JANUARY 13, 2026

IESO Technical Panel

Adjustments to Real-Time Make-Whole Payments: Examples, Vote to Post

Presented by:
Karen Backman, Supervisor, Market Development
Jonathan Paredes, Senior Specialist Market Analysis
Megan Cairns, Advisor Market Development

ieso
Connecting Today. Powering Tomorrow.

Agenda

- Recap of issues
- Examples and Red-Line Documents:
  - Item 1 – EOP and Forbidden Regions
  - Item 2 – Operating Reserve (OR) Ramping in Lost Opportunity Cost EOP Calculations
  - Item 3 – MWP not Offsetting Amongst Energy and Operating Reserve Products
- Next Steps and Timelines

Background

- Ongoing monitoring and review of the renewed market has identified specific Real-Time Make-Whole Payment (MWP) circumstances under which inappropriate MWP payments are calculated.
- These are very specific and limited circumstances and only became apparent after the renewed market "go-live" and relate to the interaction between payments for Energy and Operating Reserve.
- The DSO calculations, scheduling and pricing are correct; however, adjustments are needed to some settlement equations and Lost Opportunity Cost EOP calculations.
- The IESO will be making targeted corrections to the formulas in Market Rules, Market Manuals and related tools to ensure continued accuracy and consistency.

Overview

Item	Description
1	Lost Opportunity Cost (LOC) and Forbidden Regions
2	Operating Reserve (OR) Ramping in LOC EOP Calculations
3	Make-Whole Payment (MWP) Not Offsetting Amongst Energy and OR Products

Item 1

Lost Opportunity Cost (LOC) and Forbidden Regions

Impacts:	Hydro Resources with forbidden regions who provide Operating Reserve.
Rationale for Change:	MWP should not be paid for MW that are within a forbidden region and not physically feasible.

Item 1 Recap: LOC and Forbidden Regions

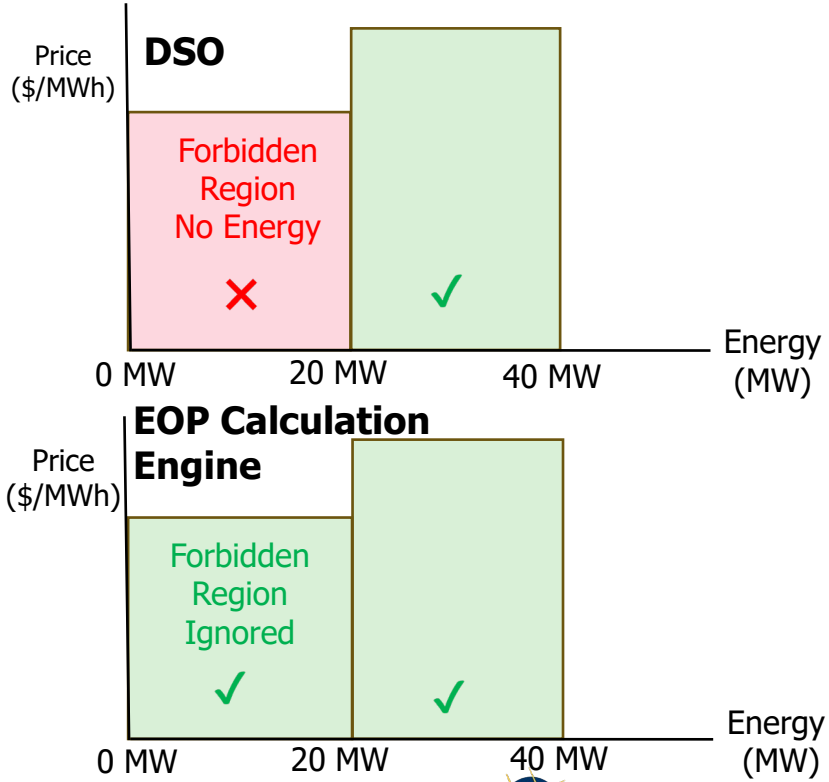
- Some hydro generators have Forbidden Regions in which they cannot maintain steady operation without equipment damage and can only ramp through.
- These Forbidden Regions are correctly considered in dispatch schedules but not when determining the EOPs upon which MWPs are based. **The result is that the EOPs can be physically unattainable for the purpose of calculating the MWP**.
- To ensure that MWP are based on physically achievable operations, there is a settlement process that subtracts out the portion of the MWP resulting from an **energy** schedule in a Forbidden Region or at the upper boundary. However, this settlement process does not exist for **OR** LOC MWP calculations when the energy schedule is in a Forbidden Region or at the upper boundary, resulting in unwarranted MWP.

Item 1: DSO Treatment When Energy Scheduled in Forbidden Regions

The **DSO** considers these constraints and will not schedule **energy** in a Forbidden Region except to ramp through it.

The **EOP calculation engine** does not consider Forbidden Regions. As a result, energy EOPs can be in a Forbidden Region, an infeasible physical result.

Chapter 9 contains settlement equations to remove any unwarranted **energy** MWP resulting from energy scheduled in a Forbidden Region or a boundary.



Item 1: Example of OR + Forbidden Region

Forbidden Region 1	Max Capacity
0 MW – 20 MW	40 MW

The dispatch schedule must respect the Forbidden Region of 0 – 20 MW for energy.

Dispatch

Energy	10S
20 MW	20 MW

The DSO schedules the unit to the upper boundary of the Forbidden Region for energy. **This is a feasible schedule**

EOP

Energy	10S
5 MW	35 MW

Energy LMP	Energy Offer PQ1	Energy Offer PQ2
$5/MWh	20MW @ $1	40MW @ $19

10S LMP	10S Offer
$10/MWh	35MW @ $1

Since the EOP calculation engine does not have the Forbidden Region constraint, the EOP for energy lands within the forbidden region and the remaining 15MW of the forbidden region is scheduled in OR. **This is an infeasible schedule and can result in a higher MWP than warranted.**

Item 1: Example of OR + Forbidden Region Calculations

Current Calculation

RT_OLOC = {(($10 - $1) x 35 MW) – Max[0, (($10 - $1) x 20MW)]}/12

RT_OLOC = ($135)/12

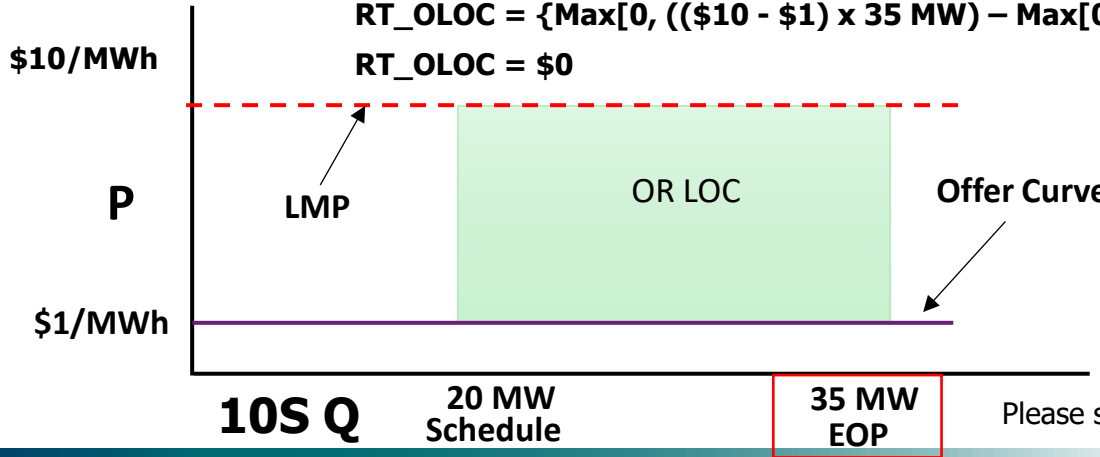
RT_OLOC = $11.25

Proposed Calculations

RT_OR_FROP_LOC = {Max[0, (($10 - $1) x (35 MW – 0 MW))] – Max[0, (($10 - $1) x 20 MW)]} = $135

RT_OLOC = {Max[0, (($10 - $1) x 35 MW) – Max[0, (($10 - $1) x 20 MW)]- $135}/12

RT_OLOC = $0



In this example, the RT_OR_FROP_LOC reduces the RT_OLOC to zero. That is not always the case.

Please see Supplementary Material for a more detailed example.

Item 1: Changes to Market Rules and Charge Types & Equations

Correction required: In the Market Rules, update the calculation for real time lost opportunity cost for Operating Reserve to exclude the forbidden region for Operating Reserve. A similar change is needed in Charge Types and Equations (CT 1905, 1906 and 1907), along with rounding conventions for the new equations.

Chapter 9 Section	Description
3.5.6 d.	Update the real-time lost opportunity cost for Operating Reserve ($RT\_OLOC_{k,h}^{m,t}$) to exclude the forbidden region for operating reserve ($RT\_OR\_\mathrm{FROP}\_LOC_{r,k,h}^{m,t}$). Note: Another edit is made in this formula for Item 3
3.5.6.3	New formula that calculates $RT\_OR\_\mathrm{FROP}\_LOC_{r,k,h}^{m,t}$, which represents the portion of the OR Lost Opportunity Cost Make-Whole Payment resulting from an energy schedule in a Forbidden Region or at the upper boundary.

Item 2

Operating Reserve Ramping in Lost Opportunity Cost EOP Calculations

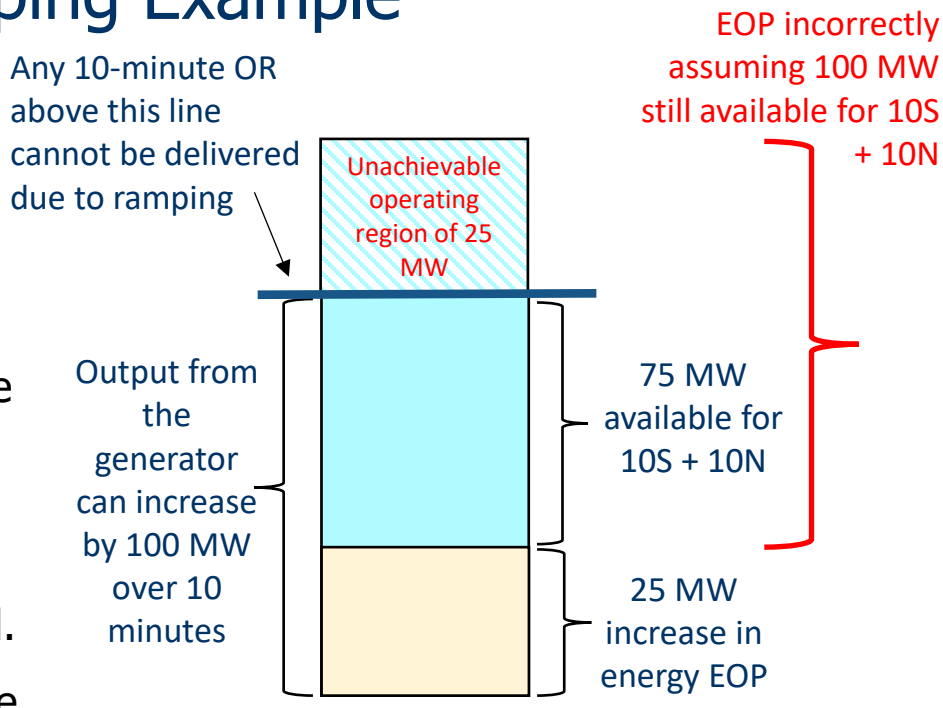
Impacts:	Resources who provide Operating Reserve
Rationale for Change:	MWP should not be paid for MW that are above a resource's physical capability.

Item 2 Recap: OR Ramping in Lost Opportunity Cost EOP Calculations

- There is an inconsistency between OR ramp constraints in the DSO and EOP Calculation Engine.
- This inconsistency results in overstating LOC OR EOPs beyond what resources can be scheduled to.
- The result is inappropriate LOC MWPs.

Item 2: 10-minute OR Ramping Example

- Assumptions
  - The Operating Ramp Rate (ORR) is 10 MW/min
  - The energy EOP in the previous interval was 0 MW
  - The energy EOP in the current interval is 25 MW
- The calculation of the 10S and 10N EOPs is ignoring the ramp up in energy from the previous interval.
- As a result, the 10S and 10N Lost Opportunity Cost (LOC) EOPs can be at levels that cannot be delivered if activated.
- This leads to unwarranted LOC MWP in the unachievable operating region.



This example is for a dispatchable generator. The same logic applies to dispatchable load. The same concept applies to 30-minute OR.

Item 2: 10-minute OR Ramping Example Continued

Current OR LOC Calculation

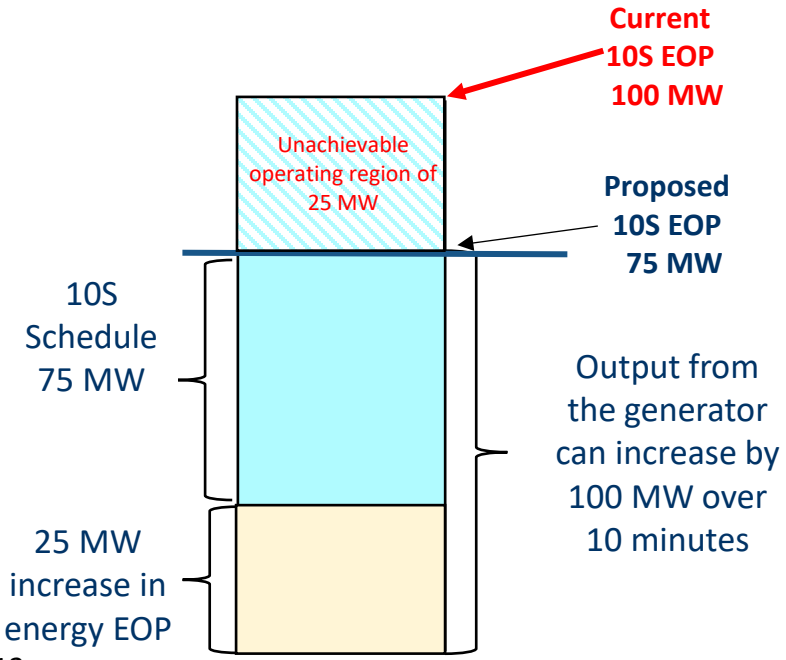
Product	Schedule (MW)	LOC EOP (MW)	Price ($/MWh)	Offer ($/MWh)
10S	75	100	10	1

OR LOC = {(($10 - $1) x 100 MW) – Max[0, (($10 - $1) x 75 MW)]}/12
OR LOC = $18.75

Proposed OR LOC Calculation

Product	Schedule (MW)	LOC EOP (MW)	Price ($/MWh)	Offer ($/MWh)
10S	75	75	10	1

OR LOC = {Max[0, (($10 - $1) x 75 MW)] – Max[0, (($10 - $1) x 75 MW)]}/12
OR LOC = $0



This example is for a dispatchable generator. The same logic applies to dispatchable load. The same concept applies to 30-minute OR.

Item 2: Changes to Market Rules

Correction required: Include the ramping constraints that are in the real-time calculation engine (Chapter 7 App 7.6 s.8.6.3) into the constraints section of the Economic Operating Point calculations (Chapter 7 App 7.8 s.4.4).

Chapter 7 App 7.8 Section	Description
4.4.25	New section that introduces a constraint to recognize interval-to-interval changes in the energy schedule that may modify the amount of Operating Reserve that a dispatchable generation resource or a dispatchable load can provide.
4.4.26 through to 4.4.29	Renumbering of subsequent sections required.

Item 3

Real-Time Make-Whole Payments Not Offsetting Amongst Energy and Operating Reserve Products

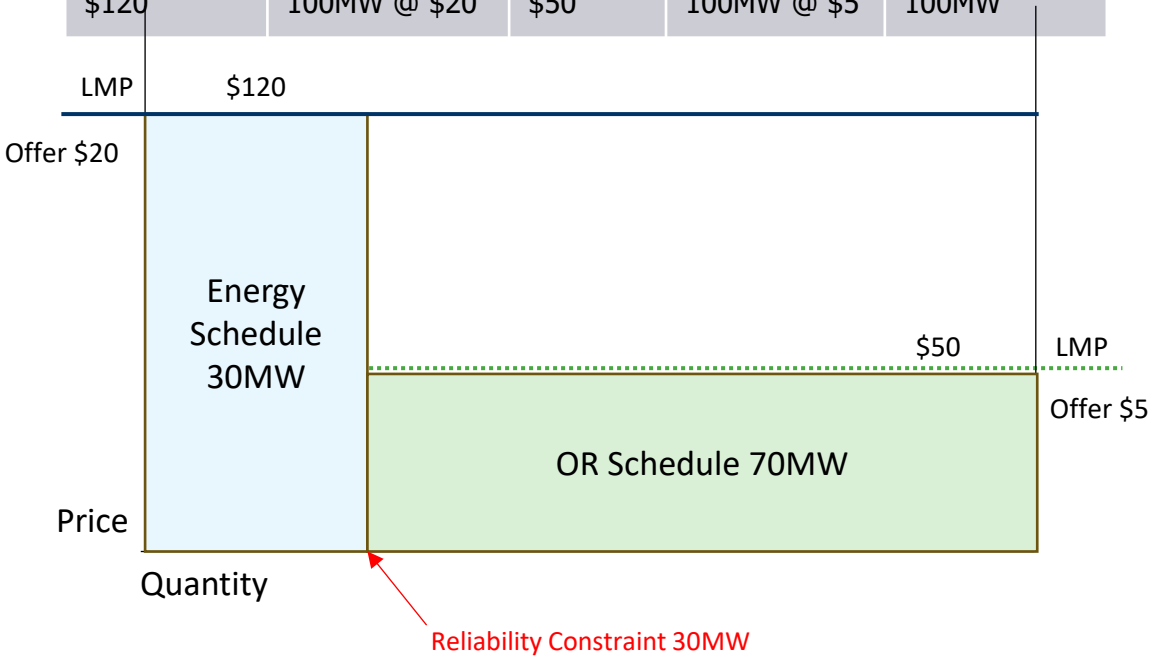
Impacts:	Resources who provide Operating Reserve
Rationale for Change:	MWP should not be paid for MW that are above a resource's physical capability. EOPs should be congruent with how energy and OR schedules are co-optimized.

Item 3 Recap: RT-MWP Not Offsetting Amongst Energy and OR Products

- Make-Whole Payments are intended to keep a Market Participant whole for following dispatch instructions that are co-optimized across energy, 10S, 10N, and 30R products.
- The RT-MWP calculation must be congruent to how energy and OR schedules are co-optimized.
- Lost Opportunity Cost MWP settlement is ignoring the profit realized for the same capacity in the market.
- At present, RT-MWP are not correctly netting across products, resulting in market participants being paid for the same MW twice.

Item 3: Lost Opportunity Cost **for Each Product**

Energy LMP	Energy Offer	OR LMP	OR Offer	Max Capacity
$120	100MW @ $20	$50	100MW @ $5	100MW

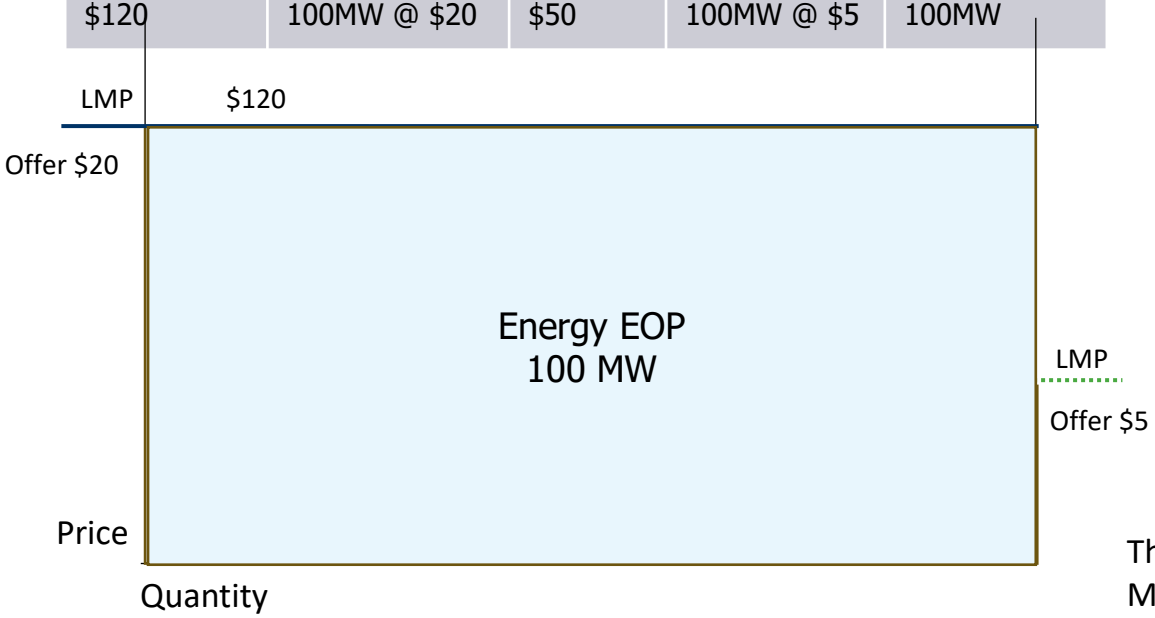


DSO Schedule Outcome:

- Reliability constraint on energy to 30 MW, in this case the resource is economic for more than 30 MW in energy, this creates a LOC in energy.
- The OR schedule is economic for the remaining 70 MW.

Item 3: Lost Opportunity Cost **for Each Product**

Energy LMP	Energy Offer	OR LMP	OR Offer	Max Capacity
$120	100MW @ $20	$50	100MW @ $5	100MW



DSO Schedule Outcome:

- Reliability constraint on energy to 30 MW, in this case the resource is economic for more than 30 MW in energy, this creates a LOC in energy.
- The OR schedule is economic for the remaining 70 MW.

EOP Schedule Outcome:

- The full 100 MW is allocated to energy as it is the resource's most economical operating point.
- Because the DSO schedule and EOP schedules differ there will be a LOC calculated for this resource.

The resource is compensated twice for the same MW – scheduled in the market for 70MW OR while also receiving an energy MWP for 70MW.

Item 3: Lost Opportunity Cost **for Each Product** OP

Without the reliability constraint placed on energy, in the market this resource should have been scheduled to 100 MW in energy and 0 MW in OR, based on economics.

"Operating Profit" for each product = (LMP - Offer) x MW

Energy Operating Profit
= [($120 - $20) x 30MW]/12
= [($100) x 30MW]/12
= $250

OR Operating Profit
= [($50 - $5) x 70MW]/12
= [($45) x 70MW]/12
= $262.50

Total Operating Profit
= $250 + $262.50
= $512.50

Optimal Operating Profit
= [($120 - $20) x 100MW]/12
= [($100) x 100MW]/12
= $833.33

This is what the resource should have made if they did not have a reliability constraint.

The resource is owed the difference of $320.83 between these two outcomes in the form of a MWP.

Item 3: Current LOC Eligibility Criteria for Each Product

LOC EOP vs. Dispatch Schedule	Sign of LOC MWP	LOC Eligibility
EOP > Dispatch Schedule	Positive	Y
EOP > Dispatch Schedule	Negative	Y
EOP < Dispatch Schedule	Positive	N
EOP < Dispatch Schedule	Negative	N

Item 3: LOC MWP – As Implemented

LOC MWP = max(0, ELOC + 10S LOC + 10N LOC + 30R LOC)

ELOC = {(OP of energy EOP) – Max [0,(OP of energy schedule)]}/12
ELOC = [$10,000 - $3,000]/12
ELOC = $583.33

OR LOC = {(OP of OR EOP) – Max [0,(OP of OR Schedule)]}/12
OR LOC = [$0 - $3,150]/12
OR LOC = -$262.50
OR LOC = $0

LOC EOP vs. Dispatch Schedule	Sign of LOC MWP	LOC Eligibility
EOP > Dispatch Schedule	Positive	Y
EOP > Dispatch Schedule	Negative	Y
EOP < Dispatch Schedule	Positive	N
EOP < Dispatch Schedule	Negative	N

LOC MWP = max(0, $583.33 + $0)
LOC MWP = $583.33

Item 3: Proposed LOC Eligibility Criteria for Each Product

LOC EOP vs. Dispatch Schedule	Sign of LOC MWP	LOC Eligibility
EOP > Dispatch Schedule	Positive	Y
EOP > Dispatch Schedule	Negative	Y
EOP < Dispatch Schedule	Positive	N
EOP < Dispatch Schedule	Negative	Y

Item 3: LOC MWP – Offsetting Under Proposed Change

LOC MWP= **max(0, ELOC + 10s LOC + 10N LOC + 30R LOC)**

ELOC = {Max [0,(OP of energy EOP)] – Max [0,(OP of energy schedule)]}/12
ELOC = [$10,000 - $3,000]/12
ELOC = $583.33

OR LOC = {Max [0,(OP of OR EOP)] – Max [0,(OP of OR schedule)]}/12
OR LOC = [$0 - $3,150]/12
OR LOC = -$262.50

LOC EOP vs. Dispatch Schedule	Sign of LOC MWP	LOC Eligibility
EOP > Dispatch Schedule	Positive	Y
EOP > Dispatch Schedule	Negative	Y
EOP < Dispatch Schedule	Positive	N
EOP < Dispatch Schedule	Negative	Y

LOC MWP= max(0, $583.33 + (-$262.50))
LOC MWP = $320.83

Item 3: Changes to Market Rules

Corrections required:

- In the eligibility sections of 3.5.4.5 to 3.5.4.8, a change is made so that a resource is only ineligible for **positive** make-whole payment components (ELC, ELOC, OLC, OLOC) to ensure that off-setting occurs when they are negative values.
- Introduce a max function in energy and OR Lost Opportunity Cost calculations to ensure the operating profit based on EOP is always a positive value.

Item 3: Changes to Market Rules

Chapter 9 Section	Description
3.5.4.5 thru to 3.5.4.8	Added the term "positive" to the conditions for when resources are ineligible for Lost Cost or Lost Opportunity Cost for energy and operating reserve, thereby permitting offsetting to occur when such values are negative. Additionally, amended sections 3.5.4.5 and 3.5.4.6 to refer to real-time schedules rather than injections and withdrawals.
3.5.6	For dispatchable generation and storage; integrated a maximum amount of zero into the existing equations for Real Time lost opportunity cost for energy ($RT\_ELOC_{k,h}^{m,t}$) and operating reserve ($RT\_OLOC_{k,h}^{m,t}$) Note: another edit is made in this formula for Item 1
3.5.7	For dispatchable loads and storage; integrated a maximum amount of zero into the existing equations for Real time lost opportunity cost for energy ($RT\_ELOC_{k,h}^{m,t}$) and operating reserve ($RT\_OLOC_{k,h}^{m,t}$)
3.5.9	For combustion turbine resources in pseudo-units; integrated a maximum amount of zero into the existing equations for Real time lost opportunity cost for energy ($RT\_ELOC_{k,h}^{c,t}$) and operating reserve ($RT\_OLOC_{k,h}^{c,t}$)
3.5.10	For steam turbine resources in pseudo-units: integrated a maximum amount of zero into the existing equations for Real time lost opportunity cost for energy ($RT\_ELOC_{k,h}^{s,t}$) and operating reserve ($RT\_OLOC_{k,h}^{s,t}$)

Item 3: Changes to Charge Types & Equations

Charge Type	Change Required
1904	Integrate the max function into the energy Lost Opportunity Cost calculations into the following formulas: • $RT\_ELOC_{k,h}^{m,t}$ for dispatchable generation resources (that are not pseudo-units), storage and dispatchable loads • $RT\_ELOC_{k,h}^{c,t}$ for combustion turbines of pseudo-units • $RT\_ELOC_{k,h}^{s,t}$ for steam turbines of pseudo-units • $RT\_FROP\_LOC_{k,h}^{m,t}$ for the forbidden regions of hydro-electric resources.
1905 (10 minute spinning Operating Reserve) 1906 (10 minute non-spinning Operating Reserve) 1907 (30 minute Operating Reserve)	Integrate the max function into the OR Lost Opportunity Cost calculations into the following formulas: • $RT\_OLOC_{k,h}^{m,t}$ for dispatchable generation resources (that are not pseudo-units), storage, and dispatchable loads • $RT\_OLOC_{k,h}^{c,t}$ combustion turbines of pseudo units • $RT\_OLOC_{k,h}^{s}$ steam turbines of pseudo units • $RT\_OR\_FROP\_LOC_{r,k,h}^{m,t}$ for the forbidden regions of hydro-electric resources.

Stakeholder Feedback and Next Steps

Stakeholder Feedback

- Two public sessions have been held along with some additional one-on-one meetings with specific market participants in advance of the December 16 session to ensure the requested examples met their expectations;
- **November 21**: Topic and the principles were introduced, and stakeholders requested examples along with more information on testing plans.
- **December 16:** Examples were provided and reviewed with one written submission received following the session from OPG.
  - Stakeholder feedback from both sessions, with IESO responses for the Nov 21st feedback can be found on the Adjustments to Real-Time Make-Whole Payments webpage.

Next Steps

Timing	Engagement Activity
November 21, 2025 ✓	Public Engagement Session #1
December 1, 2025 ✓	Deadline for External Feedback (written)
December 2, 2025 ✓	Technical Panel - Education
December 16, 2025 ✓	Public Engagement Session #2
December 30, 2025 ✓	Deadline for External Feedback (written)
January 13, 2026	Technical Panel – Vote to Post (for broader sector feedback)
February 10, 2026	Technical Panel – Vote to Recommend (to IESO Board)
April 2026	Planned Implementation

Appendix

Acronym List

Acronym	
LC	Lost Cost
LOC	Lost Opportunity Cost
EOP	Economic Operating Point
MWP	Make-Whole Payment
DSO	Dispatch Scheduling Optimizer
FR	Forbidden Region
OP	Operating Profit
OR	Operating Reserve (10S – 10 minute spin; 10N – 10 minute non-spin; 30R – 30 minute)

Acronym	
MR	Market Rules
MM	Market Manuals
ELC	Energy Lost Cost
OLC	Operating Reserve Lost Cost
ELOC	Energy Lost Opportunity Cost
OLOC	Operating Reserve Lost Opportunity Cost
ORR	Operating Reserve Ramp Rate