Review of March 1, 2017 Implementations

March 1 – October 31, 2017

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Presentation Road Map

- Fast-start pricing (FSP)
- Sub-hourly settlement (SHS)
- Net Commitment-Period Compensation (NCPC)
- Dispatchable-asset-related demand (DARD pumps)
- Summary
March 1 implementations were intended to:

- Enable rapid response pricing assets (RRPAs) to set real-time locational marginal price (LMP) more frequently by:
  - Participating in price setting when they are part of the least-cost solution
  - Reflecting costs of dispatching the resources in market clearing prices

- Enhance price formation to increase transparency, efficiency, and maintain system reliability

- More precisely compensate resources by applying pricing that aligns more closely with the service provided

- Provide NCPC payments to enhance incentive to follow dispatch instructions

- Improve modeling and dispatch of pumps to better reflect the operating characteristics of pumped storage
Overview

- March 1 implementations went smoothly
- Market outcomes consistent with design expectations
  - **Fast-start pricing** (FSP) has raised real-time (RT) LMPs and reserve prices
  - **Sub-hourly settlement** (SHS) has increased generator revenue compared to hourly compensation
  - New **Net Commitment-Period Compensation** (NCPC) categories implemented to incent dispatch following
  - **Dispatchable-asset-related demand** (DARD pumps) modeling changes have reduced self-scheduling of pumping load
FAST-START PRICING
Summary - Fast-start Pricing

• Changes enable rapid response pricing assets (RRPA) to set real-time LMP more frequently by
  – Participating in price-setting when they are a part of the least-cost solution to meet RT demand
  – Reflecting costs of dispatching the resource (including start-up and no-load costs) in market clearing prices

• NCPC rules changed to compensate dispatchable resources that incur an opportunity cost when RRPAs are setting price (presented later)
Fast-start pricing has increased energy component of RT LMP – March 1 - October 31

Avg Five-Minute Energy LMP Difference ($/MWh) with FSP reforms*

Avg. Energy Component increase: $3.27/MWh (13%)
- **On-Peak**: +$5.37/MWh
- **Off-Peak**: +$1.42/MWh

*Compares prices using new vs. old method
Fast-start pricing has changed prices in about 42% of intervals – March 1 - October 31

No change in 58% of intervals

Impact ranges from $0.01/MWh to $25/MWh in 29% of intervals

Note: Compares Energy LMP results using the new method vs. the old method. No price change means the application of fast-start pricing resulted in the marginal unit staying within the same price offer block under the new method.
RRPA Price Setting by Type of Resource and Time of Day – March 1 - October 31

Note: More than one resource (or category of fast-start resource) may be marginal in the same interval.
FSP has raised reserve prices; largest impact on TMSR

Avg. Reserve Price Increases March - October
- TMSR: $2.14/MWh
- TMNSR: $0.73/MWh
- TMOR: $0.66/MWh

Warm weather; high LMPs, RCPF
High LMPs, RCPF
**Fast-start Pricing - Conclusions**

- Changes have enabled RRPAs to set real-time LMP more frequently
  - Average energy price has increased by $3.27/MWh, or 13%
    - Average RT energy price, March 1 - October 31: $28.45/MWh
  - FSP has affected reserve price frequency and levels

- Enhanced price formation under FSP makes the cost of dispatching RRPAs more transparent and efficient
  - Incents RRPA performance to meet demand for load and maintain system reliability

- Dispatchable resources that incur an opportunity cost when RRPAs are setting price receive NCPC payments (presented later)

- SHS impacts (presented in the next section) are over and above this increase
SUB-HOURLY SETTLEMENT OF REAL-TIME MARKETS

- Energy
- Reserves
Objective: Increase Accuracy of Compensation

- The sub-hourly settlement revisions to the Real-Time Energy Market were intended to have two important benefits:
  - Enhance incentives to follow dispatch instructions
  - More accurately compensate the energy and reserve products delivered in real time
Sub-hourly Energy and Reserve Settlement – Summary

- Real-time energy revenues for supply have increased
- Real-time reserve revenues have decreased
- Combined impact is a net increase to supply
SUB-HOURLY REAL-TIME ENERGY SETTLEMENT
Nearly all wholesale energy production is produced by generators that are telemetry profiled.

97.7% of wholesale energy from telemetry profiled generators.

Telemetry profiled: 67.5M MWh, 97.67%
Flat-profiled: 0.03M MWh, 0.04%
SOGs: 1.58M MWh, 2.29%
RT energy revenue increases per MWh are higher for fast-start generators under SHS

$/MWh Energy Revenue Increase

Overall increase: $0.60/MWh
- $1.64/MWh for fast start
- $0.45/MWh for non-fast start
RT energy revenue increases are higher for non-fast-start generators under SHS

Total energy revenue increase $2.1M or 2.1% under sub-hourly settlements

Revenue increase is $0.7M fast start; $1.4M non-fast start

High LMPs, RCPFs
Sub-hourly Settlement – Energy Summary

• Real-time energy settlement revenues for telemetry-profiled generators increased 2.1% ($2.1M) due to sub-hourly settlement
  – This impact is over and above FSP impacts
• Impacts are greatest for more flexible generators
SUB-HOURLY REAL-TIME RESERVES
Sub-hourly Settlement – Reserve Market Overview

- Real-time reserve payments under sub-hourly settlements decreased (as expected) due to more precise compensation
As expected, sub-hourly settlement reduced reserve revenue

- $0.05
- $0.04
- $0.03
- $0.02
- $0.01
- $0.00

All Reserve Products

Total Change in Reserve $: ($346K) or (1.1%)

RSV

RCPFs
Sub-hourly Settlement – Reserves Summary

• Overall decrease to reserve providers due to five-minute settlement was 1.1% or $346K from March 1 - October 31
Sub-hourly Energy and Reserve Settlement – Summary

• Sub-hourly changes to real-time energy and reserves (over and above FSP) have resulted in a net increase to suppliers
  – Real-time energy revenues for generators and reserve providers resulted in a net increase of $1.7M

• Overall pricing reforms more closely align compensation with services provided
MARCH 1 NCPC IMPLEMENTATION
March 1 NCPC Implementation – Overview

• Overall NCPC trend is down
  – First contingency NCPC reductions\(^1\) due to:
    • FSP (higher RT LMPs)
    • SHS (higher net RT revenues)
    • Increased precision of five-minute revenues and costs reflected in RT
      NCPC calculations
  – Three new NCPC categories created to enhance incent dispatch following
    • DARD pumping (DA and RT)
    • Dispatch Lost Opportunity Cost (DLOC)
    • Rapid Response Pricing Opportunity Cost (RRP OC)

\(^1\) Results shown do not control for weather (milder) and gas prices (slightly higher)
New NCPC categories are 17% of total NCPC between March 1 and October 31

Day Ahead and Real Time

Existing first contingency NCPC down $5.6M year over year

New categories comprise $4.3M of total over period

NCPC

- First Contingency
- All Other Types
- New NCPC Types
March 1 NCPC Summary

- New NCPC categories total $4.3M from March 1 through October 31
  - DARD pumping NCPC
    - $421K over the eight months
  - Rapid Response Pricing Opportunity Cost (RRP OC) (paid almost entirely to non-RRPAs)
    - $1.9 million over the eight months
  - Dispatch Lost Opportunity Cost (DLOC)
    - $2.0 million over the eight months

- As expected, reductions in first contingency NCPC due to higher market prices and more precise compensation*

*Results shown do not control for weather (milder) and gas prices (slightly higher)
March 1 NCPC – Summary

- New NCPC payments are $4.3M
- Estimated decreases in first contingency NCPC resulting from increased prices and more precise compensation are $5.6M
- Overall reforms more closely align compensation with services provided

Note: Results shown do not control for weather (milder) and gas prices (slightly higher)
DARD INTERTEMPORAL PARAMETERS
Summary – DARD Pumps

- Improved modeling and dispatch of pumps better reflects the operating characteristics of pumped storage
- Enhanced financial incentives through addition of NCPC payments
DARD Pump Parameters – Key Features

• New modeling practices and bidding parameters
  – **Min consumption limit** ensures dispatch matches physical ability of pump
  – **Min run time and min down time** increase certainty around expected operation
  – **Max daily consumption and max daily starts** aid DA clearing

• DA and RT NCPC settlements modified to include payments to pumps
Improved daily dispatch has resulted from improved modeling

Note: Economically dispatched units only
Improved dispatch has increased economically scheduled pumping; decreased self-scheduling.

**Economically Dispatched MWh**

**Self-Scheduled MWh**

- **Pre-Implem**
- **Post-Implem**

The chart shows increased economically dispatched MWh by +39% and decreased self-scheduled MWh by (32%).
Conclusions – DARD Pumps

• Improved modeling and dispatch of pumps better reflects their operating characteristics

• Economically scheduled pumping is now a larger share of total DARD pumping operations
March 1 implementations were intended to:

- Enable RRPAs to set real-time LMP more frequently by:
  - Participating in price-setting when they are part of the least-cost solution
  - Reflecting costs of dispatching the resources in market clearing prices
- Enhance price formation to increase transparency, efficiency, and maintain system reliability
- More precisely compensate resources by applying pricing that aligns more closely with the service provided
- Provide NCPC payments to enhance incentive to follow dispatch instructions
- Improve modeling and dispatch of pumps to better reflect the operating characteristics of pumped storage
## Summary of Energy Market Enhancement Impacts on Generator Compensation

<table>
<thead>
<tr>
<th>Market</th>
<th>Item</th>
<th>Incr/(Decr)</th>
<th>Direction</th>
</tr>
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<tbody>
<tr>
<td>RT Energy Market</td>
<td><em>FSP effect on generator deviations</em>¹</td>
<td>$13.3M</td>
<td>▲</td>
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<td></td>
<td><em>SHS methodology</em></td>
<td>$2.1M</td>
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<td>RT Reserve Market</td>
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<td><em>SHS methodology</em></td>
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<td>NCPC</td>
<td><em>New NCPC Categories</em></td>
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<tr>
<td></td>
<td><em>SHS methodology</em>²</td>
<td>($5.6M)</td>
<td>▼</td>
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<tr>
<td>All Markets</td>
<td>Net impact (8 months)</td>
<td>$33.6M</td>
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### RT Energy Settlement

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<th>Item</th>
<th>Total Value of RT Generator Deviations</th>
<th>$100M</th>
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<tr>
<td></td>
<td><em>Impact as % Deviations</em></td>
<td>34%</td>
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### Value of Generation

<table>
<thead>
<tr>
<th>Item</th>
<th>Day-Ahead and Real-Time</th>
<th>$2,000M</th>
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<tbody>
<tr>
<td></td>
<td><em>Impact as % of Total Generation Value</em></td>
<td>1.7%</td>
</tr>
</tbody>
</table>

¹ Estimates resulting from application of price deltas to 5-minute deviations, plus SOGs.
² Results are estimated, and do not control for weather (milder) and gas prices (slightly higher).
Summary

• March 1 implementations went smoothly
  – FSP has increased the frequency of RRPAs setting price
    • The new treatment of RRPAs has resulted in RT LMPs increasing by $3.27/MWh or 13%
    • FSP enhances transparent and efficient pricing signals; contributes to system reliability
  – SHS has increased generator energy revenue and decreased reserve revenue by $1.7M net
  – DARD pumps modeling changes have reduced self-scheduling of pumping load
  – NCPC additions have been $4.3M
    • Higher RT prices and more precise compensation is affecting first contingency NCPC
Questions