supply items such as operating reserve and congestion costs.

10.1 Settlement Statements

The IESO issues a preliminary settlement statement (PSS) and a final settlement statement for each trading day (TD). These statements indicate amounts of power purchased or produced, the applicable day-ahead and real-time market prices for those transactions, and the total daily charges. The IESO also issues recalculated settlement statements (RSS) if necessary to restate a trade date's original and resettled settlement charges. Ten business days after the trading day, the IESO posts on the reports site each participant a preliminary statement of transactions for that trading day. Time is allowed for the participants to verify the statement, and for the IESO to verify and recalculate charges, if necessary. Ten business days after the preliminary settlement statement is issued, the IESO issues the final settlement statement (FSS) for the trading day.



10.2 Invoices

Once a month, the IESO issues invoices to Market Participants based on the daily statements. The monthly invoices are issued ten business days after the last billing day of the month.

These invoices must be paid within two business days, to allow the IESO to pay suppliers two business days later.

The Invoice and Payment Timeline

11. The Market Rules and Market Manuals

11.1 Market Rules

The Market Rules govern Ontario's IESO-controlled grid and Ontario's IESO-administered markets, with the goal of ensuring an efficient, competitive and reliable wholesale electricity market.

11.2 Market Manuals

In order to support market operations, the IESO has produced procedures, forms, standards and policies. The market manuals provide the details of these procedures and policies.

11.3 Compliance with the Market Rules

The IESO is responsible for supervising, administering and enforcing the Market Rules. Both the IESO and market participants are bound to comply with the rules, and the IESO is responsible for ensuring compliance. In case of disagreement, the rules set out a procedure for resolving disputes.

11.4 Accessing the Market Rules and Market Manuals

The complete Market Rules and market manuals are available in the Documents section of the IESO Market Rules & Manuals Library (ieso.ca) webpage.

12. Conclusion

This guide provides an overview of Ontario's competitive electricity market. The IESO website at https://www.ieso.ca provides a wealth of additional information, including:

Training Materials (Instructor-Led Courses, Training Materials and Participant Tool Training)

- Guides are available for such topics as Settlements, Prudentials, Dispatchable Loads, and Interjurisdictional Trading.
- In-depth training is available through Training courses (print material, face-to-face courses, and recorded presentations).

12.1 Market Rules and Manuals

The Market Rules and Market Manuals legally define the operation and administration of Ontario's IESO-administered markets. They are the source for all training material, and can be found on the Market Rules and Manuals webpage.

12.2 Market Information

Ontario's IESO publishes a great deal of information in the Power Data section of the website and on the IESO Reports website, including current and historical demand and prices, adequacy reports, transmission rights auction reports, and weekly and monthly market reports.

In addition, the IESO publishes 18-month outlooks, which assess the adequacy of generation and transmission capability for the Ontario electricity system.

12.3 Other Web Resources

- Ontario Energy Board at https://www.oeb.ca/
- Ministry of Energy and Electrification at https://www.ontario.ca/page/ministry-energy-and-electrification
- North American Electric Reliability Corporation at https://www.nerc.com/
- Northeast Power Coordinating Council (NPCC) at http://www.npcc.org

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