Interjurisdictional Energy Trading

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1. Introduction

The IESO-controlled grid is connected to five neighbouring jurisdictions with intertie transmission lines. These lines allow Ontario to import and export energy. This workbook introduces the basic concepts of Interjurisdictional Energy Trading (IJT) in the IESO-administered markets.

Note: This workbook does not include detailed information on interjurisdictional energy trading under the Day-Ahead Market (DAM). For information on the DAM, please refer to:

Market Manual 0.4.2 concerning the Operation of the Day-Ahead Market, available on the Market Rules and Manuals Library web page.

1.1 Prerequisite

To benefit from this module, users need an understanding of how Ontario's physical markets work. This knowledge can be gained by reading the Introduction to Ontario's Physical Markets workbook, available on the Training home page.

Objectives

After completing this workbook users will be able to:

- Identify the markets in which importers and exports can participate
- List the three types of import/export transactions and relate them to transactions within Ontario
- Distinguish between Ontario prices and prices used for imports and exports
- Identify the impact imports and exports have on Ontario prices
- Explain how prices are set for imports and exports
- Recall how imports and exports are scheduled
- Calculate intertie offer guarantee (IOG) payments
- Explain the application of the net interchange schedule limit
- Discuss the settlements process and associated charge types
- Explain schedule compliance requirements and potential failure charges

2. Interjurisdictional Energy Transactions

Moving energy across intertie transmission lines to or from other control areas is referred to as interjurisdictional energy trading (IJT). Market Participants (MP's) wishing to conduct IJT can participate in both the real-time energy and operating reserve markets in Ontario. While interjurisdictional transactions are similar to transactions within Ontario, there are significant differences. These differences will be explained in this workbook.

Objectives

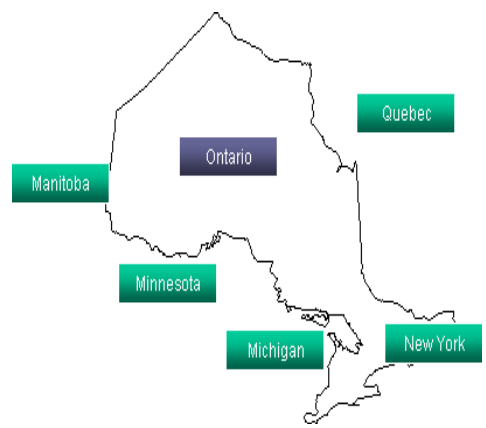
When users have completed this section, they will be able to:

- List the adjacent control areas available for interjurisdictional trade
- Explain the types of interjurisdictional transactions
- Identify when interchange schedules are determined and explain why this is different from when schedules for facilities within Ontario are set

2.1 Interties

Ontario is interconnected with five other jurisdictions (or "control areas"):

- Manitoba
- Minnesota
- Michigan
- New York
- Quebec



Interties are transmission lines that allow energy to move between adjacent balancing authorities. Like any transmission line, interties can carry only so much energy. Exceeding this level can result in reliability issues such as overheating.

Ontario's IESO and our interconnected partners work together to keep flows across the interties within these limits. Intertie flows are also managed by the IESO to ensure the stable operation of the electricity grid within Ontario.

2.2 Types of Interjurisdictional Energy Trading

There are three types of interjurisdictional energy transactions. A participant can:

- Import energy or operating reserve from another control area into Ontario
- Export energy from Ontario to another control area
- Move energy from one jurisdiction, through Ontario, to a different jurisdiction (called "wheeling" or a "Wheel-Through)

In order for an intertie transaction scheduled in Ontario to flow, there must be a matching transaction scheduled in a neighbouring jurisdiction. For example, an import from New York scheduled in the Ontario market must have a matching export scheduled in the New York market. It is the responsibility of the MP to ensure that appropriate matching transactions are scheduled by meeting the requirements of the neighbouring jurisdiction.

2.2.1 Import

An import involves moving energy from another control area into Ontario for use by consumers within Ontario. An import acts much like an internal generator in that it helps meet Ontario energy demand. As with internal generators, a participant wishing to complete an import transaction must make a supply offer in the IESO-administered market. Import offers are considered along with all other offers received from suppliers. An import offer is accepted and scheduled if:

- It is required to meet demand,
- It is economic in comparison to other supply, and
- It can be physically accommodated by the intertie and the IESO-controlled grid.

2.2.2 Export

Exports are treated in much the same way as internal dispatchable load. In order to export energy, an MP must place a bid in the IESO-administered market to purchase energy at the intertie. An export will be scheduled if the bid is economic, and the intertie and IESO-controlled grid can physically accommodate the transaction.

2.2.3 Wheel-Through

A wheel-through[1] allows an MP to move energy from one jurisdiction through Ontario to another jurisdiction. For example, an MP may want to move energy from New York to Minnesota through Ontario. This movement is achieved by transacting both an import to Ontario and an export from Ontario during the same period.

[1] For more information regarding wheeled transaction, refer to Market Manual 4.1: Submitting Dispatch Data in the Physical Markets, Section 4.2.

In the simplest form of wheel-through, an MP makes an offer to import energy and a bid to export energy during the same period. If both the bid and offer are accepted, the energy will flow into and out of Ontario at the same time. Importantly, in this form of wheel-through the two transactions (import and export) are totally independent from each other. The success of one transaction has no influence on the success of the other. Therefore, if one leg fails, the other may still flow. This may present a risk to the MP.

This risk can be avoided by "linking" the two legs of the wheel-through. This ensures that if one leg of a wheel-through is curtailed or fails, the other leg will also be curtailed.

Linking a wheel-through is achieved by submitting the NERC tags for each leg in a particular format (see the example below)[2]

Below is an example of a linked wheel intended from Michigan to Quebec. In the first scenario, the prefixes were not added to the e-Tag IDs for the import and export transactions and the engine evaluated the transactions separately, scheduling them to different quantities. In the second scenario, the WI and WX prefixes were included in the e-Tag IDs and the engine scheduled the transactions to the same quantity.

Scenario	Leg	e-Tag ID Submitted	Offer / Bid	Schedule	Outcome
e-Tag ID and prefix requirements not met	Import	MECS_ONTMM1234_HQT	120	100	• Transactions not considered as a linked wheel by the DAM and PD engines • Import and export legs may be scheduled to different quantities
	Export	MECS_ONTMM1234**5**_HQT	120	110	
e-Tag ID and prefix requirements met	Import	**WI_MECS_ONTMM1234_HQT**	120	100	• Transactions considered as a linked wheel by the DAM and PD engines • Import and export legs scheduled to the same quantity
	Export	**WX_MECS_ONTMM1234_HQT**	120	100	

2.2.4 Operating Reserve

Operating Reserve (OR) is stand-by power or demand reduction that the IESO must have available in case of a contingency on the grid such as the loss of a generator. If a contingency occurs, OR is activated, re-establishing the balance between supply and demand and thereby maintaining system reliability. The IESO purchases OR on behalf of the market. The cost is then charged back to loads (including exports) through an uplift.

MP's involved in imports and exports can offer 10-minute non-spinning and 30-minute operating reserve. In order to offer OR an MP must:

- Be able to provide the energy when called upon within the time frame specified by the class of operating reserve involved (either 10 minutes or 30 minutes)
- Be able to supply the energy for up to one hour (the neighbouring jurisdiction must allow this to occur)

[2] Please see Market Manual 4.1: Submitting Dispatch Data in the Physical Markets on the Market Rules and Manuals Library web pages for more details on wheel-throughs

- Have a bid or offer in the energy market for an amount greater than or equal to the quantity of your operating reserve offer

2.2.5 Capacity Backed Exports

Ontario-based generation resources as well as the injecting component of electricity storage resources may be eligible, subject to IESO pre-approval, to export capacity to designated external control areas during specified periods of time (refer to Market Rules Chapter 7: System Operations and Physical Markets, Section 20). Resources which have been approved for export may at times be "called" by the jurisdiction into which it has sold its capacity. An external jurisdiction may call on capacity exports when they are experiencing or anticipate experiencing an operating reserve or energy shortfall. Called exports are required to export energy to the calling jurisdiction for a specific period of time in a specified amount.

Bids[3] for called capacity exports will need to have the Capacity Transaction Flag dispatch parameter set to "Yes" for each dispatch hour for which the bid is submitted. Unlike most other export transactions, the IESO will assess a capacity backed export in all PD runs regardless of whether it was offered in the DAM or not.

[3] For detailed information regarding capacity transactions, refer to Market Manual 4.1: Submitting Dispatch Data in the Physical Markets, Section 4.3.

3. Placing Bids and Offers

Placing an offer or bid at an intertie is very similar to placing one within Ontario:

- Bids and offers are placed using the Energy Market Graphical User Interface (EMI) Workspace.[4]
- No physical transmission rights are required. Once a transaction is scheduled, the MP has access to Ontario's transmission system.

Objectives

When users have completed this section they will be able to:

- List the offer/bid information requirements for interjurisdictional trade
- Explain the concept of a boundary entity

There are two primary differences, however, between bids and offers within Ontario and those at the interties:

- An MP bidding or offering in Ontario must indicate the location of the desired transaction (i.e., where the energy will either be injected into or taken out of the IESO-controlled grid). This information is required by the IESO calculation engine so it can evaluate the effects of any physical system constraints when considering the transaction. Knowing the location of the transaction is also critical information for settlement purposes. An MP indicates it’s transaction’s location by entering a resource name with their bid or offer. A resource name is a unique identifying reference which is associated with a facility (e.g., a generator or load).
- With intertie transactions, the IESO needs to know where the energy is going to (if an export) or coming from (if an import). However, intertie bids and offers are not associated with a facility registered within Ontario. Therefore, a boundary entity resource is used to indicate an intertie transaction’s location.[5] In addition to the resource, the participant must also indicate which intertie they plan to use.

[4] Please see the “Submitting, Revising and Cancelling” series of Training Guides available on the Participant Tool Training web page for more information on entering, revising and cancelling offers and bids.

[5] Please see Market Manual 4.1: Submitting Dispatch Data in the Physical Markets on the Market Rules and Manuals Library web page for a complete listing of boundary entity resources.

- The MP must enter a NERC tag with their export bid or import offer.[6] Participants are responsible for updating the tag if the quantity of energy that clears the market is different from the quantity indicated in the originally submitted NERC tag (see the next section for timing).[7] The Ontario portion of the transaction should be designated as FIRM "7F". Quebec transactions should use the control area HQT.

Summary

MP's who wish to import energy must make an offer to inject into the IESO-controlled grid. An import offer is placed using the EMI interface or an available API in much the same way as a generator in Ontario places an offer.

MP's who wish to export energy must make a bid to withdraw energy from the IESO-controlled grid. An energy bid is placed using the EMI in much the same way as a dispatchable load in Ontario places a bid.

Import offers and export bids are evaluated by the calculation engines, taking into consideration both the economic competitiveness of the bid or offer, and the physical ability of the intertie and of the IESO-controlled grid to accommodate the transaction.

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[6] NERC (North American Electric Reliability Corporation) tags are participant-selected codes that identify intertie transactions. For more information on NERC Tags, please see the NERC web site: www.nerc.com and Market Manual 4.1: Submitting Dispatch Data in the Physical Markets on the Market Rules and Manuals Library web page web page.

[7] Except for transactions with New York, where the sink balancing authority will make any required changes for you. Please see Market Manual 4.1: Submitting Dispatch Data in the Physical Markets on the Market Rules and Manuals Library web page.

4. Skill Check One

1. What are interties and why are they important for Ontario's electricity grid? (Select the correct answer)
   a) Interties are power plants within Ontario that generate electricity
   b) Interties are transmission lines that allow energy to move between adjacent balancing authorities
   c) Interties are storage facilities for excess energy
   d) Interties are financial instruments used in energy trading

2. An import offer is accepted and scheduled if it is required to meet demand, is economic in comparison to other supply, and can be physically accommodated by the intertie and the IESO-controlled grid. (Select True or False)
   a) True
   b) False

3. What are the three types of interjurisdictional energy transactions that can occur in Ontario? (Select the correct answer)
   a) Import, Export, and Storage
   b) Generation, Distribution, and Consumption
   c) Import, Export, and Wheeling (Wheel-Through)
   d) Transmission, Distribution, and Retail

4. What is Operating Reserve (OR) and what are the requirements for an MP to offer OR? (Select the correct answer)
   a) OR is excess energy stored for future use; MPs must have storage facilities
   b) OR is stand-by power or demand reduction; MPs must be able to provide energy within the specified time frame, supply energy for up to one hour, and have a bid or offer in the energy market
   c) OR is energy imported from other jurisdictions; MPs must have import agreements
   d) OR is energy exported to other jurisdictions; MPs must have export agreements

5. A boundary entity resource is used to indicate the location of an intertie transaction because intertie bids and offers are not associated with a facility registered within Ontario. (Select True or False)
    a) True
    b) False

4.1 Skill Check One Answers

1. What are interties and why are they important for Ontario's electricity grid? (Select the correct answer)

   a) Interties are power plants within Ontario that generate electricity

   b) Interties are transmission lines that allow energy to move between adjacent balancing authorities

   c) Interties are storage facilities for excess energy

   d) Interties are financial instruments used in energy trading

2. An import offer is accepted and scheduled if it is required to meet demand, is economic in comparison to other supply, and can be physically accommodated by the intertie and the IESO-controlled grid. (Select True or False)

   a) True

   b) False

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   b) Generation, Distribution, and Consumption

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   d) OR is energy exported to other jurisdictions; MPs must have export agreements

5. A boundary entity resource is used to indicate the location of an intertie transaction because intertie bids and offers are not associated with a facility registered within Ontario. (Select True or False)

    a) True

    b) False

5. Intertie Scheduling

The IESO uses three calculation engines (DAM. PD and RTM) to determine prices and schedules[8] that run in three timeframes:

- Daily in the "Day-Ahead Market" to produce financially binding day-ahead schedules for all hours of the next day for all dispatchable, self-scheduling and intermittent resources. This includes producing energy and OR (10NS and 30R) schedules for imports and exports.
- Hourly in "pre-dispatch" to determine projected prices, projected schedules for dispatchable facilities within Ontario, and projected and actual interchange schedules
- Every five minutes in "real-time" to determine actual dispatch schedules for facilities within Ontario, and settlement prices.

Objectives

When users have completed this section they will be able to:

- Explain the offer/bid information requirements for interjurisdictional trade, including the necessary details and submission deadlines.
- Identify the relevant IESO resources for obtaining information about intertie scheduling, including the IESO Reports site and Market Rules.
- Explain how intertie transactions are scheduled in the Day-Ahead Market (DAM), pre-dispatch (PD), and real-time (RT) timeframes.
- Recognize the exceptions to the normal intertie scheduling process, such as those related to capacity obligations, emergency energy transactions, and reliability management.

MP's with dispatchable facilities in Ontario receive dispatch instructions every five minutes. Dispatch instructions tell the participant what quantity of energy they should be injecting or withdrawing by the end of the five-minute interval during which the instruction was received.

The IESO cannot issue dispatch instructions every five minutes in real-time to facilities located outside of Ontario. Instead, interjurisdictional trade is co-ordinated between the IESO and other balancing authorities, using hourly interchange schedules. Imports and exports are scheduled on an economic basis within the physical security limits of the intertie and of the IESO-controlled grid.

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[8] See the Introduction to Ontario's Physical Markets workbook available on the Training web page.

Which imports or exports are accepted for a particular dispatch hour is determined by the pre-dispatch calculation engine run during the preceding hour (for example, the schedule for 12:00 to 13:00 is determined between 11:00 and 12:00). This schedule is then confirmed with IESO's neighbouring jurisdictions to determine if matching transactions have been scheduled. Once this is confirmed, transactions become fixed for the dispatch hour. This means that they do not change during the hour (unless a change is needed for reliability reasons). Further, no additional intertie transactions can be made to flow during the hour using market mechanisms.

Therefore, intertie transactions compete economically in both the DAM and in pre-dispatch in order to be scheduled, but are then fixed for the hour in real-time. This has an important effect on pricing and settlements, which will be explained in later sections.

MP's use the IESO Reports site to retrieve their interchange schedules before the dispatch hour. For example, the interchange schedule for the hour starting at 9:00 eastern standard time (EST) is determined by a run of the IESO algorithm during the previous hour. This interchange schedule should be available by 8:20 Participants are required to supply valid NERC tags at least 30 minutes prior to the dispatch hour (35 minutes if Transmission Load Relief (TLR) has been declared).

5.1 DAM Scheduling

The DAM calculation engine runs once per day to produce financially binding day-ahead schedules for all hours of the next day for all dispatchable, self-scheduling and intermittent resources. This includes producing energy and OR (10NS and 30R) schedules for imports and exports. Bids and offers must be submitted between 6:00 and 10:00 Eastern Prevailing Time (EPT)[9] to be considered in the DAM, which begins its run at 10:00 EPT. Standing bids and offers will be automatically entered into the DAM at 6:00 EPT. The DAM will normally complete its run at 13:30 EPT, although it may be delayed as late as 15:30 EPT.

5.2 PD Scheduling

Actual Ontario supply and demand in real-time can differ from day-ahead forecasts due to a number of factors. As a result, the PD calculation engine is used to transition from day-ahead to real-time operations. The PD calculation engine run which starts at 20:00 Eastern Standard Time (EST) produces look-ahead schedules and prices for each of the remaining hours of the day and all hours of the next day. PD is run hourly thereafter with each run's look-ahead period reducing by one hour until 20:00 EST the next day, at which point the cycle repeats.

The PD calculation engine receives information from the DAM, including offers and bids and day-ahead import and export schedules. Intertie transaction offers and bids can also be submitted without IESO approval after the close of the DAM submission window up to the start of the mandatory window, two hours before the dispatch hour.

[9] Eastern Prevailing Time (EPT) means the current time applicable in Ontario, whether Eastern Standard Time or Eastern Daylight Savings Time.

The PD calculation engine which initiates in any given hour (let's call it Hour T) will evaluate and schedule both DAM-scheduled and non-DAM-scheduled intertie transactions for Hours T+1 and T+2 of the PD run look-ahead period. For all hours beyond T+2, the PD calculation engine will normally only evaluate DAM-scheduled intertie transactions, up to the MW quantity of the DAM schedule. Exceptions include:

- The intertie transaction is associated with a capacity obligation,
- If it is an emergency energy transaction, or
- As otherwise allowed by the IESO, such as:
- In response to a DAM failure,
- To manage overall reliability of the system, or
- To manage surplus conditions.

Intertie schedules for the next hour are determined by pre-dispatch (so for Hour T+1) and will represent the schedules for actual intertie operations for the next hour, subject to any changes resulting from formal checkout procedures with our neighbouring jurisdictions.

5.3 RT Scheduling

The RT calculation engine[10] will perform multi-interval optimization to determine real-time dispatch for internal Ontario resources for the next five-minute dispatch interval and advisory dispatches for the subsequent ten five-minute intervals. The engine considers resource and system constraints to determine dispatch schedules and real-time LMPs.

The schedules for imports and exports are held fixed by the RT calculation engine as determined by the PD calculation engine and as confirmed during checkout unless reliability-related curtailments are made during the hour.

[10] For more information regarding the PD and RT scheduling process, refer to Market Manual 4.3: Operation of the Real-Time Market, Section 2 and 3 respectively.

6. Pricing and Scheduling of Interjurisdictional Trade

Imports are paid the price in the zone through which they are importing while exports pay the price in the zone through which they are exporting. Intertie zone prices may be higher, lower, or the same as the price used to settle transactions occurring in the Ontario zone. Differences between the Ontario and intertie zone prices are caused by congestion.

Objectives

When users have completed this section, they will be able to:

- Define "intertie congestion price" (ICP)
- Analyze intertie prices with and without congestion
- Recognize the impact of NISL on intertie prices and market dynamics
- Understand how scheduling imports and exports an hour ahead affects intertie prices

The calculation engines determine prices for Ontario as well as for a number of intertie zones:

Control Area	Code(s)
Ontario	ONZN
Manitoba	MBSI
Minnesota	MNSI
Michigan	MISI
New York	NYSI
Quebec	PQBE
	PQDA
	PQDZ
	PQHA
	PQHZ
	PQPC

	PQQC
	PQXY
	PQAT

Imports are paid the price in the intertie zone while exports pay the price in the zone. As with any transmission line, the interties that connect Ontario to neighbouring control areas have a maximum allowable flow limit. Scheduling transactions in excess of this limit can result in reliability issues, such as overheating. A maximum flow limit can be referred to as a "constraint" as it constrains the ability of the calculation engine to schedule transactions. Because of these flow limits, there can be more energy trying to move in a given direction across an intertie than can be physically accommodated. When this occurs, the calculation engine may not be able to schedule all the transactions that have an economic bid or offer. Instead, because energy can only be scheduled up to the maximum flow limit, energy that is otherwise economic may be left unscheduled. When this occurs the "constraint" is said to be "binding" due to congestion. A binding intertie constraint impacts both scheduling and pricing.

Intertie Locational Marginal Prices (LMP) will be made up of the Intertie Border Price (IBP) plus the Intertie Congestion Price (ICP). This LMP includes costs associated with internal congestion and losses, external congestion, and the Net Interchange Scheduling Limit (NISL) as shown in the equation:

$$\text{Intertie LMP} = \text{IBP} + \text{ICP}$$

Where:

Intertie Border Price (IBP) is the LMP at the Ontario side of an interface.[11]

IBP = Reference Bus Component + Loss Component (reference bus to the border) + Internal Congestion Component (reference bus to the border).

Reference Bus Component is the cost of serving one additional increment of demand above actual demand at a specific location on the grid known as the 'Reference Location'.

Loss Component which reflects the impact on system losses of serving an additional increment of demand at a pricing location with supply from the reference bus.

Internal Congestion Component which reflects the cost impact of relaxing each system constraint in turn between the Reference Bus and the pricing location.

Intertie Congestion Price (ICP) = External Congestion Component + Net Interchange Scheduling Limit (NISL) Congestion Component.

External Congestion Component is the cost of congestion across the intertie when intertie limits are binding.

[11] See the Introduction to Ontario's Physical Markets workbook available on the Training web page for information on Locational Marginal Prices for Ontario

NISL Congestion Component is the cost of congestion across all the interties when NISL is binding.

6.1 Intertie Boarder Price (IBP)

The IBP is the LMP at the Ontario side of an intertie. As such, it includes the Ontario reference price plus the costs of congestion and losses between the reference bus and the intertie with the external jurisdiction.

6.2 Intertie Congestion Price (ICP)

The ICP includes:

- the external congestion, as determined in the last pre-dispatch before the start of the dispatch hour, as well as.
- the congestion cost associated with the Net Intertie Scheduling Limit (NISL).

External Congestion Component

Let’s look at a simplified example to illustrate the potential pricing impact of external intertie congestion.

Assume

An intertie can flow 200 MW of exports.

Four exports are bid:

- MP A bids for 60MW at a price of $15
- MP B bids for 50MW at a price of $20
- MP C bids for 50MW at a price of $25
- MP D bids for 50MW at a price of $30

Intertie Border Price (IBP) is $9

With this border price, all four transactions would be scheduled to 50 MW each for a total intertie schedule of 200 MW because they were all willing to pay more than the IBP is lower than their bid prices. This includes MP A who bid for 60 MW since they bid the lowest and since the total capacity of the intertie does not accommodate all 210 MW bid economically. Since this is the case, there is external congestion.

To determine the external congestion cost, the 200MW limit is relaxed by an incremental amount (easiest to think of as 1 MW) and the resulting change in costs determined. If the intertie could accommodate 201 MW, that would allow 1 additional MW of MP A’s $15 bid to flow. The difference between the IBP of $9 and MP A’s bid of $15 is $6. This becomes the external congestion cost.

Net Interchange Schedule Limit (NISL) Component

NISL is included in the DAM and pre-dispatch calculation engines to limit the net allowable change in intertie schedules across the top of an hour. As mentioned, intertie schedules are for one-hour blocks. Changes in schedules from one hour to the next are achieved by dispatching facilities within Ontario either up (to achieve net exports) or down (to accommodate net imports) to account for the total intertie schedule change across all interties. This ramping takes ten minutes, starting five minutes before the hour and ending five minutes after the start of the hour. NISL is respected to ensure Ontario resources can satisfy hour-to-hour ramping needs without adversely impacting reliability. NISL is set to plus or minus 700 MW, unless changed by the IESO to support reliability.

To respect NISL the day-ahead Market (DAM) and pre-dispatch (PD) calculation engines may reduce or increase imports and exports that would have otherwise been economically scheduled. When doing so, they take the impact on cost into consideration.

As an example, assume an Hour 1 net import schedule of 500 MW. For Hour 2, assume the pre-dispatch intertie price is $38 and that the following are the available import offers and export bids:

Transaction	Hour 2 Offers and Bids
Import A	1,300 MW@ $30
Import B	300 MW @ $35
Export C	100 MW @ $50
Export D	300 MW @ $34

With an intertie price of $38, Imports A and B and Export C would be economic. Export D would be uneconomic. If the three economic transactions were all scheduled in full, the resulting net schedule would be imports of 1,500 MW (1,300 MW plus 300 MW, less 100 MW). However, because Hour 1'snet schedule was 500 MW of imports, the net import schedule for Hour 2 must be limited to 500 MW plus the 700 MW NISL, or 1200 MW.

To produce a net import schedule of 1200 MW in hour 2, the DACP and pre-dispatch would evaluate the following options to determine what the impact on cost would be:

- The algorithm could choose not to schedule Import B. With an offer price of $35 and an intertie price of $38, it had been scheduled to 300 MW. Not scheduling this transaction would represent a cost of $38 less $35, or $3/MWh, or $900 in total. This is the amount that the import stood to benefit by if it had flowed. Not receiving it would, therefore, be a cost to be considered.

- Alternatively, the algorithm could schedule Export D. With a bid price of $34 and a price of $38, it had not been previously scheduled to flow. If Export D was now scheduled, it would be required to pay a price higher than it's bid. The difference between its bid and what it would be required to pay given the intertie price is $4/MWh. This represents a total cost of $1200.

Option	Economic Schedule	Schedule to Respect NISL	Offer/Bid Price	Cost [(Intertie Price – Offer/Bid Price) x Schedule Change to Respect NISL
Do not schedule Import B	300 MW	0 MW	$35	($38 - $35) x 300 MWh = $900
Schedule Export D	0 MW	300 MW	$34	($38 - $34) x 300 MWh = $1200

Therefore, the calculation engines will choose not to schedule Import B (and to leave Export D unscheduled) as this is the least cost solution to respect NISL.

The cost of NISL will be incorporated into the intertie price. To calculate the NISL congestion component for the intertie price, the DAM and pre-dispatch calculation engines will determine the savings resulting from expanding the NISL constraint by 1 MW. To determine this, the calculation engines will look at all possible solutions, including whether Import A and Export D could help. Import A cannot as it is already fully scheduled. Export D cannot because it is uneconomic and is not required to be scheduled to respect NISL. This makes Export D unavailable.

Transaction	Offers/Bids	Schedule to Satisfy 700 MW NISL	Eligible to satisfy next MW (i.e., 701 MW NISL)?	Savings (Difference Between IBP and Eligible Offer/Bid)
Import A	1,300 MW@ $30	1,300 MW	No	N/A
Import B	300 MW @ $35	0 MW	Yes	$38 - $35 = $3
Export C	100 MW @ $50	100 MW	Yes	$38 - $50 = -$12
Export D	300 MW @ $34	0 MW	No	N/A

Import B could flow 1 MW if the NISL constraint were relaxed by a megawatt. The savings associated with this would be the $3 difference between its offer price and the Intertie Border Price.

Because Export C bid at $50, it was fully scheduled while respecting the 700 MW NISL limit. If Export C was reduced by 1 MW to allow for additional import flow, there would be a cost of $12 since Export C was willing to pay up to $50 to export.

Therefore, the NISL price is set at Import B's $3 savings since it is the most economic outcome. The intertie price, then, would be the Intertie Border Price of $38 plus an ICP of -$3 (assuming no congestion due to the intertie limit) which equals $35. The NISL congestion price is negative because it is binding in the import direction.

That the price in this example dropped due to NISL congestion makes sense in terms of market dynamics – reducing the intertie price by $3 makes transacting imports less attractive and makes it more attractive to export. This is what one would want to have happen to resolve an import-congested intertie.

6.3 Real-Time Price Setting

Real-time will have dynamic intertie settlement pricing. The exact approach will depend on the whether the intertie was congested or not in the final pre-dispatch run:

- If there was no congestion (external congestion of a binding NISL) in pre-dispatch, the price will be the real-time intertie border price.
- If there was export congestion, the price will be the sum of the five-minute real-time intertie border prices and the pre-dispatch intertie congestion price.
- If there was import congestion, the price will be the lesser of the pre-dispatch intertie locational marginal price (that is, the pre-dispatch intertie border price, plus the cost of external congestion plus the cost of NISL), or the five-minute real-time intertie border prices,

7. The Intertie Offer Guarantee

Import transactions are locked in for the hour based on pre-dispatch prices. However, these transactions are settled using real-time prices. As a result, those conducting imports face a settlement price risk due to the scheduling process. Intertie offer guarantee (IOG) payments reduce this price risk for importers. IOG payments are intended to encourage imports, helping to ensure adequate supply in Ontario.

The RT_IOG will be offset where no net power is provided. The RT_IOG Offset will be applied to implied linked wheels, and real-time imports when the MP has DAM imports that were not scheduled in real-time for the hour. Please see Market Manual 5.5, Appendix D for an example of the IOG offset process.

Imports scheduled in the day-ahead market and real-time for the same MWs in the same hour and linked wheels are not eligible for a real-time intertie offer guarantee.

Real-time intertie offer guarantees are discussed in market manual 5.5: IESO-Administered Markets Settlement Amounts, section 2.18 and Appendix D where an example is presented.

Objectives

After completing this section users will be able to:

- Explain the purpose of the intertie offer guarantee
- Calculate an intertie offer guarantee payment
- Discuss the impact of implied wheel-throughs on the intertie offer guarantee

7.1 Calculation of the Real-Time Intertie Offer Guarantee (RT_IOG)

The RT_IOG ensures that, over the course of an hour, an importer will receive revenue at least equal to their schedule times their average offer price. By doing this, the RT_IOG ensures that an importer does not suffer a negative operating profit over the course of an hour. In other words, they are assured that they will receive at least a $0 operating profit. The IOG is calculated as follows:

IOG = Potential IOG – Offset MWs x IOG rate

To calculate the RT_IOG four (4) steps are performed:

1. Calculate the potential guarantee amount for each import based on MW scheduled:

$$\text{Potential IOG} = -1 \times \text{Min}[0, \textstyle\sum \text{OP(RT\_LMP, SQEI, BE)} - \sum \text{OP(RT\_LMP, Min[SQEI, DAM\_QSI], BE)}\ ]/12$$

2. Determine the $/MW rate for the resource:

$$\text{IOG Rate} = \text{Potential IOG} / \text{MW scheduled}$$

Determine the offset MWs by removing import MWs that are deemed as scheduled in DAM and by removing import MWs that are deemed to be part of an implied linked wheel. The offset will be done 3 times: on the intertie, neighbouring electricity system and Ontario level.

$$\text{Offset MW} = \sum \text{DAM Import MWs} + \sum \text{Implied Linked Wheel MWs}$$

3. Recalculate the IOG amount: IOG = Potential IOG – Offset MW x IOG rate

8. Compliance with IESO Interchange Schedules

If an interchange transaction fails to flow for a reason that was within the participant's control, that participant is subject to a settlement charge. In some cases, there may also be compliance actions, including penalties.

Objectives

After completing this section users will be able to:

- Explain the impact of interchange failures on IESO-controlled grid operations and IESO-administered markets
- Calculate both an import and an export failure settlement charge

8.1 Interchange Failures

Interchange transactions fail to flow for a variety of reasons. Some of these reasons are beyond a participant's control, such as being cut by a system operator. However, MP's can avoid others, including:

- Not entering a valid NERC tag
- Not successfully scheduling the transaction in the neighbouring jurisdiction

Interchange failures can have a significant impact on IESO-controlled grid operations and on IESO-administered markets:

- The IESO may have to replace a failed import by taking actions that increase market costs, either through increased uplift or higher prices
- For failed exports, the IESO may have to constrain off generation, which may lower the real-time price. Failed exports can also have operational impacts during low demand periods.

Because of these negative effects of failed interchange transactions, an automatic settlement charge is applied to a participant who fails to flow an interchange transaction if the reason for failure was within their control.

8.2 The Intertie Failure Charge (IFC)

The intertie failure charge is applicable to import or export transactions which fail in real-time.

8.2.1 DAM Intertie Failure Charge

An intertie failure charge will apply to day-ahead scheduled transactions which fail to flow in real-time for a reason within the MPs control. DAM failed MWs will be any MWs scheduled in the DAM and also scheduled by the last pre-dispatch before the start of the hour, but which do not flow in real-time. These MWs will be charged the real-time external congestion and real-time NISL costs.

8.3 DAM Import Failure Charge (DAM_IMFC)

The first step in calculating the DAM intertie failure charge is to calculate the total of DAM MWs failed. Once this is done, the total DAM_IMFC can be calculated.

8.3.1 Total of DAM MW's Failed (DAM_IMFC)

The total DAM MWs failed will be calculated as the greater of zero or the lesser of the DAM quantity scheduled for injection and the pre-dispatch quantity scheduled for injection less the real-time scheduled quantity of energy injected:

$$MAX\ (0,\ MIN\ (DAM_{QSI}\ ,\ PD_{QSI}) - RT_{SQEI})$$

Where:

- DAM_{QSI} – The quantity scheduled for injection day-ahead (i.e., the day-ahead import quantity)
- PD_{QSI} – The quantity scheduled for injection in the last pre-dispatch before the start of the dispatch hour (i.e., the pre-dispatch scheduled import quantity)
- RT_{SQEI} – The real-time scheduled quantity of energy injected (i.e., the actual import quantity which flowed in real-time)

Example

	DAM_{QSI}	PD_{QSI}	RT_{SQEI}	Failed DAM Quantity
Schedule 1	100	100	70	30
Schedule 2	100	120	70	30
Schedule 3	100	70	70	0

Schedule 1 had a DAM_{QSI} and PD_{QSI} of 100 MWs, but a RT_{SQEI} of 70 MWs. Therefore, 30 MWs failed.

Schedule 2 had a DAM_{QSI} of 100 MWs and a PD_{QSI} of 120 MWs, but a RT_{SQEI} of 70 MWs. Therefore, it also had a 30 MW failure because the lower of the DAM_{QSI} and PD_{QSI} is considered.

Using this same principle, schedule 3 had a DAM_{QSI} of 100 MWs but a PD_{QSI} and RT_{SQEI} of 70 MWs. As such, it did not have any failed MWs.

8.3.2 DAM_IMFC

The DAM Import Failure charge for each interval in an hour will be calculated as the sum of the lesser of zero or the real-time price of external congestion plus the real-time net interchange scheduling limit cost all times the DAM quantity of failed imports divided by twelve.

$$\text{Sum of } (MIN\ (0,(RT_{PEC} + RT_{NISL})\ X\ DAM_{Q\ IMPORT\ FAILED} / 12)$$

Where:

- RT_{PEC} – The real-time price of external congestion

- RT_{NISL} – The real-time net interchange scheduling limit cost

Example:

As an example, assume:

- The real-time price of external congestion is negative $3 because the intertie was export congested.
- The real-time net interchange scheduling limit cost is $2
- and the DAM quantity of failed imports is 30 MWs.

$$(MIN\ (0,(-\$3 + \$2) \times 30 / 12) = -2.50$$

This results in a failure charge of $2.50 for this interval.

Note that if the real-time price of external congestion had been positive $3, reflecting import congestion, the failure charge would have been zero, because the calculation would have used the lesser of 0 or $12.50.

The same calculation would be done for each five-minute interval in the hour

8.4 DAM Export Failure Change (DAM_EXFC)

Similar to imports, the first step in calculating the EXFC is to calculate the total DAM MWs failed. Once this is done, the total DAM_EXFC can be calculated.

8.4.1 Total of DAM MW's Failed (DAM_EXFC)

The total DAM export MWs failed will be calculated as the greater of zero or the lesser of the DAM quantity scheduled for withdrawal and the pre-dispatch quantity scheduled for withdrawal less the real-time scheduled quantity of energy withdrawn.

$$MAX\ (0,\ MIN\ (DAM_{QSW}\ ,\ PD_{QSW}) - RT_{SQEW})$$

Where:

DAM_{QSW} – The quantity scheduled for withdrawal day-ahead (i.e., the day-ahead export quantity)

PD_{QSW} – The quantity scheduled for withdrawal in the last pre-dispatch before the start of the dispatch hour (i.e., the pre-dispatch scheduled export quantity)

RT_{SQEW} – The real-time scheduled quantity of energy withdrawn (i.e., the actual export quantity which flowed in real-time)

8.4.2 DAM_EXFC

The DAM Export Failure charge for each interval during an hour will be calculated as the sum of negative one (-1) times the greater of zero or the real-time price of external congestion plus the real-time net interchange scheduling limit cost all times the DAM quantity of failed exports divided by twelve

$$Sum\ of\ (-1) \times MAX\ (0,\ (RT_{PEC} + RT_{NISL}) \times DAM_{Q\ EXPORT\ FAILED} / 12)$$

Example:

As an example, assume:

- The real-time price of external congestion is $3 because the intertie is export congested.
- The real-time net interchange scheduling limit cost is $2.
- The DAM quantity of failed exports is 30 MWs.

$$(-1) \times MAX\ (0, (3 + 2) \times 30 / 12) = -12.50$$

This results in a failure charge of $12.50 for this interval.

The same calculation would be done for each five-minute interval in the hour.

8.4.3 Real-Time Intertie Failure Charges

A Real-Time Intertie Failure Charge will apply to import and export transactions scheduled in the last pre-dispatch before the start of the dispatch hour which are incremental to any scheduled day-ahead and which fail to be scheduled in real-time due to a reason within the participant's control. Please see Section 4.1.1.1 in Market Manual 4.3: Operation of the Real-Time Market for information on intertie coding and intertie failure charge application.

The failure charge will be applied to the portion of the pre-dispatch schedule that is greater than the DAM schedule. This means the charge covers both transactions wholly scheduled after the completion of the DAM and those where the quantity of a day-ahead scheduled transaction was subsequently increased.

In the calculations, real-time prices will be adjusted by a Price Bias Adjustment Factor. This adjusts the real-time price for the effect of systemic differences between pre-dispatch and real-time price calculations.

Similar to the day-ahead failure charges, the formula for the real-time failure charges will include the costs of intertie congestion and NISL.

8.5 RT Import Failure Charge (RT_IMFC)

The first step in calculating the RT_IMFC is to calculate the total DAM MWs failed. Once this is done, the total RT_IMFC can be calculated.

8.5.1 The Total Real-Time Import MWs Failed (RT_IMFC)

The total real-time import quantity failed will be calculated as the greater of zero or the pre-dispatch quantity scheduled for injection from the last pre-dispatch before the start of the dispatch hour less the greater of the DAM quantity scheduled for injection or the real-time scheduled quantity of energy injected.

$$MAX\ (0, PD_{QSI} - MAX\ (DAM_{QSI}\ , RT_{SQEI}))$$

Example:

	PD_{QSI}	DAM_{QSI}	RT_{SQEI}	Failed RT Quantity
Schedule 1	100	100	80	0
Schedule 2	130	100	70	30
Schedule 3	100	70	70	30

For Schedule 1 in the example, the failed import MWs were zero because both the pre-dispatch quantity scheduled for injection and the DAM quantity scheduled for injection were 100 MWs. So, subtracting the DAM quantity from the pre-dispatch quantity results in zero.

For Schedule 2, 30 MWs failed because the greater of the real-time scheduled quantity of energy injected, or 70 MWs, and the DAM quantity scheduled for injection, or 100 MWs, is subtracted from the pre-dispatch quantity scheduled for injection of 130 MWs.

Lastly, Schedule 3 had 30 MWs of failed imports since both the DAM quantity scheduled for injection and the real-time scheduled quantity of energy injected were 70 MWs.

8.5.2 RT_IMFC

The Real-Time Import Failure charge is calculated as the sum of negative one times the lesser of the greater of zero or the real-time intertie border price plus the import price bias adjustment factor less the pre-dispatch intertie border price all times the real-time import quantity failed, or the greater of zero or the real-time intertie border price times the real-time import quantity failed, plus the lesser of zero or the real-time price of external congestion plus the real-time net intertie scheduling limit cost times the real-time import quantity failed all divided by twelve.

$$\Sigma\ [(-1) \text{ X MIN } (\text{MAX } (0,(RT_{IBP} + PBAF_{I} - PD_{IBP}) \text{ X } RT_{Q\ IMPORT\ FAILED}), \text{MAX } (0, RT_{IBP} \text{ x } _{RTQ\ IMPORT\ FAILED})) + \text{MIN } (0, (RT_{PEC} + RT_{NISL}) \text{ x } RT_{Q\ IMPORT\ FAILED})] / 12)$$

Where:

- PD_{IBP} – The pre-dispatch Intertie Border Price
- RT_{IBP} – The real-time Intertie Border Price
- RT_{PEC} – The real-time price of external congestion
- RT_{NISL} – The real-time net interchange scheduling limit cost

Example:

Assume that:

- The real-time intertie border price is $30, and the pre-dispatch intertie border is $25;
- The import price bias adjustment factor is $2.30;
- The real-time price of external congestion is $3;
- The real-time net intertie scheduling limit cost is $2; and
- Lastly, the real-time quantity of imports failed is 30 MWs

The RT Import Failure charge will be calculated as follows:

$$\Sigma\ [(-1) \times MIN\ (MAX\ (0,(30 + 2.30 - 25)\ X\ 30), MAX\ (0, 30 \times 30)) + MIN(0,(3 + 2) \times 30)] / 12)$$

$$= [(-1)\ X\ MIN\ (MAX\ (0, 7.30\ X\ 30), MAX\ (0, 900)) + MIN(0, 5 \times 30)] /12$$

$$= [(-1)\ X\ 219 + 0] / 12$$

$$= -\$18.25$$

Applying these numbers to the formula would result in a charge for this interval of $18.25.

As with the DAM import failure charge, the same calculation would be done for each five-minute interval in the hour.

8.6 RT Export Failure Charge (RT_EXFC)

The first set in calculating the real-time export failure charge is to calculate the total of DAM MW's failed. Once this is done, the total RT_EXFC can be calculated.

8.6.1 The Total Real-Time Export MWs Failed (RT_EXFC)

The total real-time export quantity failed will be calculated as the greater of zero or the pre-dispatch quantity scheduled for withdrawal from the last pre-dispatch before the start of the hour less the greater of the DAM quantity scheduled for withdrawal or the real-time scheduled quantity of energy withdrawn.

$$MAX\ (0, PD_{QSW} - MAX\ (DAM_{QSW}\ , RT_{SQEW}))$$

8.6.2 RT_EXFC

The real-time export failure charge for an interval during an hour will be calculated as the sum of negative one times the lesser of the greater of zero or the pre-dispatch intertie border price less the export price bias adjustment factor less the real-time intertie border price all times the real-time exports quantity failed or the greater of zero or the pre-dispatch intertie border price times the real-time export quantity failed less the greater of zero or the real-time price of external congestion plus the real-time net interchange scheduling limit cost times the real-time export MWs failed all divided by twelve.

$$\Sigma\ [(-1) \times MIN\ (MAX\ (0,\ (PD_{IBP} - PB_{AFE} - RT_{IBP}) \times RT_{Q\ EXPORT\ FAILED}),\ MAX\ (0,\ PD_{IBP} \times RT_{Q\ EXPORT\ FAILED}\ )) - MAX\ (0,(RT_{PEC} + RT_{NISL}) \times RT_{Q\ EXPORT\ FAILED})]\ /\ 12)$$

Example:

Assume that:

- The real-time intertie border price is $25, and the pre-dispatch intertie border price is $30;
- The export price bias adjustment factor is $3.01;
- The real-time price of external congestion is $3;
- The real-time net intertie scheduling limit cost is $2; and
- Lastly, the real-time quantity of exports failed is 30 MWs

The real-time Export Failure charge will be calculated as follows:

$$\Sigma\ [(-1)\ X\ MIN\ (MAX\ (0,(30 - 3.01 - 25)\ X\ 30),\ MAX\ (0,\ 30 \times 30)) - MAX\ (0,(3 + 2) \times 30)]\ /\ 12)$$

$$= [(-1)\ X\ MIN\ (MAX\ (0,\ 1.99\ X\ 30),\ MAX\ (0,\ 900)) - MAX\ (0,\ 150)]\ /\ 12$$

$$= [(-1)\ X\ 59.7 - 150]\ /\ 12$$

$$= (-59.7 - 150)\ /12$$

$$= -\$209.70$$

Applying these numbers to the formula would result in a charge for this interval of $209.70.

The same calculation would be done for each five-minute interval in the hour.

8.7 Price Bias Adjustment Factor

Prices will be adjusted in real-time failure charge calculations by a ‘Price Bias Adjustment Factor’. This factor compensates for systematic differences between how prices are calculated in pre-dispatch and how they are calculated in real-time. For example, pre-dispatch is an hourly calculation that projects future prices using expected demand for the hour whereas in real-time, prices are set every five minutes using updated demand forecasting.

The Price Bias Adjustment Factor page of the IESO website lists the factors. The variables used in settlements for the Price Bias Adjustment Factor are:

- PBAFI – The Price Bias Adjustment Factor for Imports
- PBAFE – The Price Bias Adjustment Factor for Exports

9. Make Whole Payments (MWP)

There can be situations where an intertie transaction may be scheduled in such a way that it deviates from its energy or operating reserve economic operating point causing an implied lost cost or an implied lost opportunity. This can result from a manual control action or as a result of differences between pre-dispatch scheduling and the real-time pricing pass. If this happens, a make-whole payment (MWP) will compensate for any loss. MWP's help maintain reliability, as they incentivize market participants to follow their schedules.

Objectives

After completing this section users will be able to:

- Explain the role and impact of the make-whole payment.
- Calculate both the day-ahead and real-time make-whole payment.

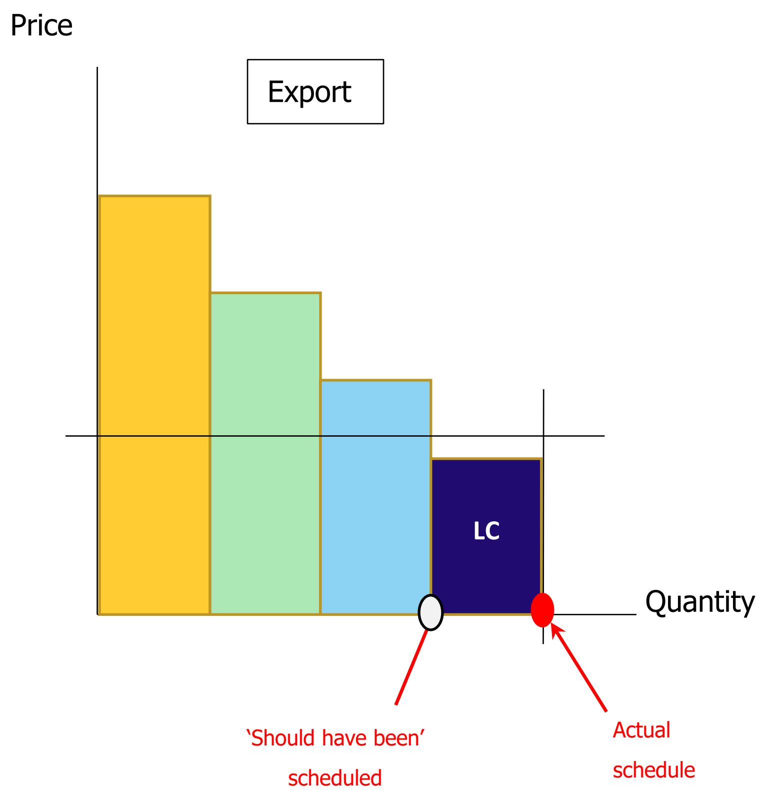
MWP's are designed to pay for the financial difference between where a resource was actually dispatched to, and where it otherwise would have been based on the LMP and its offer or bid curve but-for a binding constraint.

In order to calculate an MWP, one needs dispatch schedules, offer/bid curves, LMPs, and a determination of the 'ideal dispatch' schedule. The resource's economic operating point (EOP) is its ideal dispatch schedule.

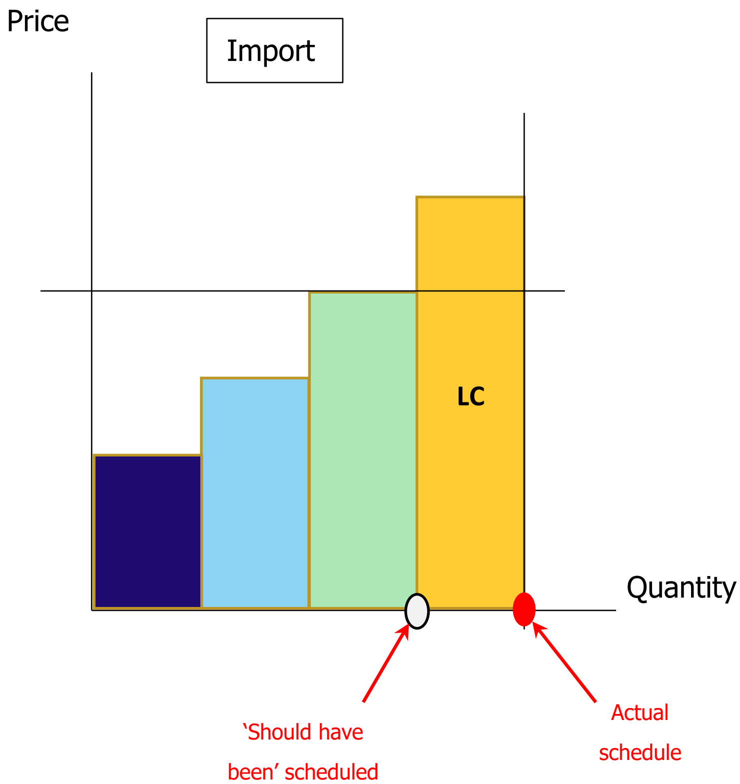
9.1 Lost Cost

Lost cost scenarios occur when the LMP implies the resource should have been scheduled lower:

- For an export, lost cost would occur when it is scheduled above its EOP so the energy or operating reserve real-time price is higher than its bid price.



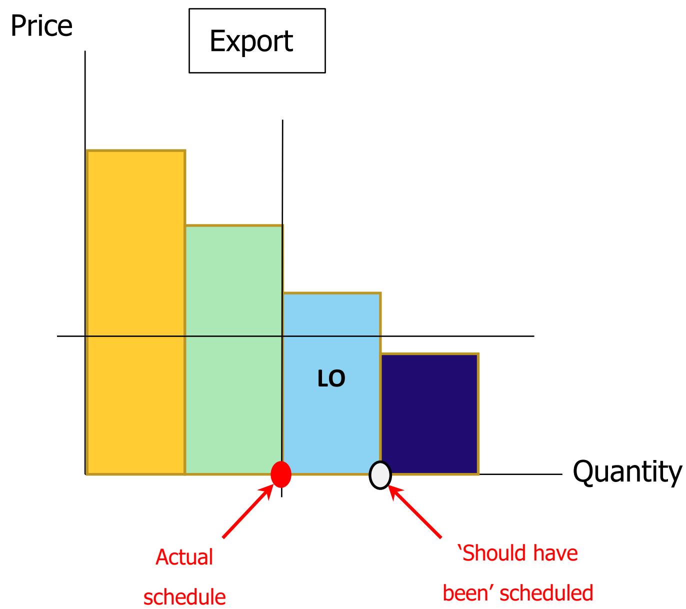
- For an import transaction, this occurs when it is scheduled above its economic operating point (or EOP) so its energy or operating reserve cost is greater than the real-time price.



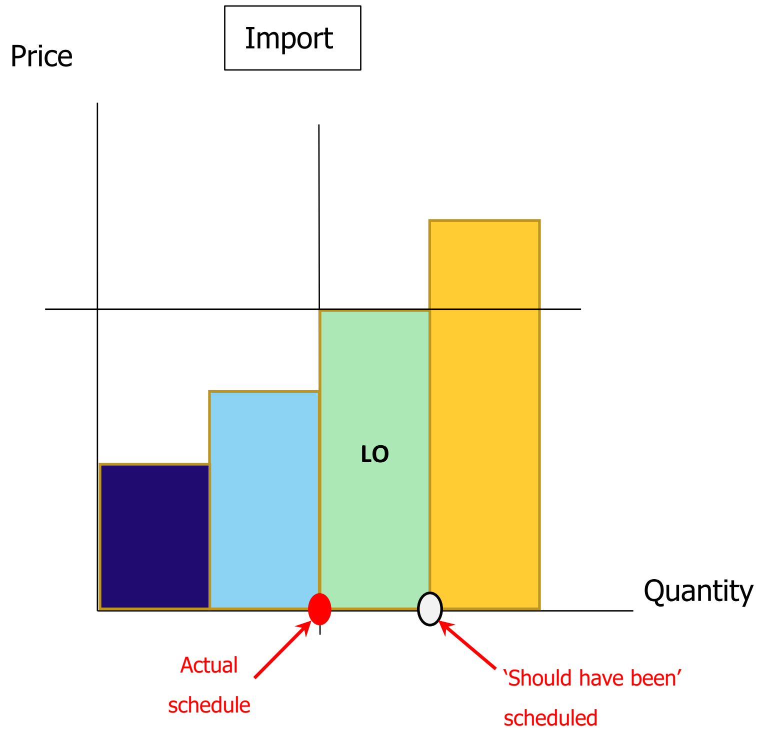
9.2 Lost Opportunity

Lost opportunity scenarios occur when the LMP implies the resource should have been scheduled higher:

- For exports, this occurs when it is scheduled below its EOP – in this case so it is unable to realize its full potential economic benefit of exporting.



- For an import transaction a lost opportunity cost occurs when it is scheduled below its economic operating point so it is unable to earn additional market revenue above its market cost.



9.3 The Types of MWPs and EOPs

The renewed market includes three types of MWP's:

1. Lost Cost MWP for the Day-Ahead Market (DAM).
2. Lost Cost MWP for the Real-Time Market (RTM) incremental to the DAM Lost Cost MWP.
3. Lost Opportunity MWP for the RTM.

Lost opportunity MWPs are not required in DAM since opportunity costs are not fully realized until real-time.

9.3.1 DAM Lost Cost Make-Whole Payment

Intertie transactions are eligible for the day-ahead make-whole payment (DAM_MWP). The DAM_MWP provides a settlement amount for resources that are scheduled in the day-ahead market when the market participant would incur an implied loss. An implied loss is incurred when the energy and operating reserve revenue earned is insufficient to cover the offer costs or bid benefits of the MP.

The calculation engines will maximize the gains from trade over their entire look-ahead periods given market participant offers and bids, resource constraints and the reliability needs of the system. At times, however, the most efficient and reliable schedule for the system as a whole can result in some transactions being scheduled at an implied loss.

At a high level, the formula for calculating a DAM make-whole payment is:

$$DAM\_MWP = DAM\_COMP1 + DAM\_COMP2$$

Where:

- DAM Component 1 is the make-whole payment for energy. This is equal to negative one times the operating profit based on the day-ahead market quantity scheduled for injection less the operating profit based on the day-ahead market economic operating point.

$$= -1 \times [OP(DAM\_QSI) - OP(DAM\_EOP)]$$

- DAM Component 2 is the make-whole payment for operating reserve. This is equal to negative one times the operating profit based on the day-ahead market quantity of operating reserve scheduled for injection less the operating profit based on the day-ahead market operating reserve economic operating point.

$$= -1 \times [OP(DAM\_QSOR) - OP(DAM\_OR\_EOP)]$$

Example:

Assume an import is scheduled uneconomically above its economic operating point (EOP) for energy in DAM in HE3. It offered to import up to 100 MW if the price was $10 or greater, up to 200 MW if the price was $20 or greater, up to 300 MW if the price was $30 or greater, and up to 400 MW if the price was $40 or more. In the DAM, the intertie price was $20.

Based on this price, its economic operating point would be 200 MW since it offered to supply that if the price was at least $20. The DAM, however, scheduled it for 250 MW – which is 50 MW above its EOP.

PQ #	Price ($/MWh)	Quantity (MW)
1	10	0
2	10	100
3	20	200
4	30	300
5	40	400

DAM Price	$
DAM_LMP	$20

DAM Schedule and EOP	Quantity (MW)
DAM_QSI	250
DAM_EOP	200

Applying this information to the DAM Component 1 formula.

DAM_COMP1 = -1 x [OP(DAM_QSI) – OP(DAM_EOP)]		
	OP (DAM_QSI)	OP (DAM_EOP)
Revenue	250MW x $20 = $5,000	200MW x $20 = $4,000
Costs	(100MW x $10) + (100MW x $20) + (50MW x $30) = $4,500	(100MW X $10) + (100MW x $20) = $3,000
Net	$5,000 - $4,500 = $500	$4,000 - $3,000 = $1,000
DAM COMP1	-1 x ($500 - $1000) = $500	

The operating profit based on the DAM quantity scheduled for injection is revenue less costs. Revenue would be the 250 MW quantity scheduled for injection times the DAM intertie price of $20 for a total of $5,000.

Costs to deliver 250 MW would be $4,500. This is found by looking at the import offer laminations. As discussed, this import was offered as $10 for the first 100 MW and $20 for the next 100 MW. The final 50 MW of the 250 MW quantity scheduled for injection would come from the next offer lamination at $30.

Therefore, the net operating profit based on the DAM quantity scheduled for injection is $500.

9.3.2 Real-Time Market Make-Whole Payment

A real-time MWP may be payable for transaction quantities over and above that which were scheduled day-ahead – this includes transactions wholly scheduled after close of the DAM, or additional quantities scheduled in pre-dispatch above that which was scheduled for a transaction in the DAM.

The formula for the real-time make-whole payment will be the greater of zero or the energy lost cost plus the operating reserve lost cost plus the greater of zero or the energy load opportunity cost plus the operating reserve lost opportunity cost.

RT_MWP = Max (0, Energy Lost Cost + OR Lost Cost) + Max(0, Energy Lost Opportunity Cost + OR Lost Opportunity Cost)

Example:

In this example, an export was scheduled uneconomically. Based on its bid, and the pre-dispatch price of $25, its economic operating point was 200 MW. However, it was scheduled to 300 MW in pre-dispatch. In real-time, the LMP was $30. It was scheduled to 300 MW for real-time as well although its economic operating point was only 200 MW.

Energy Bids – Dispatch Data		
PQ #	Price ($/MWh)	Quantity (MW)
1	40	0
2	40	100
3	30	200
4	20	300
5	10	400

The price in both the last pre-dispatch before the start of the hour and real-time exceeded the export bid cost. Therefore, the export will be compensated for lost cost based on the lesser of the pre-dispatch or real-time LMP.

RT Energy Lost Cost Calculation		
	OP (Max (SQEW, DAM_QSW))	OP (Max (RT_LC_EOP, DAM_QSW))
Revenue	300MW x $25 = $7,500	200MW x $25 = $5,000
Costs	100MW x $40 + 100MW x $30 + 100MW x $20 = $9,000	100MW X $40 + 100MW x $30 = $7,000
Net	$7,500 - $9,000 = -$1,500	$5,000 - $7,000 = -$2,000
RT_ELC	Max (0, -$1,500 - -$2,000) = $500	

In this example, the export's real-time make-whole payment would be $500.

10. Energy Settlements

The physical market has a two-settlement system; day-ahead scheduled transactions will be settled using day-ahead LMPs, while deviations from day-ahead schedules in real-time (including those which were scheduled only in pre-dispatch) are settled using real-time LMPs.

Objectives

After completing this section users will be able to:

- Explain the two-settlement system used for intertie transactions
- Utilize the provided formula to calculate the overall intertie energy settlement amount, considering both day-ahead and real-time components
- Explain the purpose of various settlement amounts including: DAM BC, DAM MWP, RT MWP, Hourly Uplifts, Non-Hourly Uplifts, and External Congestion and NISL Residuals

The IESO uses a two-settlement system through which the DAM and RTM are each settled separately. For example, day-ahead scheduled export transactions will appear under CT 1112 while real-time export transactions will appear under CT 1113..

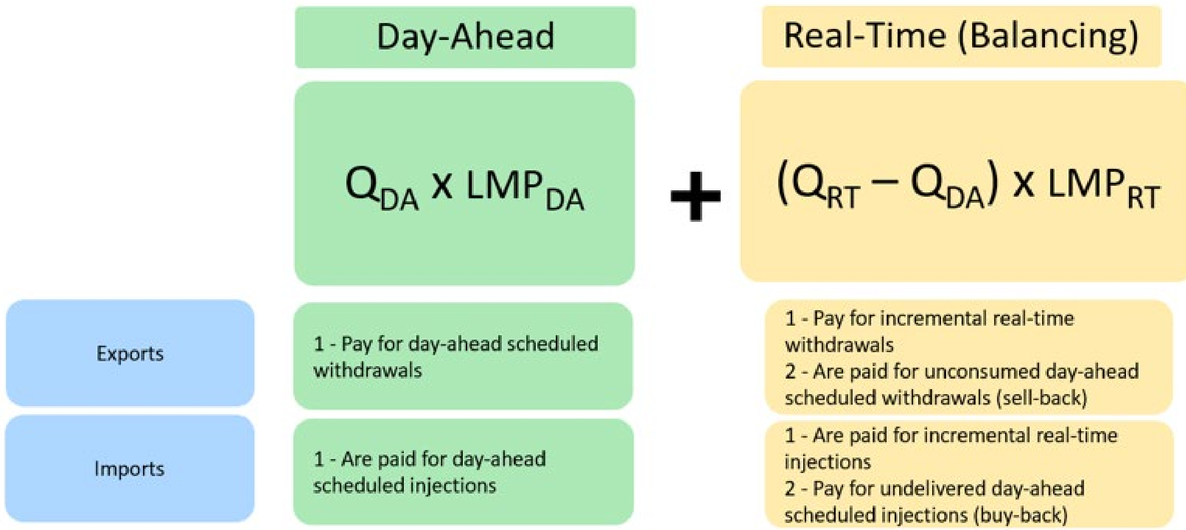
The DAM is settled on an hourly basis, so schedules and prices are for an entire hour. The general formula for DAM energy settlement is the day-ahead quantity times the day-ahead locational marginal price:

DAM Quantity Scheduled X DAM LMP

The RTM operates on a five-minute basis, so it’s prices and schedules are determined for each of the 12 five-minute periods in an hour. Intertie transaction schedules are the same for each interval, unless curtailed during the hour for reliability. The general formula for RTM energy settlement is the difference between the quantity injected/withdrawn in real-time less the quantity scheduled in day-ahead times the five-minute real-time locational marginal price:

(RTM Quantity Actually Injected/Withdrawn – DAM Quantity Scheduled) X RTM LMP

The combination of the two above formulas represents the overall effect of the two-settlement system. A simplified formula for overall intertie energy settlement (i.e., total of day-ahead and real-time) is:



10.1 Hourly Uplifts and Non-Hourly Uplifts

Similar to the current market, hourly uplifts[14] are collected or disbursed on a pro-rata basis to loads and exports that consume in real-time. Refer to Market Rules Chapter 9, section 3.9 for more information uplifts. Non-hourly uplifts are collected or disbursed on a pro-rata basis to loads and exports that consume in real-time.

[14] Refer to Market Rules Chapter 9, section 4 for more information

11. Day-Ahead Balancing Credit

The day-ahead balancing credit (DAM_BC) provides compensation to offset a negative buy-back incurred when the IESO curtails day-ahead scheduled imports or exports in real-time due to a reliability need.

Objectives

After completing this section users will be able to:

- Explain the role of the DAM Balancing Credit.
- Utilize the provided formula to calculate the overall intertie energy settlement amount, considering both day-ahead and real-time components.
- Explain the purpose of various settlement amounts including DAM_BC, DAM_MWP, RT_MWP, Hourly Uplifts, Non-Hourly Uplifts, and External Congestion and NISL Residuals.

An intertie trader may be eligible for compensation through a DAM_BC if:

- Their day-ahead scheduled transaction is reduced or cut by the IESO in order to maintain reliability, or
- Their transaction was activated for operating reserve.

The DAM_BC will not apply, however, if:

- The transaction was part of a linked wheel
- The transaction is an energy import, and
- The DAM LMP is equal to or higher than the real-time LMP; or
- The lesser of the real-time economic operating point or the DAM quantity scheduled for injection is less than the real-time scheduled quantity of energy injected
- The transaction is an energy export, and:
- The DAM LMP is equal to or less than the real-time LMP; or
- The lesser of the real-time economic operating point or the DAM quantity scheduled for injection is less than the real-time scheduled quantity of energy withdrawn
- It is an operating reserve transaction, and:
- The DAM OR price is equal to or greater than the real-time OR price; or
- The lesser of the real-time economic operating point or the DAM OR quantity scheduled is less than the real-time OR scheduled quantity

11.1 DAM Energy Balancing Credit Formulas

The DAM energy balancing credit for imports is calculated as the operating profit given the real-time LMP and the lesser of the DAM quantity scheduled for injection or the real-time lost opportunity cost economic operating point less the operating profit at the real-time scheduled quantity of energy for injection given the real-time LMP.

$$= MAX\,(0, OP\,(RT\_{LMP}, MIN(DAM\_{QSI}, RT\_LOC\_EOP), BE) - OP\,(RT\_{LMP}, SQEI, BE)$$

The DAM energy balancing credit for exports is calculated as negative one times the lesser of zero or the operating profit given the real-time LMP or the lesser of the DAM schedule or the real-time lost opportunity cost economic operating point or the energy bid less the operating profit at the real-time scheduled quantity of energy for withdrawal given the real-time LMP or the energy bid.

$$= (-1) \times MIN(0, OP\,(RT\_{LMP}, MIN(DAM\_{QSW}, RT\_LOC\_EOP), BL) - OP\,(RT\_{LMP}, SQEW, BE))$$

Example One – Import constrained down in real-time

Let’s go through an example of an import that has been constrained down. Assume an import was offered as follows:

- Up to 50 MWs if the price is $25 or greater,
- Up to 70 MWs if the price is $30 or greater, and
- Up to 100 MWs if the price is $50 or greater.

Further, assume there is a real-time LMP of $50 and a DAM LMP of $20. The DAM quantity scheduled for injection was 100 MWs but in real-time, only 30 MWs was scheduled.

Schedules, LMP, EOP		
Type	Quantity	Units
RT LMP	50	$
DAM LMP	20	$
DAM QSI	100	MW
SQEI	30	MW
RT LOC EOP	70	MW

The real-time lost opportunity cost economic operating point is 70 MW since the real-time price was $50 which would normally mean that this transaction would be scheduled to 70 MW.

This import is eligible for the DAM Balancing Credit because:

- The real-time LMP is higher than the DAM LMP, and
- The DAM quantity scheduled for injection is higher than the real-time scheduled quantity of energy injected

In this example, the day-ahead schedule was 100 MW, and the lost opportunity cost economic operating point was 70 MW. So, the revenue portion of the operating profit calculation in the first part of the equation would be equal to 70 MW times $50 or $3,500.

If 70 MWs had been scheduled, the cost given the offer laminations would be equal to $25 for the first 50 MWs plus $30 for the next 20 MW for a total of $1,850.

This would make the net operating profit for the first part of the equation (i.e., MAX (0, OP (RT_LMP, MIN(DAM_QSI, RT_LOC_EOP), BE)) equal to $3,500 minus $1,850 or $1,650.

The second part of the equation (i.e., – OP (RT_LMP, SQEI, BE)) is the operating profit given the real-time scheduled quantity for injection.

Given that 30 MWs flowed in real-time, revenue was 30 MWs times the real-time LMP of $50 which equals $1,500.

The cost for 30 MWs based on the submitted offer laminations is $25 per MW for a total of $750. Therefore, operating profit is $1,500 minus $750 or $750.

Therefore, the DAM Energy Balancing Credit in this example is $1,650 less $750 or $900. In this way, the market participant will receive in total the operating profit they should have based on the lesser of their day-ahead schedule or their real-time lost opportunity cost economic operating point.

Example Two - Export constrained down in real-time

For this next example, assume an export was bid as follows:

- Up to $10 to export 70 MWs,
- Up to $5 to export 100 MWs, and
- If the price is $2 or less, they are willing to export up to 120 MWs.

For our example, assume there is a real-time LMP of $6 and a DAM LMP of $15. The DAM quantity scheduled for withdrawal was 100 MWs but in real-time, only 30 MWs was scheduled.

The real-time lost opportunity cost economic operating point is 70 MWs since the real-time price was $6 which would normally mean that this transaction would be scheduled to 70 MWs.

Schedules, LMP, EOP		
Type	Quantity	Units
RT LMP	6	$
DAM LMP	15	$
DAM QSW	100	MW
SQEW	30	MW
RT LOC EOP	70	MW

This export is eligible for the DAM Balancing Credit because:

- The real-time LMP is lower than the DAM LMP, and
- The DAM quantity scheduled for withdrawal is higher than the real-time scheduled quantity of energy withdrawn.

As a reminder, the DAM energy balancing credit for exports is the operating profit given the real-time LMP and the lesser of the DAM schedule or the real-time lost opportunity cost economic operating point less the operating profit at the scheduled quantity of energy for withdrawal given the real-time LMP or the export bid.

OP (RT_LMP, MIN (DAM_QSW, RT_LOC_EOP), BL) – OP (RT_LMP, SQEW, BE)

The cost portion of the operating profit calculation in the first part of the equation (i.e., OP (RT_LMP, MIN (DAM_QSW, RT_LOC_EOP), BL)) would be 70 MWs times $6 which equals $420.

With 70 MWs scheduled, the cost given the bid laminations would be 70 MWs times $10 which equals $700.

As such, the net operating profit for the first part of the equation is $420 minus $700 which equals negative $380.

The second part of the equation (i.e., OP (RT_LMP, SQEW, BE)) is the operating profit given the 30 MW real-time scheduled quantity of energy withdrawn.

Given a $6 real-time LMP, the cost to export 30 MWs was $180.

The market participant bid $10 to export up to 30 MWs, so their bid cost was $300. This would make their resulting operating profit negative $120.

Therefore, the DAM Energy Balancing Credit for this export is equal to negative one times the lesser of zero or negative $380 less negative $120, or $260.

12. Market Power Mitigation

Intertie traders are subject to the IESO's Market Power Mitigation (MPM) framework as it relates to potential economic withholding on uncompetitive intertie zones. Uncompetitive intertie zones are determined by the IESO in accordance with Market Manual 14.1, section 3 and will be published on the IESO website.

Mitigation will be evaluated ex-post[20] for intertie transactions. This process uses conduct and impact tests to identify instances of economic withholding of energy and operating reserve on uncompetitive interties. The conduct test will determine if offers for energy bids for energy, or offers for operating reserve were submitted at prices significantly higher than intertie reference levels.

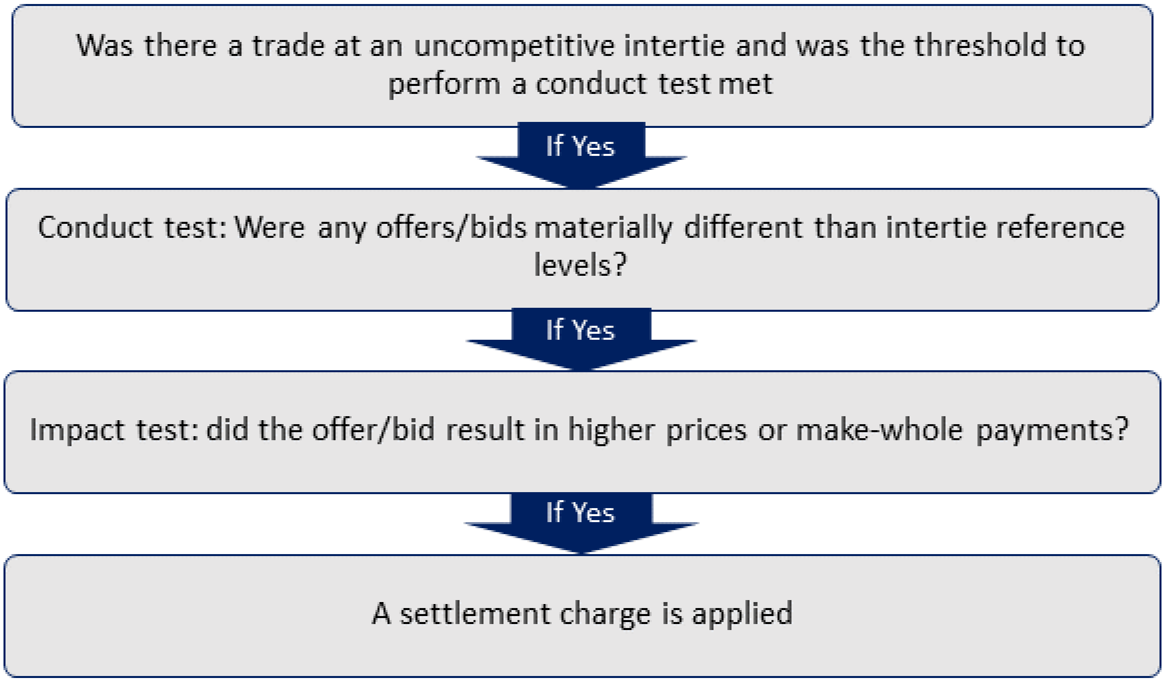
Export bids are not assessed for intertie economic withholding unless they meet the conditions related to market control entities found in Market Rules Chapter 7, section 22.17.11.1. Under this market rule, export bids are only assessed for intertie economic withholding if the relevant energy trader has disclosed a market control entity that has also been designated as a market control entity for physical withholding for a dispatchable resource that is authorized to supply energy or operating reserve in the Ontario physical market. The impact test will determine if prices or make-whole payments were greater by a specified threshold than those that would have occurred if the intertie reference levels were submitted. If both the conduct and impact tests are failed, it would result in a settlement charge to the market participant. An illustration of this process is provided below. The process for assessing uncompetitive intertie zones is conducted by the IESO in accordance with the process detailed in Market Manual 14.1, section 6 and Market Rules Chapter 7, section 22.17-22.19.

The IESO may assess intertie economic withholding by a boundary entity resource in either or both of the day-ahead market and the real-time market for a given dispatch day. If the IESO selects a single market, the IESO will deem the megawatt hours withheld in the other market to be zero for all relevant dispatch hours when calculating the intertie economic withholding settlement amount.

Participants whose transactions were mitigated will be confidentially notified and provided an opportunity to provide supplementary information prior to issuance of a settlement charge.

At a high level, the process for assessing economic withholding at an intertie involves asking a few questions. The answer must be yes to all of them for a settlement charge to be applied.

[20] For more information regarding how ex-post mitigation is applied for intertie traders, refer to Market Manual 14.1, section 6.



For intertie traders, intertie reference levels are established based on the previous 90 days of intertie trading activity. For detailed information regarding the IESO's process for determining intertie reference levels, refer to Market Rule Chapter 7, section 22.16.

If the IESO determines that an energy bid or offer or offer for operating reserve failed an impact test, the IESO will issue a first notice of economic withholding to the relevant market participant within 180 days of when the instance occurred.

Within 45 days after the date of the notice, the market participant can submit a request that the IESO determine an alternative intertie reference level value for the relevant boundary entity resource during the dispatch day in which the offer or bid was submitted. The request must include documentation to support any resource-specific considerations that were not accounted for when the intertie reference levels were determined which were used when the instance of intertie economic withholding was determined.

Within 90 days after the receipt of a reconsideration request or, if none is submitted, after the 45 days elapses, the IESO will complete its analysis and notify the registered market participant whether a settlement charge will be imposed. If this is the case, it will appear on the settlement statements for the next available month end.

13. Reports

The IESO produces a number of reports relevant to intertie traders. Several are described below.

13.1 Pre-DAM Reports

Report Name	Public or Private	Description
Adequacy Report	Public	Overall system conditions including any expected surplus/shortfalls, published at various times throughout the day-ahead and pre-dispatch timeframes including daily at 5:30 and 9:00 EPT
Day-Ahead Area Reserve Constraints Report (Pre-DAM)	Public	Hourly maximum and minimum constraints for the area operating reserve regions expected to be used by the DAM engine, published daily at approximately 9:00 EPT
Day-Ahead Intertie Scheduling Limits Report (Pre-DAM)	Public	Expected intertie scheduling limits to be used by the DAM engine, published daily at approximately 09:00 EPT

13.2 DAM Reports

Report Name	Public or Private	Description
Day-Ahead Area Reserve Constraints Report	Public	Hourly maximum and minimum constraints for the area operating reserve regions used by the DAM engine, published at approximately 13:30 EPT
Day-Ahead Intertie Scheduling Limits Report	Public	Actual intertie scheduling limits used by the DAM engine, published after DAM completion
Day-Ahead Hourly Intertie Energy Price Report	Public	Intertie LMPs for energy, including LMP components for all intertie locations, published after DAM completion
Day-Ahead Hourly Intertie Operating Reserve Price Report	Public	Intertie LMPs for operating reserve, including LMP components for all intertie locations, published after DAM completion

Day-Ahead Schedule Report	Private	Hourly DAM energy and operating reserve intertie schedules, issued after DAM completion
Dispatch Data Report for the Day-Ahead Scheduling Process	Private	Daily confirmation of an MP's daily and hourly dispatch data submitted into the DAM, issued after DAM completion

13.3 Pre-dispatch Reports

Report Name	New or Existing	Public or Private	Description
Pre-dispatch Intertie Scheduling Limits Report	Existing	Public	Actual intertie scheduling limits used by the PD engine, published after PD completion around 30 minutes past the hour
Pre-Dispatch Hourly Intertie Energy Price Report	New	Public	Intertie LMPs for energy for all hours of the PD look-ahead period, including LMP components for all intertie locations, published after PD completion around 30 minutes past the hour
Pre-Dispatch Hourly Intertie Operating Reserve Price Report	New	Public	Intertie LMPs for operating reserve for all hours of the PD look-ahead period, including LMP components for all intertie locations, published after PD completion around 30 minutes past the hour
Pre-Dispatch Schedules Report	Existing	Private	Hourly energy and operating reserve intertie schedules for all hours of the PD look-ahead period, issued after PD completion around 30 minutes past the hour
Pre-dispatch Intertie Transactions Report and GOG Eligible Extensions Reports	New	Private	For intertie traders, schedules for energy and operating reserve for the first two hours of the PD look-ahead period only, issued 15 minutes past the hour

13.4 Real-Time Reports

Report Name	New or Existing	Public or Private	Description
Real-Time Intertie Scheduling Limits Report	Existing	Public	Actual intertie scheduling limits for each five-minute interval used by the RTM engine, published after every interval

Intertie Schedule and Flow Report	Existing	Public	Total quantities of energy included in interchange schedules and quantities of energy that have been conveyed to and from each intertie zones for each five-minute interval using hourly averages, published every hour
Real-Time 5-Minute Intertie Energy Price Report	New	Public	Intertie LMPs for energy for each five-minute interval, including LMP components for all intertie locations, published after every interval
Real-Time 5-Minute Intertie Operating Reserve Price Report	New	Public	Intertie LMPs for operating reserve for each five-minute interval, including LMP components for all intertie locations, published after every interval

14. Skill Check Two

1. Intertie traders are subject to the IESO's Market Power Mitigation (MPM) framework as it relates to potential economic withholding on uncompetitive intertie zones. (Select True or False)
   a) True
   b) False

2. Which of the following tests are used by the IESO to identify instances of economic withholding of energy and operating reserve on uncompetitive interties? (Select the correct answer)
   a) Conduct test and impact test
   b) Efficiency test and reliability test
   c) Supply test and demand test
   d) Price test and quantity test

3. Which of the following statements about congestion rents is correct? (Select the correct answer)
   a) Congestion rents result from price differentials created by non-binding transmission constraints.
   b) Congestion rents occur when lower priced supply on one side of a constraint cannot fully serve demand on the other side, leading to higher priced supply serving the remaining demand.
   c) Congestion rents are unrelated to transmission constraints and are solely based on supply and demand.
   d) Congestion rents are collected only in the day-ahead market.

4. Imports are paid the price in the intertie zone while exports pay the price in the zone through which they are exporting. (Select True or False)
   a) True
   b) False

5. Which components make up the Intertie Locational Marginal Price (LMP)? (Select the correct answer)
    a) Reference Bus Component, Loss Component, and Internal Congestion Component
    b) Intertie Border Price (IBP) and Intertie Congestion Price (ICP)
    c) External Congestion Component and Net Interchange Scheduling Limit (NISL) Congestion Component
    d) All of the above

6. What is the Net Interchange Scheduling Limit (NISL) and why is it important? (Select the correct answer)
    a) NISL is the maximum allowable flow limit for intertie transactions; it ensures Ontario resources can satisfy hour-to-hour ramping needs without adversely impacting reliability.
    b) NISL is the price paid for intertie transactions; it determines the cost of imports and exports.
    c) NISL is the total amount of energy scheduled for import and export; it balances the supply and demand in the Ontario market.
    d) NISL is the limit on the number of transactions that can be scheduled; it prevents market congestion.

7. The DAM Energy Balancing Credit for exports is calculated based on the operating profit given the real-time LMP and the lesser of the DAM schedule or the real-time lost opportunity cost economic operating point, less the operating profit at the scheduled quantity of energy for withdrawal given the real-time LMP or the export bid. (Select True or False)
    a) True
    b) False

14.1 Skill Check Two Answers

1. Intertie traders are subject to the IESO’s Market Power Mitigation (MPM) framework as it relates to potential economic withholding on uncompetitive intertie zones. (Select True or False)

    a) True

    b) False

2. Which of the following tests are used by the IESO to identify instances of economic withholding of energy and operating reserve on uncompetitive interties?

    a) Conduct test and impact test

    b) Efficiency test and reliability test

    c) Supply test and demand test

    d) Price test and quantity test

3. Which of the following statements about congestion rents is correct?

    a) Congestion rents result from price differentials created by non-binding transmission constraints.

    b) Congestion rents occur when lower priced supply on one side of a constraint cannot fully serve demand on the other side, leading to higher priced supply serving the remaining demand.

    c) Congestion rents are unrelated to transmission constraints and are solely based on supply and demand.

    d) Congestion rents are collected only in the day-ahead market.

4. Imports are paid the price in the intertie zone while exports pay the price in the zone through which they are exporting.

    a) True

    b) False

5. Which components make up the Intertie Locational Marginal Price (LMP)?

    a) Reference Bus Component, Loss Component, and Internal Congestion Component

    b) Intertie Border Price (IBP) and Intertie Congestion Price (ICP)

    c) External Congestion Component and Net Interchange Scheduling Limit (NISL) Congestion Component

    d) All of the above

6. What is the Net Interchange Scheduling Limit (NISL) and why is it important?

    a) NISL is the maximum allowable flow limit for intertie transactions; it ensures Ontario resources can satisfy hour-to-hour ramping needs without adversely impacting reliability.

    b) NISL is the price paid for intertie transactions; it determines the cost of imports and exports.

    c) NISL is the total amount of energy scheduled for import and export; it balances the supply and demand in the Ontario market.

    d) NISL is the limit on the number of transactions that can be scheduled; it prevents market congestion.

7. The DAM Energy Balancing Credit for exports is calculated based on the operating profit given the real-time LMP and the lesser of the DAM schedule or the real-time lost opportunity cost economic operating point, less the operating profit at the scheduled quantity of energy for withdrawal given the real-time LMP or the export bid.

    a) True

    b) False

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