JANUARY 24, 2023

Market Renewal Energy Project Implementation | Technical Panel

Settlements Q&A Session #1

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Meeting Agenda

Agenda:

- Overview of the proposed market rules and market manuals for Settlements and Billing
- Focus on examples in areas where we think the Technical Panel would have questions:

  NEW Hourly and Non-Hourly Settlement amounts

Engagement Timeline

December 1: Materials posted for stakeholder review

December 14: Introduction and discussion with participants

Throughout December and January: Stakeholders can request additional examples or scenarios through engagement@ieso.ca

Mid-January: Segmented discussions with stakeholders to review examples/scenarios

February 21: Comments/feedback on market rules and market manuals due to IESO

Market Settlements Batch

Impacted Market Rules and Manuals

Market Rules	
Market rule provisions that describe financial obligation arising from the IESO-administered market, including new defined terms	Chapter 9, Settlements and Billing Chapter 9, Appendix 9.1 VEE Process Chapter 9, Appendix 9.2 Data Inputs and Variables (New) Chapter 9, Appendix 9.3 Pseudo-Unit Translations (New) Chapter 9, Appendix 9.4 Settlement Mitigation (New)

Market Manuals	
Market procedures and standards that describe the settlement process of the IESO-administered market	Market Manual 5.3 Physical Bilateral Contract Data Market Manual 5.5 IESO-Administered Markets Settlement Amounts (Renamed) Market Manual 5.6 Non-Market Settlement Programs (New) Market Manual 5.7 Settlement Process Market Manual 5.8 Settlement Invoicing Market Manual 5.10 Settlement Disagreements IESO Charge Types and Equations

Market Manual Timelines

December 1

- MM 5.5 IESO-Administered Markets Settlement Amounts
- MM 5.3 Physical Bilateral Contract Data

RSS Release

- MM 5.7 Settlement Process
- MM 5.8 Settlement Invoicing
- MM 5.10 Settlement Disagreements

Future Batch(TBD)

- MM 5.6 Non-Market Settlement Programs
- IESO Charge Types and Equations

Overview

- Hourly Settlement Amounts:
  - Two-Settlement (including NDLs)
  - DAM Balancing Credit
  - Day-Ahead and Real-Time Make-whole payments
- Non-Hourly Settlement Amounts
  - Day-Ahead and Real-Time Generator Offer Guarantee
  - Generator Failure Charges
  - Congestion and Loss Residuals
  - DAM Reliability Scheduling Uplift

Market Settlements Batch:
Hourly Settlement Amounts

Overview: Two-Settlement

- Two-Settlement is the settlement of the day-ahead market (DAM) and real-time market (RTM) for energy and operating reserve
- Settlement applies to:
  - dispatchable resources including new virtual transactions and price responsive load (PRL); and
  - non-dispatchable resources (modified two-settlement)

DAM Settlement and Real-Time Balancing Settlement

DAM Settlement

- Paid or charged the DAM scheduled quantity for energy and operating reserve at the applicable DAM locational marginal price (LMP) on an hourly basis

Real-Time Balancing Settlement

- 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 DAM scheduled quantity at the 5-min interval basis

Two-Settlement Mechanics – Dispatchable Resource

	Day-Ahead		Real-Time (Balancing)
	$Q_{DA} \times LMP_{DA}$	+	$(Q_{RT} - Q_{DA}) \times LMP_{RT}$
Loads and exports	1 - Pay for day-ahead scheduled withdrawals		1 - Pay for incremental real-time withdrawals 2 - Are paid for unconsumed day-ahead scheduled withdrawals (sell-back)
Generators and imports	1 - Are paid for day-ahead scheduled injections		1 - Are paid for incremental real-time injections 2 - Pay for undelivered day-ahead scheduled injections (buy-back)

Virtual Transactions

- Submit bids and offers just like physical resources to purchase or sell energy in DAM
- Are different from physical resources in that they do not require physical delivery or consumption in real-time
- Cannot participate in the operating reserve market
- Are settled based on DAM schedule and differences between DAM and RT price

Price Responsive Loads

Price responsive load (PRL) is a new load resource type that:

- can submit bids in DAM
- are not dispatchable in real time
- are scheduled only for energy
- are settled at the locational marginal price in both DAM and RT

Physical HDR associated with PRL

- Physical HDR that are registered as PRLs will receive separate energy schedules for HDR and associated PRL under different delivery points
- Physical HDR and associated PRL resource consumption will be measured under the same metering point, and thus are settled together under the delivery point for the associated PRL

Hourly Settlement Amounts: Non-Dispatchable Resources

Non-Dispatchable Loads

- The IESO forecasts demand quantities for non-dispatchable loads (NDLs) and calculates the DAM Ontario Zonal Price
- NDLs will only be exposed to settlement when they consume energy in real time
- NDLs will be settled based on the DAM Ontario Zonal Price plus load forecast deviation charge at the real-time energy consumption
- NDL settlement excludes PRLs

Load Forecast Deviation Charge

- Total value of the IESO's forecast deviation for all NDLs in dollars per MWh for a given settlement hour
- A function of the total sum of forecast deviations at every NDL location and the sum of DAM to RTM price differences at each NDL location, calculated as two components:
  - Real-Time Purchase Cost/Benefit
  - DAM Volume Factor Cost/Benefit

Forecast Deviation Components

Component	Description
Real-time Purchase Cost/Benefit	• represents the total hourly $ cost or benefit, arising from DAM load forecast deviations in the real-time market • calculated as the difference between the actual energy consumed by non-dispatchable loads in real time and the DAM load forecast, multiplied by the real-time market LMP $= LMP_{RT} \times (Q_{RT} - Q_{DAM\ Forecast})$
DAM Volume Factor Cost/Benefit	• represents the total hourly cost or benefit to all non-dispatchable loads, arising from DAM load forecast deviations in the DAM • calculated as the difference between the DAM load forecast and the actual energy consumed by non-dispatchable loads, multiplied by the Ontario zonal price $= OZP_{DAM} \times (Q_{DAM\ Forecast} - Q_{RT})$

Load Forecast Deviation Charge

- The sum of two components is allocated over the total real-time energy withdrawn by all NDLs, resulting in the load forecast deviation charge (LFDC), expressed in $/MWh
- The load forecast deviation charge can be a positive or negative value

$$\text{LFDC} = \frac{\text{(Real-Time Purchase Cost/Benefit) + (DAM Volume Factor Cost/Benefit)}}{\text{real-time energy withdrawn by all NDLs}}$$

Settlement - Non-Dispatchable Loads

$$Q_{RT} \times (OZP_{DAM} + LFDC)$$

- Q_{RT} = real-time market actual consumption
- OZP_{DAM} = day-head Ontario zonal price
- LFDC = load forecast deviation charge

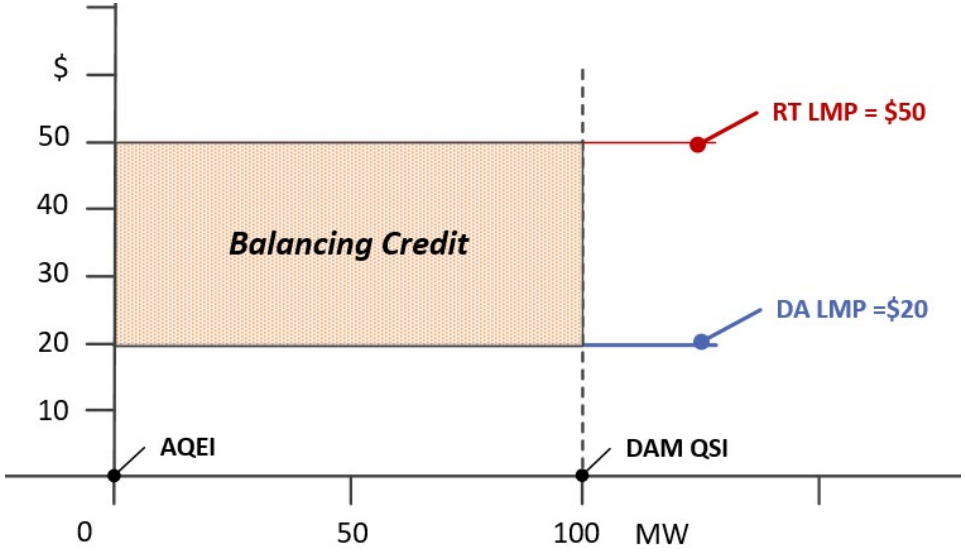
Hourly Settlement Amounts:
Day-Ahead Balancing Credit

Background: DAM Balancing Credit (DAM_BC)

- Offsets any negative buyback incurred as a result of following IESO dispatch instruction in RT to meet a reliability need.
- Applied in RT when the IESO curtails imports and exports, or de-commits GOG-eligible resources after it receives a DAM schedule
- A resource will not be eligible for DAM Balancing Credit payment if:
  - it does not follow dispatch instructions
  - it was dispatched on request from market participant, to prevent endangering the safety of any person, or equipment damage, or violation of any applicable law
  - it received a RT MWP for the same interval

DAM Balancing Credit – Scenario 1

Scenario 1: GOG-eligible resource is de-committed in RT after it received a DAM schedule



BCE (DAM Balancing Credit Energy component)

= (RT LMP – DAM LMP) x (DAM QSI – AQEI)

=($50 - $20) x (100 MW – 0)

= $30 x 100 MW

= $3000

DAM_BC of $3000 would be paid to the GOG-eligible resource to cover buyback cost incurred as a result of being de-committed by IESO

DAM Balancing Credit – Imports and Exports

- DAM Balancing Credit for imports and exports will be adjusted if the resource increases its offer or decrease its bid in real-time relative to DAM LMP
- DAM Balancing Credit excludes any negative buy-back incurred for the portion of DAM schedule that would not have been scheduled in RT due to the increase in offer or decrease in bid
- This rules applies to both energy and operating reserve

Hourly Settlement Amounts:
Day-Ahead and Real-Time Market Make-Whole Payment

Overview: DAM Make-Whole Payment (DAM_MWP)

- Provides compensation for any shortfall in payment incurred by a resource that was scheduled above its economic operating point in DAM for energy and operating reserve
- Compensation is limited to lost cost only
- Consistent with the principles in the current market to minimize uplift costs to Ontario consumers; negative offers and bids will be adjusted when calculating DAM MWP as follows:
    - Offers will be limited to lesser of $0 and DAM LMP
    - Bids will be limited to lesser of replacement bid price and DAM LMP (replacement price is $15/MWh for dispatchable loads and -$125/MWh for exports)

DAM MWP – Eligibility Rules

- All dispatchable resources, PRLs and self-scheduling electricity storage resources that are injecting energy are eligible for DAM MWP
- A resource will not be eligible for DAM MWP in any hour that is:
  - part of a ramp-up period for non-quick start (NQS) resources
  - called capacity
  - binding combined cycle physical unit constraint
  - linked wheeling through transaction
  - for the portion of energy bid at $2000 indicating it is non-dispatchable

DAM MWP for Hydroelectric Generation Resources

- A hydroelectric generation resource will not be eligible for the energy component of DAM MWP if:
  - it is scheduled across the trade day at Minimum Daily Energy Limit (MinDEL); or
  - the sum of the energy schedule for the trade day across all generation resources that share a forebay equals MinDEL; or
  - it has a minimum hourly output or hourly must run constraint
- DAM MWP will be adjusted for the forbidden region to avoid over-compensation

Overview: Real-Time Make-Whole Payment (RT_MWP)

- Provides compensation when a resource deviates from its EOP in response to dispatch instruction or when the resource is scheduled uneconomically due to differences between scheduling and pricing pass
- Resources that are eligible for RT_MWP may be able to recover lost cost and lost opportunity cost for energy and operating reserve
- RT_MWP is calculated as:

$$RT\_MWP = \underbrace{Max\ (0,\ ELC + OLC)}_{\text{Lost cost}} + \underbrace{Max(0,\ ELOC + OLOC)}_{\text{Lost opportunity cost}}$$

Real-Time Make-Whole Payments

- Consistent with the principle in the current market to minimize uplift costs to Ontario consumers, negative offers and bids will be adjusted when calculating RT_MWP as follows:
    - offers will be limited to lesser of $0 and RT LMP
    - bids will be limited to lesser of replacement bid price and RT LMP (where bid is less than replacement price -$15/MWh for dispatchable loads and -$125/MWh for exports)
- RT MWP lost cost and lost opportunity cost will also be adjusted when a hydroelectric generation resource is scheduled within its forbidden region

Real-Time Make-Whole Payments – Eligibility Rules

The following eligibility rules applies to dispatchable loads and are consistent with the current market rules:

- Portion of energy bid at $2000 are ineligible for lost cost and lost opportunity cost for energy (s 3.5.4.1a)
- Lost opportunity cost and lost cost for energy will not be paid when energy bid for an hour is not the same as the preceding or next hour and such change results in ramping of the resource (s 3.5.4.4)
- Lost opportunity cost will not be paid when the dispatchable load deviates from dispatch or is unable to follow its dispatch instructions (s 3.5.4.7) unless the resource was:
  - activated for operating reserve; or
  - dispatched by the IESO to maintain reliability

Real-Time Make-Whole Payments – Eligibility Rules

- A hydroelectric generation resource will not be eligible for the energy component of RT_MWP if:
  - it is scheduled across the trade day at MinDEL; or
  - the sum of the energy schedule for the trade day across all generation resources that share a forebay equals MinDEL
- Imports are eligible for RT MWP lost cost for operating reserves only while exports can recover lost cost for energy and operating reserves
- Variable generation are ineligible for RT MWP when under release notification
- Resources with binding combined cycle physical unit constraint are ineligible for RT MWP

DAM_MWP – Scenario 1

Scenario 1: Generator is scheduled uneconomically above its economic operating point (EOP) in DAM for both energy and operating reserve in HE3

DAM Energy & OR Offers (DAM_BE & DAM_BOR)		
PQ #	Price ($/MWh)	Quantity (MW)
1	10	0
2	10	100
3	20	200
4	30	300
5	40	400

DAM Schedules	Quantity (MW)
Energy	
DAM_QSI	250
DAM_EOP	200
Operating reserve	
DAM QSOR (10S)	200
DAM_OR_EOP	100

DAM Prices	$
DAM_LMP	$20
DAM_PROR	$11

DAM_MWP = DAM_COMP1 + DAM_COMP2

DAM_MWP – Scenario 1

Energy (DAM_COMP1)

DAM_COMP1 = -1 x [OP(DAM_QSI) – OP(DAM_EOP)]		
	OP (DAM_QSI)	**OP (DAM_EOP)**
Revenue	250MW x $20 = $5000	200MW x $20 = $4000
Costs	(100MW x $10) + (100MW x $20) + (50MW x $30) = $4500	(100MW X $10) + (100MW x $20) = $3000
Net	$5000 - $4500 = $500	$4000 - $3000 = $1000
DAM COMP1	-1 x ($500 - $1000) = $500	

Operating Reserve (DAM_COMP2)

DAM_COMP2 = -1 x [OP(DAM_QSOR) – OP(DAM_OR_EOP)]		
	OP (DAM_QSOR)	**OP (DAM_OR_EOP)**
Revenue	200MW x $11 = $2200	100MW x $11 = $1100
Costs	(100MW x $10) + (100MW x $20) = $3000	100MW x $10 = $1000
Net	$2200 - $3000 = -$800	$1100 - $1000 = $100
DAM COMP2	-1 x (-$800 - $100) = $900	

DAM_MWP – Scenario 1

DAM_MWP =	Max (0, DAM_COMP1 + DAM_COMP2)
DAM_MWP =	Max (0, 500 + 900) = $1400

DAM_MWP is a positive amount, therefore the following amounts will appear on the generator settlement statement:

Settlement amounts on Settlement Statement		
1800	Day-Ahead Market Make-Whole Payment - Energy	$500
1801	Day-Ahead Market Make-Whole Payment - 10-Minute Spinning Reserve	$900

Non-Hourly Settlement Amounts:
Day-Ahead and Real-Time Generator Offer Guarantee

Overview: Day-Ahead Market and Real-Time Generator Offer Guarantee

- Provide compensation to GOG-eligible resources for any loss they incur relative to costs implied by their offers for the period in which their resource is committed by the day-ahead market calculation engine or pre-dispatch calculation engine
- DAM GOG will be calculated over the DAM commitment period and RT GOG is calculated over RT commitment period or a RT reliability commitment period for a single dispatch day
- The commitment period will consist of three possible variants each of which determines the components that will be included in the calculation

Day-Ahead Market and Real-Time Generator Offer Guarantee - Eligibility

Day-Ahead Generator Offer Guarantee

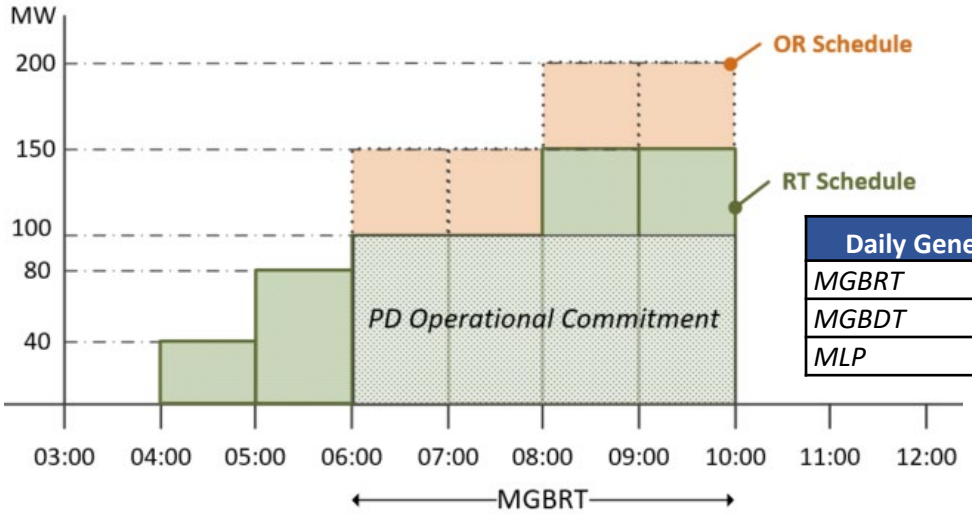
- A resource is not eligible for DAM GOG if the resource is scheduled at the beginning of the dispatch day to ramp down and desynchronize from the grid

Real-Time Generator Offer Guarantee

- A resource will not be eligible for RT GOG if:
  - it received a binding combined cycle physical unit constraint; or
  - it was dispatched, on request from the market participant, to prevent endangering the safety of any person, equipment damage, or violation of any applicable law

RT_GOG – Scenario 1

- Resource is committed by the pre-dispatch engine with an operational commitment from HE7 to HE10
- It is scheduled in real time for both energy and operating reserve
- No commitments or schedules in the preceding or succeeding hours



Daily Generation Data	
MGBRT	4 hrs
MGBDT	2 hrs
MLP	100 MW

RT Price and Schedule		
HE	RT_LMP ($)	RT_QSI (MW)
5	40	40
6	40	80
7	40	100
8	40	100
9	40	150
10	40	150

RT OR 10S Price and Schedule		
HE	*RT_PROR*	*RT_QSOR*
5		
6		
7	2	50
8	2	50
9	2	50
10	2	50

RT_GOG – Scenario 1

- The energy and OR offers are the same for all of the scheduled hours

RT Energy Offers (BE)		
PQ #	Price ($/MWh)	Quantity (MW)
1	35	0
2	35	100
3	40	200
4	50	300

RT OR 10S Offer(BOR)		
PQ #	Price ($/MWh)	Quantity (MW)
1	1.5	0
2	1.5	50
3	3	100

Start-Up Offer $ (PD_BE_SU)
10,000

SNL Offer $ (PD_BE_SNL)
800

- Resource injects in real time and achieves MLP at the first interval of the pre-dispatch operational commitment

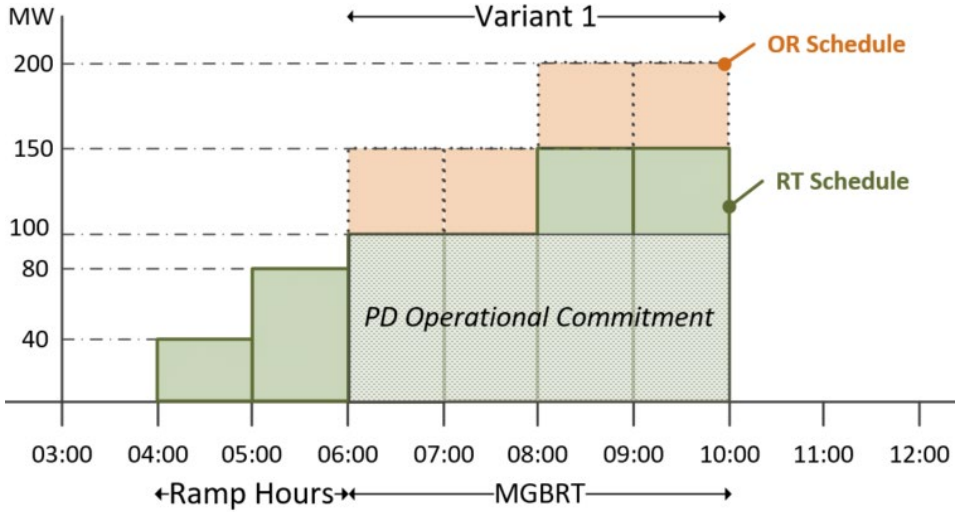
RT Hourly Schedule and Injection		
HE	RT_QSI (MW)	AQEI (MW)
5	40	40
6	80	80
7	100	100
8	100	100
9	150	150
10	150	150

**Assumption: resource is injecting at the real-time scheduled position*

RT_GOG Calculation – Scenario 1

Step 1: Determine the commitment period, variant number and ramp hours for GOG calculation

HE	Period Definition	Variant #
5	Ramp-up period	
6	Ramp-up period	
7	Real-time commitment period	1
8	Real-time commitment period	1
9	Real-time commitment period	1
10	Real-time commitment period	1



DAM_GOG for Variant 1 = Max(0, COMP1 + COMP2 + COMP4 - COMP5)

RT_GOG Calculation – Scenario 1

Step 2: Calculation of RT_GOG Component 1

RT_GOG_COMP1 = - OP(RT Energy) + SNL Cost – Ramp Revenue

- 1 x OP(RT Energy)		
HE	**-1 x Max(OP(RT_LMP,RT_QSI,BE), OP(RT_LMP,AQEI,BE))*** **	**Result**
5		
6		
7	-1 x (40$/MWh x 100MW - 35$/MWh x 100MW) =	**-500**
8	-1 x (40$/MWh x 100MW - 35$/MWh x 100MW) =	**-500**
9	-1 x (40$/MWh x 150MW - 40$/MWh x 50MW - 35$/MWh x 100MW) =	**-500**
10	-1 x (40$/MWh x 150MW - 40$/MWh x 50MW - 35$/MWh x 100MW) =	**-500**

****As RT_QSI=AQEI, the operating profit calculation is the same for the two quantities****

- *The operating profit for energy will be calculated for each hour of the commitment period from HE7 to HE10, excluding the ramp hours*

RT_GOG Calculation – Scenario 1

Step 2: Calculation of RT_GOG Component 1

RT_GOG_COMP1 = - OP(RT Energy) + SNL Cost – Ramp Revenue

SNL Cost			
HE	***N - # of Inj Int***	***PD_BE_SNL x N/12***	**Result**
5			
6			
7	12	800 x 12/12 =	**800**
8	12	800 x 12/12 =	**800**
9	12	800 x 12/12 =	**800**
10	12	800 x 12/12 =	**800**

- *The speed-no-load will be calculated for each hour of the commitment period starting from HE7 to HE10*
- *N is the number of metering intervals in settlement hour that the resource was synchronized and injecting energy into the grid*
- *As resource is injecting for all four hours of the commitment period,* ***N=12*** *for all four hours*

RT_GOG Calculation – Scenario 1

Step 2: Calculation of RT_GOG Component 1

RT_GOG_COMP1 = - OP(RT Energy) + SNL Cost – Ramp Revenue

COMP1 = - OP(RT Energy) + SNL Cost – Ramp Revenue				
HE	*-OP (RT Energy)*	*SNL Cost*	-Ramp Revenue	COMP1
5			-1,600	**-1,600**
6			-3,200	**-3,200**
7	-500	800		**300**
8	-500	800		**300**
9	-500	800		**300**
10	-500	800		**300**

- Ramp Revenue		
HE	- RT_LMP x AQEI	Result
5	- 40$ x 40 MW =	**-1,600**
6	- 40$ x 80 MW =	**-3,200**
7		
8		
9		
10		

RT_GOG Calculation – Scenario 1

Step 3: Calculation of RT_GOG Component 2

RT_GOG_COMP2 = -1 x OP(RT OR)

COMP2 = -1 x OP(RT_QSOR)		
HE	**-1 x OP(RT_PROR,RT_QSOR,BOR)**	**COMP2**
5		
6		
7	-1 x (2$/MWh x 50MW - 1.5$/MWh x 50MW) =	**-25**
8	-1 x (2$/MWh x 50MW - 1.5$/MWh x 50MW) =	**-25**
9	-1 x (2$/MWh x 50MW - 1.5$/MWh x 50MW) =	**-25**
10	-1 x (2$/MWh x 50MW - 1.5$/MWh x 50MW) =	**-25**

RT_GOG Calculation – Scenario 1

Step 4: Calculation of RT_GOG Component 4

COMP4 = PD_BE_SU		
HE	***PD_BE_SU***	**COMP4**
5		
6		
7	10,000	**10,000**
8		
9		
10		

- *The start-up offer associated with the **first hour (HE7)** of the commitment period is considered in the GOG calculation*
- *As the resource achieves MLP on time at the first interval of the commitment period, the **full** start-up offer is included in the calculation*

RT_GOG Calculation – Scenario 1

Step 5: Calculation of RT_GOG

RT_GOG = Max(0, COMP1 + COMP2 + COMP4 - COMP5)					
HE	**COMP1**	**COMP2**	**COMP4**	**- COMP5**	**Total**
5	-1,600				**-1,600**
6	-3,200				**-3,200**
7	300	-25	10,000		**10,275**
8	300	-25			**275**
9	300	-25			**275**
10	300	-25			**275**
Total	**-3,600**	**-100**	**10,000**	**0**	**6,300**
RT_GOG = Max(0,6300) = $6,300					

- *Resource is scheduled economically in all hours of the commitment period, therefore no DAM_MWP is generated:* ***COMP5 = 0***

RT GOG is a positive value, therefore the market participant will receive a payment of $6300

Non-Hourly Settlement Amounts:
Generator Failure Charge

Overview: Generator Failure Charge (GFC)

- The calculation of the GFC will occur when a GOG-eligible resource fails to deliver energy as committed by the PD calculation engine
- The failure charge is intended to reduce the risk of system reliability events due to failed commitments and to improve efficiency
- GFC will be broken into two components:
  i. Market Price Component – assesses the impact of the generator failure on the market price
  ii. Generator Cost Component – assesses an approximate cost of the impact of the generator failure on the market

Generator Failure Charge - Eligibility Rules

- A resource will not be eligible for a generator failure charge if:
  - the resource failed due to an unplanned outage on the IESO-controlled grid
  - the IESO dispatched the resource to maintain the reliability of the IESO-controlled grid
  - the resource was dispatched at or above its MLP on request by market participant to prevent endangering the safety of any person, equipment damage, or violation of any applicable law

Non-Hourly Settlement Amounts: Congestion and Loss Residuals

Congestion and Loss Residuals

Type	Disbursed to or collected from	Resolution	Allocation Methodology
Internal Congestion and Loss Residual	All Loads including PRLs	Monthly	Based on their proportion of share of monthly metered consumption in the real time
Real-Time External Congestion	Loads and Exports	Monthly	Based on their proportion of transmission service charges paid over the past month
Day-Ahead NISL	Loads and Exports	Daily	Based on their proportionate share of daily metered consumption in the real time
Real-Time NISL	Loads and Exports	Hourly	Based proportionate share of hourly metered consumption in the real time

* Day-ahead External Congestion is used to fund TR market

Non-Hourly Settlement Amounts:
DAM Reliability Scheduling Uplift

Overview: DAM Reliability Scheduling Uplift (DRSU)

- The intent of DRSU is to uplift the cost associated with the scheduling of additional NQS and incremental MWs from boundary entities during Pass 2 – Reliability Scheduling and Commitment on a cost-causation basis
- DRSU is allocated first to virtual supply, then to loads and exports based on RT consumption
- Recovers costs associated with DAM MWP and DAM GOG only

Next Steps

Next Steps:

Throughout December and January: Stakeholders can review appendix material, and request additional examples or scenarios through engagement@ieso.ca

February 21: Comments/feedback on market rules and market manuals due to IESO

March 21: Second Technical Panel Q and A Session for the Settlements Batch

May 16: Vote to Post for the Settlements Batch

Thank You

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