EAS WG – Roadmap Discussion
Capacity Market, Flexibility and Pricing

April 5, 2018

Westin

Agenda

- Roadmap Items
  - To integrate capacity market and pricing methodologies
  - To understand flexibility needs (NDV) and potential approaches
  - Discuss next steps in RM consultation
    - Analysis for discussion (proposal at May WG and rec by June)

- Roadmap Table
  - See separate summary table. (Handouts in 11x17 size will be brought to the WG meeting)

Roadmap

- Roadmap table shows element by year, trigger, out of scope
  - Many elements required for 2021 to align with the capacity market (Mitigation, rule changes, priced imports)
  - Alignment of settlement and dispatch is an outstanding policy item and serves greater purpose as we move into future variability to ensure price signal and incentives are strong
  - Some items taken out of scope (CMD1), some triggered.
  - Flexibility elements have a range of implementation options and timing for need that we will review as part of this work and have roadmap proposal by June.
  - Pricing also shows a range of options based on impact to systems, customers and will be discussed with the WG – spectrum symbol

Roadmap discussion – timelines

Enable Capacity Market

Key work areas that must be completed for CM enablement

1) Auction platform
2) Contract Design
3) UCAP, eligibility
4) Demand Curve

Key Timelines

CMD Design: 06/2018

Rules: Dec 2018

Auction: Q4 2019

Delivery 2021

EAS Alignment and Pricing

Key work areas that must be completed for CM enablement

1) Market Power Mitigation
2) Pricing Methodologies / settlement
3) Priced Imports
4) Current rules adapted to CCL, CCI

EAS (Flexibility)

Examine options to improve certainty for dispatch and address future flexibility needs.

Assessment to complete for variability / flexibility

1) Dispatch tolerance and ramping rule requirements/changes
2) Dispatch processes/tools – look ahead, forecasting
3) AS products
4) Align with project to assess dispatchable renewables and storage
5) Align with analysis and reporting relating to system NDV (other scenarios, future years)

Key Timelines

Detailed analysis : 05/18

Recommendation : 06/18

Further consultation: TBD

Implementation : phased

Roadmap Discussion (separate document)

- See separate document
- Shows all EAS elements
- Shows range for incremental changes / future changes
- Most changes for 2021 as part capacity market obligations

EAS Roadmap -- Draft April 4, 2018 Workgroup Discussion			Implementation Timeline				
CMD1 Category	CMD2	Comments	2021	2021 partial change	NOV Timeset 2023-2025	Triggered	OUT of Scope
Phase I items (needed for capacity market)							
Offer Obligations: – Must offer	Offer Obligations: -- All Must offer						
Capacity committed Generators	No Change	Rules reviewed and no changes are required to implement the Capacity Market	x				
Capacity committed Loads including "down-by" and "down-to"	Revised offer within merit order, last dispatch off at equal priced offers including at 999.99, detailed rules re ADR, reststatments after dispatch, AC restatement for down to	New, amended rules.	x				
Capacity committed Imports	Detailed proposal -- option to price, dispatched in merit order, aligned with BA 15 minute scheduling, CCI must offer volumes, imports dispached based on merit order	Rules for priced imports, scheduling practices.	x				
LLTE rule to align with capacity obligations	LTA rules can direct assets if required and if required would be set at MSG and paid uplift for start costs only. They would forfeit energy revenues unless they self dispatch. They would also face capacity PAM if not available during period or directed.	Rules reviewed and no changes are required to implement the Capacity Market	x				
Energy Market Mothball rule	Energy Market Mothball rule removed -- temporary delist in capacity market used for mothball process		x				
Dispatch and Scheduling, SCED, pricing impact	Dispatch and Scheduling no change to pricing or dispatch methodology (must comply with dispatch tolerance). Improve Dispatch tools but full SCED out of scope	Uplift pricing model more targetted but less efficient	x				SCED out of scope
Dispatch and Scheduling market structure – cooptimization	No change to AS market structure -- cooptimization out of scope						Co-optimization between energy and AS - Out of Scope
Dispatch and Scheduling - CCL, supply shortfall, supply surplus	CCL must follow dispatch, rules for return to market after dispatch, no change to current rules for supply shortfall, supply surplus	New rule for return following dispatch	x				
Dispatch and Scheduling - CCI, priced imports	Priced imports must follow dispatch up and down within tolerance	Rules for priced imports, scheduling practices.	x				
Unit Commitment Rules	No change	Rules reviewed and no changes are required to implement the Capacity Market	x				Security constrained unit commitment (SCUC) – OOS
Outage scheduling	No change to Outage scheduling	First draft of rules completed and sent to rules drafters The outage reporting system and STA (inside of DT) will need to be enhanced to include load outages in the calculations	x				
LTA and STA rules to reflect demand capacity resources	Update to rules to reflect resource adequacy numbers		x				
Shorter Settlement	Move to 15 min pricing interval (for tx customers, leave loads at hourly)	System evaluation required, considered rule design, RMFor 5 v. 15					
Pricing -- shortage pricing, negative pricing, price cap	no change to shortage pricing, negative pricing, price cap	Not in scope and may be reviewed in the future if a need is identified				x	1. Shortage pricing - triggered 2. Negative pricing - triggered 3. Raise price cap - triggered
Energy market mitigation - RSI screen - ex ante mitigation	Proposal -- RSI at 0.9, no look scarcity test at 300 MW, and reference price SMRC estimated by at formula (Excosts or opportunity cost). Net obligation voluntary submission.	WG consultation on new elements, review of complete rationale document materials.	x				

Roadmap - 2021 Items

- The items shown with “x” in first column with green shading are items required for the capacity market implementation
- These items include:
  - Rule changes / amendments to current offer obligation rules. For example:
    - Inclusion of capacity committed load obligations
  - Minor changes to dispatch and scheduling rules except for
    - Rule changes for priced import / export assets
    - Consideration of rules for dispatch tolerance, improvements of tools and reporting
  - Market Power Mitigation Rules

Pricing Methodology / SCED out of scope

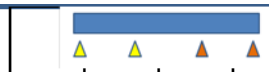
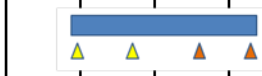
- Concluded that SCED is:
  - Prices energy in market as dispatched (including pro rata for ramp)
  - Aligns settlement with dispatch
  - Look ahead tool,
  - Optimization across assets, cooptimization
- Roadmap recommendation
  - Pricing methodology continues – dispatch for load accounting for ramp
  - Will evaluate alignment of settlement with dispatch / shorter settlement
  - Tools similar to AB dispatch tool, can model to improve aligned with ramping characteristics, certainty.
  - As per our analysis, no need to change AS market on its own, so will take out of scope.
  - Further discussion on pricing methodology and settlement below

Triggered and Out of Scope

- Some items have been shown as triggered
  - Changes to the pricing mechanism including price cap, negative pricing and shortage pricing have ben shown as triggered
  - The AESO will continue to monitor market prices and issues with clearing shortages or surpluses and consider these rule changes as required.
- Some items have been taken out of scope
  - Based on evaluation conducted with the WG, no or little efficiency gain was discovered compared to current market processes and as such, no change is made to current processes for:
    - Self commitment
    - Market format for energy and AS as separate markets

Roadmap – Flexibility elements

- Flexibility suite of rule changes grouped at bottom
- Shows range for incremental changes / future changes
- Will take longer to consult on this piece but roadmap shows early indications – will finalize pre auction.
  - See separate presentation of flexibility options
  - April (data), May (proposal), June (recommendation) including consultation plan.

Dispatch tolerance -- present data -- historic pattern, proposal for rule change	Market needs to know expected ramp response, generators should be able to follow own submitted values.				
Ramp input by participants -- examine systems, current data use - proposal	use current ramp information as historic, change rule to use ramp block for xxx, rest part of RM after further evaluation.				
Enhance Dispatch and Scheduling - full SCED Out of scope, examine improvements to Dispatch Tools, look ahead, ramp evaluation	tools in scope, evaluaton results for next WG				
Dispatch and Scheduling no immediate ramp product	no immediate ramp product, incentives for system to have ramp capability and value for ramp. Will review in future as required.			X	Ramp product phased in if/as required

Roadmap next step

- Roadmap will be finalized with CMD
- As WG considers data, proposal and recommendations for the remaining elements (with a range of options), the roadmap will be updated.
- The final roadmap provide market notice of changes for future – early, 2021 and beyond
- The flexibility section will form part of a continued consultation with the AESO efforts on dispatchable renewables and storage
  - Analysis will continue and results will be provided to industry prior to the first auction.

Pricing Methodology and Settlement

Outline

- Continued discussion on settlement options
- Alignment of settlement and Dispatch
  - Summary of expected benefits / impacts
- Metering
  - Options at metering level
  - Settlement code
- Settlement options
  - Range of options related to current systems, settlement code,
  - Will be considered as part of roadmap

Pricing Methodology and Alignment of settlement and dispatch

Pricing Methodology – Issues

- The current price methodology for the calculation of the Pool Price is:
  - This market is dispatched minute to minute to meet system conditions
  - The System Marginal Price (SMP) is set each minute at the price of the highest block dispatched
  - The Pool Price is set by the average of the 60 SMP
  - Settlement for the market is based on this hourly Pool Price
- Issues
  - Settlement and Dispatch timing is misaligned (one minute to hourly) meaning that price fidelity is impacted
  - Increasingly as the system faces more ramping, this misalignment may further be an issue and price fidelity impacts response.
  - Discrepancy between the average hourly pool price and marginal offer price is addressed through uplift payment mechanism (payment to supplier on the margin or PSM). PSM could increase as NDV increases.

Pricing Methodology and Options

- The pricing methodology impacts the dispatch results.
- Options
  - Status Quo – Single price, set ex post, settled on all delivered energy
- Alternatives in times of ramp
  - Uplift Payments to supply on the margin
    - Payments vary to parties based on contribution to ramp, settlement impact
  - Shorter settlement intervals
    - Value in aligning settlement and dispatch

Other options Evaluated

- AESO's current dispatch approach, the system controller has to forecast generation dispatch response and proactively dispatch accordingly
- Other options compared to current approach included:
  - Energy only SCED solution – generation dispatch based on unit's ramp rate, and the system ramp requirement is automatically factored in the dispatch. Similar to the AESO's current practice, except uses an automated tools solution, vs system controller expertise
  - Uplift for ramp model – same dispatch as current AESO practice, however SMP would be based on dispatch for the energy requirement. Any proactive dispatch for ramp would be paid an uplift payment for their response to the ramp event when dispatched.
    - Pros: Provides separate value for ramp. May help with the free rider problem.
    - Cons: Could argue that dispatch for ramp is same as dispatch for energy, an over dispatch is just to account for slower moving units. Energy should be priced at the highest unit dispatched to meet demand.

Pricing Methodologies

Practice	Benefits	Issues
Current practice: • Dispatching for ramp • No separation between value for energy vs value for ramp • Payments to suppliers on the margin (PSM)	• Simple dispatching • Relies on existing tools, and system controller experience • PSM ensures that participants are kept whole – incentivizes them to respond to dispatch	• Offer blocks do not represent ramp value. • Assets that were not dispatched for ramp, but were in merit at the time of an over dispatch event, receive the same price as those assets that were dispatched to provide ramp. • May not be dispatching the most effective units for ramp
Paying an “uplift” price for ramp	• Only paying units that are over dispatched for MW provided	• Could argue that ramp MW is the same as energy MW – no reason to separate the two • Assets in this scenario are still only providing one price per block. That single price would represent two values: energy and ramp • May not be dispatching the most effective units for ramp
AS product (valuing ramp outside energy market)	• Explicitly values ramp • Capacity is held aside to provide flexibility in times of high NDV	• Difficult to determine volume of ramp required to procure, especially day ahead – forecast risk • Inefficiencies with creating two separate markets – may result in market power issues
15 minute settlement	• Improved price fidelity • May provide some financial incentives for market participants to respond more quickly to dispatches when ramping up.	• There is no separation between price paid for energy and ramp

Pricing Methodology / SCED out of scope

- Concluded that SCED is:
  - Prices energy in market as dispatched (including pro rata for ramp)
  - Aligns settlement with dispatch
  - Look ahead tool,
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Real-Time Price Signal and Pricing Incentives

Alignment of Settlement and Dispatch

- First explored in the 2005 Wholesale Market policy paper:
  - At the time, it was recognized that the mismatch between dispatch and settlement results in a poor quality price signal and potentially incentivizes adverse dispatch response
  - The paper recommended that the AESO explore aligning dispatch and settlement
  - The paper also recommended using uplift payments to suppliers on the margin as an interim solution
- Most other jurisdictions in North America are moving in this direction
  - See FERC order 825

Incentives related to settlement interval

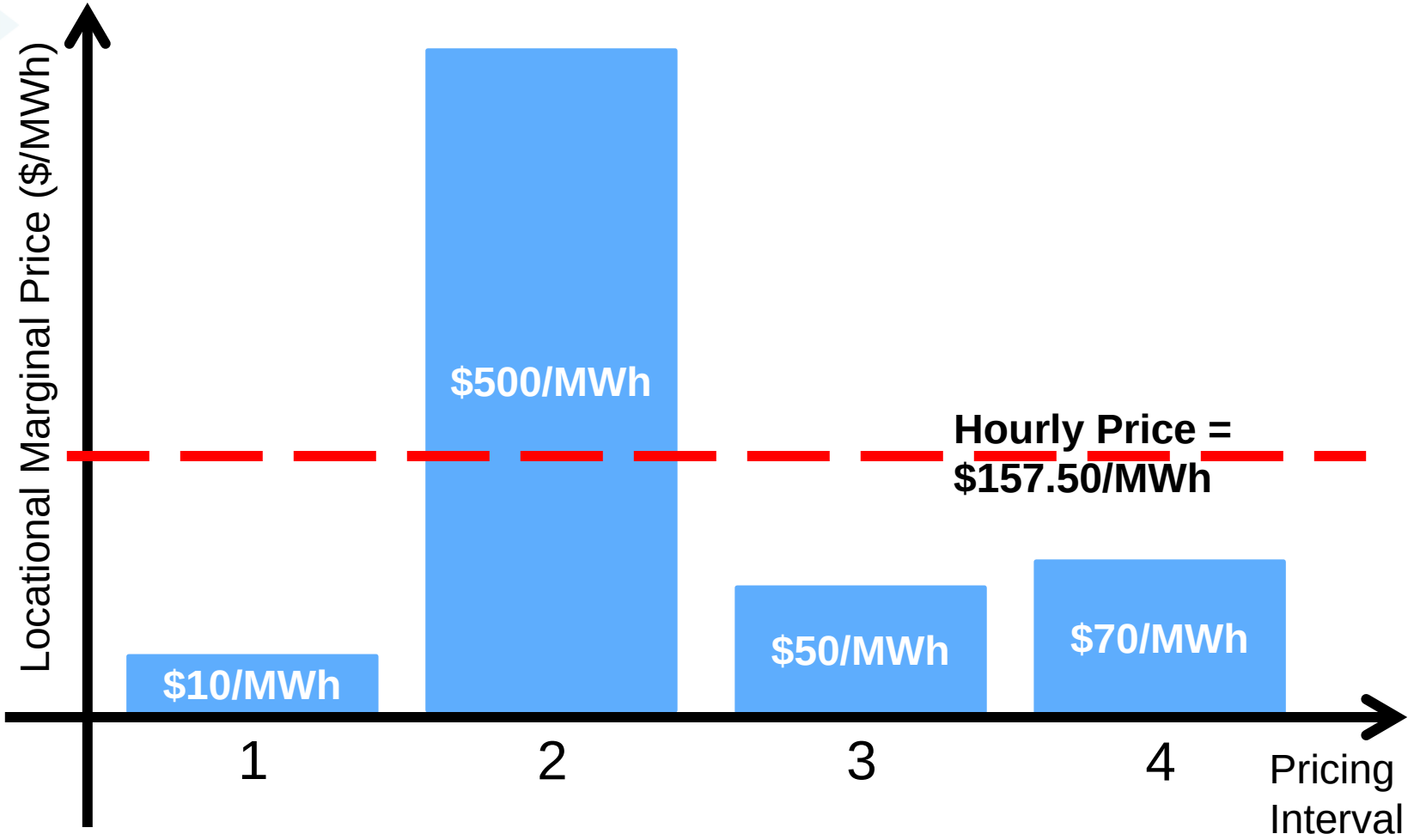
- Hourly average prices can mute price signals (incentives) to follow dispatch instructions
- This can result in flexible units operating inflexible within the dispatch tolerance in order to maximize profits
- Aligning the dispatch, pricing, and settlement intervals will directly align financial payments with system operations
- PJM Connext Graphic / Examples on next page shows how the averaged prices miss the incentives that would be sent for a high price quarter or a low price quarter by averaging

Example Generation Resource

Generator X

- Maximum output level = 500 MW
- Minimum output level = 100 MW
- Ramp rate = 10 MW/min
- Offer @ Minimum output = $40/MWh
- Offer @ Maximum output = $80/MWh
  - Assume offer curve is sloped

Example: 15-Minute Prices with Hourly Settlement



Dispatch and Profits of Generator X if it Follows Dispatch

Interval	1	2	3	4	Hourly
Price ($/MWh)	10	500	50	70	157.50
Output (MW)	100	250 (ramp limited)	200	350 (ramp limited)	225
Cost* ($/MWh)	1,000	2,781.25	2,125	4,281.25	10,187.50

* Calculated per 15 minute interval

- Under hourly pricing, Generator X would be paid $35,437.50 if it follows dispatch
- The profits for Generator X are $25,250

*Profit = (Hourly LMP * Hourly MW) – Hourly Cost*

Dispatch and Profits of Generator X if it Deviates From Dispatch

Interval	1	2	3	4	Hourly
Price ($/MWh)	10	500	50	70	157.50
Output (MW)	100	250	400	500	312.50
Cost* ($/MWh)	1,000	2,781.25	5,125	7,000	15,906.25

* Calculated per 15 minute interval

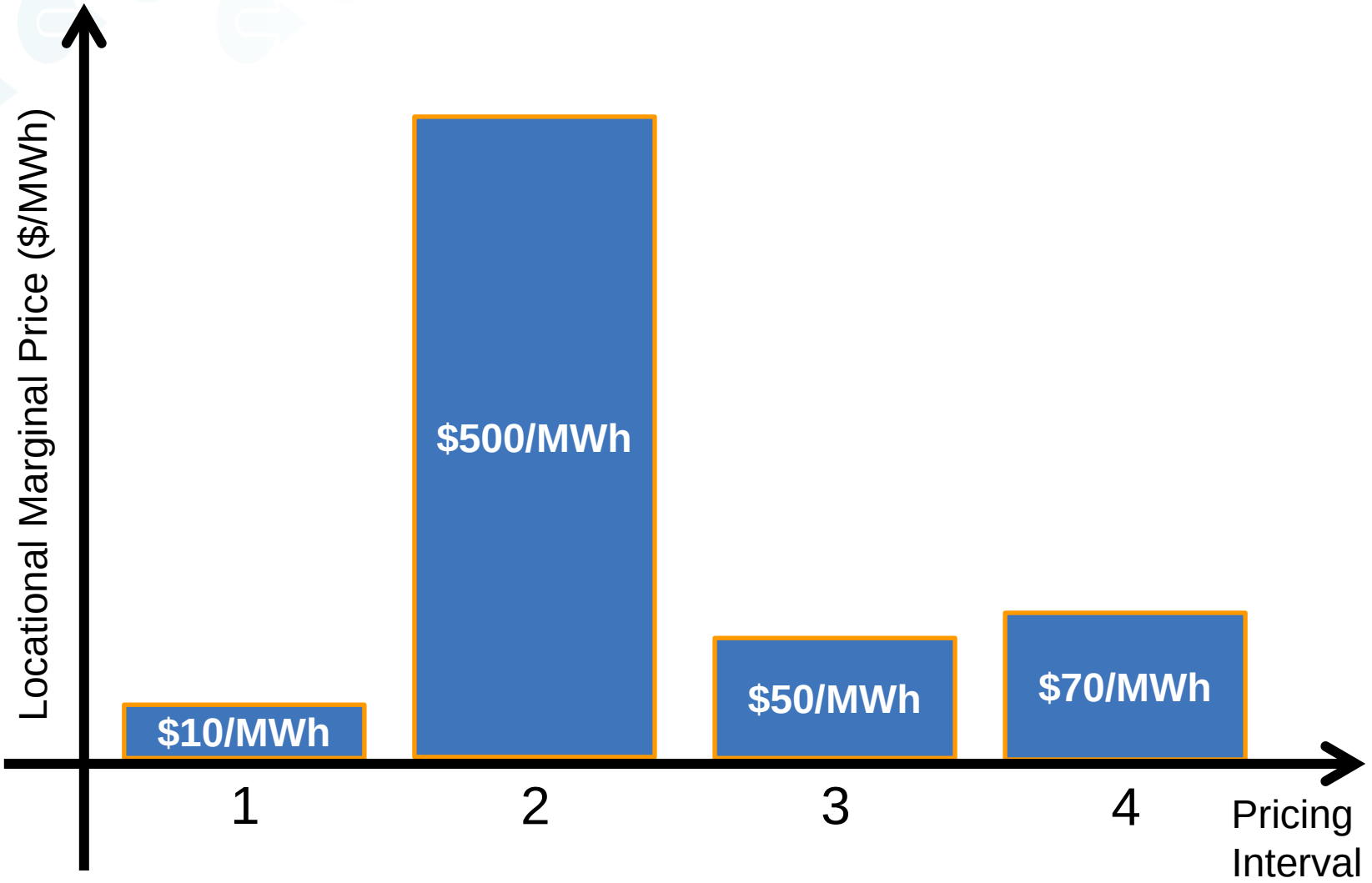
- It is in Generator X's best interest to not follow dispatch due to the high likelihood the average LMP will integrate above its cost
- The profits for Generator X are now $33,312.5

*Profit = (Hourly LMP * Hourly MW) – Hourly Cost*

Example 1 Summary

- Hourly integrated pricing mutes the individual pricing signals for each interval
- This incentivizes inflexible operation when the profit maximizing output for a generator is different than the dispatch instruction
- Generator X was able to increase approximately $8,000 by deviating from the ISO's instructions
- To correct this incentive flaw, aligning settlement intervals with pricing and dispatch integrals is critical

Example 2: Pricing Profile is Identical but Settlement Occurs in Each Interval



Dispatch and Profits of Generator X if it Follows Dispatch

Interval	1	2	3	4	Hourly
Price ($/MWh)	10	500	50	70	157.50
Output (MW)	100	250 (ramp limited)	200	350 (ramp limited)	225
Cost* ($/MWh)	1,000	2,781.25	2,125	4,281.25	10,187.50
Profit ($)*	-750	28,468.75	375	1,843.75	29,937.50

- More granular settlement directly values Generator X's output during the periods when it is most needed by the system
- This aligns the financial interest of Generator X with system conditions

Conclusions

Benefits of Faster Response to Dispatch Instructions

- More reliable system operation.
  - The system will have better ability to respond to unforeseen system events.
- Better ability to respond to variations created by renewable generation.
- Moderation of price excursions due to more units able to respond.

Benefits of Incentivizing Investment in Flexible Resources

- Align future generation fleet with operational needs.
  - Waiting for a problem to arise in real-time is too late.
- Appropriately value existing flexible resources.
  - Provide incentive to invest in maintaining and enhancing current capability.

AESO analysis on shorter settlement

- The AESO has performed preliminary analysis using historical data that compared unit revenue from a 60-minute settlement model to a 15-minute settlement model. (See previous WG)
- Conclusions from the analysis found that shortening the settlement interval to 15 minutes would provide a small financial incentive to:
  - Respond faster to dispatch instructions
  - Reduce load in response to high pool prices
  - Change overall revenues for different asset types (change the investment price signal)
- Next steps
  - AESO will examine forward looking impact of shorter settlement with increasing variability to assess value.

Analysis – Shorter Settlement

- A shorter settlement provides improvement in prices at each interval – closer aligned to the value of energy at each interval instead of averaged.
- The following analysis supports this conclusions:
  - The PJM summary noted in the following slides provides the conceptual overview of the benefit of shortening the settlement interval
  - AESO analysis presented to the Oct 25 SAM EAS WG demonstrates, on a preliminary basis, the change in financial value linked to shortened settlement.
  - AESO has done an assessment, presented to the EAS WG on Feb 14, on the impact of shorter settlement on payments to suppliers on the margin.
    - This assessment was a conceptual overview of 15-min settlement vs hourly.
    - Further analysis required to examine forecast of price impact with increased variability and compare to costs for systems.

Payments to suppliers on the margin

- The AESO uses a mechanism called payments to suppliers on the margin (PSM) to compensate supply offers that are dispatched above the averaged hourly pool price.
  - Because 60 SMPs are averaged to one hourly pool price, there will be dispatched blocks that were offered (priced) above where the pool price ultimately arrived at.
  - When these blocks are dispatched and respond by providing energy, they are compensated the difference via PSM.
- It is expected that shortening the settlement interval (e.g., moving from one hour average pool prices to 15-minute average pool price) will decrease the frequency and magnitude of PSM.
  - This is because the market clearing SMPs are averaged over a shorter period, increasing price fidelity.

Metering

Further Issues with Shortening Settlement Interval

- Transparency of the price signal
  - Without a means to achieve a reasonably accurate view of future prices, benefits may be diminished
  - In order to achieve an effective real-time response to the price signal, there needs to a means for customers to have quick exposure to the price signal through metering
- Load settlement mutes the price signal, especially for loads on cumulative meters
  - AUC rule 021 (settlement system code) impacts multiple parties (LSA, MDM, load customers on the distribution system, ISO)

Load settlement and price signals

- Benefits from shortening the settlement interval can only materialize if market participants have direct exposure to the price signal.
- Different entities are exposed to the price signal through different means.
  - Generators and tx-connected loads settle directly with the AESO
  - Loads connected to the distribution system settle through the settlement system code
    - This process involves many entities including load settlement agents, customer retailers and the AESO
    - Loads with cumulative meters (majority of distribution-connected customers) have a load profile applied to their monthly consumption. These loads have very limited ability to respond to real-time price signals.

Metering and Load Settlement Agents

- Interval metering is the first step necessary to have exposure to real-time price signals
  - Most customers, in particular, residential and small commercial customers, do not have revenue metering. Instead, they have monthly cumulative meters.
    - Depending on distribution territory, some of these customers have advanced metering capable of collecting meter data at a more granular level. This functionality is not currently in use.
- Transmission-connected loads and large industrial/commercial customers on the distribution network have interval metering that enables exposure to the financial incentives associated with shortening settlement.

Options to Consider

Summary of conclusions

- No change to pricing methodology
  - Price at SMP at highest block
  - Improvement to tools to account for ramp
  - Further analysis on shorter settlement interval
- Further consideration of options on customer type / current metering and settlement code
- Options evaluated as part of roadmap

Options for discussion

- The attached table outlines the options under evaluation as part of the roadmap development
- The options have different requirements for systems
- The options have different impacts on customer by type

Applying a shortened settlement interval to various – descriptions ….

Approach	Status Quo (hourly pricing, hourly settlement)	Shortening the pricing interval for gen-only	+shortening the pricing interval for tx-load	+shortening the pricing and settlement interval for all loads
Required system changes	N/A	Financial settlement (AESO and pool assets)	Financial settlement (AESO, pool assets, load customers)	Financial settlement
Describe	Dispatch of the EMMO results in minute-by-minute SMP. Averaged to hourly pool price that forms the price signal for all market participants	SMPs are averaged to a shortened period. Gen gets paid based upon metered energy delivered in this period	Transmission-connected loads are charged based on a 15-min pool price.	Distribution connected retailers are charged based on 15-min pool price. This charge disseminates to retail loads through the settlement system code.

Applying a shortened settlement interval to various – benefits shown by customer class

Approach	Status Quo (hourly pricing, hourly settlement)	Shortening the pricing interval for gen-only	+shortening the pricing interval for tx-load	+shortening the pricing and settlement interval for all loads
Revenue metered customers	N/A	Financial settlement (AESO and pool assets)	Financial settlement (AESO, pool assets, load customers)	Financial settlement
Small consumers / loads	Hourly pricing continues, no further benefit as compared to current	Price fidelity/price signal to generators	Price signal for tx-connected load	None/limited, especially for load on cumulative metering.

Next Steps

- Proposal at May session
- Recommendation at June session
- Will likely be part of flexibility roadmap with enhanced timeline for consultation