Flexible Ramping Product Refinements Draft Final Proposal

Stakeholder Call
5/18/20
## Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 – 1:10</td>
<td>Welcome</td>
<td>Isabella Nicosia</td>
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<tr>
<td>1:10 – 1:50</td>
<td>Changes from Revised Straw Proposal</td>
<td>Don Tretheway</td>
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<tr>
<td>1:50 – 2:50</td>
<td>Nodal Delivery of FRP – Excel Solver</td>
<td>George Angelidis</td>
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<td>2:50 – 3:50</td>
<td>Requirement Calculation</td>
<td>Hong Zhou</td>
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<tr>
<td>3:50 – 4:00</td>
<td>Next Steps</td>
<td>Isabella Nicosia</td>
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</tbody>
</table>
ISO Policy Initiative Stakeholder Process

PROPOSAL DEVELOPMENT

Issue paper

Stakeholder input

Straw proposal

Draft proposal

Draft business requirement specification

Draft tariff

Final proposal

Board

EIM Governing Body

DECISION

Final tariff

FERC

IMPLEMENTATION

Business practice manual revisions

Market simulation

Go Live

This represents the typical process, and often stages of the process run in parallel.

We are here
CHANGES FROM REVISED STRAW PROPOSAL
<table>
<thead>
<tr>
<th>Issue</th>
<th>Change from revised straw proposal</th>
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</thead>
<tbody>
<tr>
<td>Proxy demand response eligibility</td>
<td>Changed implementation to Fall 2021</td>
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<tr>
<td>Ramp management between FMM and RTD</td>
<td>None</td>
</tr>
<tr>
<td>Minimum FRP requirement</td>
<td>(1) Simplified rule by enforcing a minimum requirement only when a balancing authority area is 60% of the system requirement. (2) A nominal requirement can be used in any balancing authority area in needed.</td>
</tr>
<tr>
<td>Deliverability enhancement</td>
<td>(1) The FRP uncertainty is distributed to load and VERs in the deployment scenarios. (2) Distributing the demand curve surplus variable as decision variable at load aggregation points. (3) Since deployment scenarios are not included in the day-ahead market at this time, virtual supply and demand will not be settled for congestion from the deployment scenarios.</td>
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<tr>
<td>FRP demand curve and scarcity pricing</td>
<td>None</td>
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<tr>
<td>Scaling FRP requirement</td>
<td>None</td>
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Minimum BAA requirement for Fall 2020 implementation requires BPM changes

• If a BAA is $\geq$ 60% of the system requirement, then enforce its share as minimum requirement in that BAA

• A nominal requirement may be included in remaining BAAs
  – Full minimum requirement limits ability to meet FRP at lowest cost across area

• Eliminated proposal to increase system requirement when a minimum requirement is enforced

• With nodal FRP, there is no need for minimum requirement
Improve deliverability by not awarding FRP to resources that have a zero opportunity cost because of congestion. Target implementation Fall 2021

- Flexible ramping up awarded to resource behind constraint
  - Next market run unable to dispatch higher than current output

- Flexible ramping down awarded to resource providing counterflow
  - Next market run unable to dispatch lower than current output

- Nodal procurement ensures both energy and FRP awards are transmission feasible
Changes to nodal deliverability proposal (1 of 3)

- FRP uncertainty is distributed to load and VERs in the deployment scenarios
  - Previously distributed to load nodes only
  - Analysis showed that VER accounted for around 75% of uncertainty in middle of the day
  - Provides more accurate estimate of where the FRP will be needed for energy
Changes to nodal deliverability proposal (2 of 3)

• Distributing the demand curve surplus variable as decision variable at load aggregation points
  – Previously group of BAAs that pass and individual BAAs fail the resource sufficiency evaluation
  – Moving to load aggregation points allows for more granular relaxation of the requirement
  – Allows a share of the system requirement to be relaxed in a LAP while not limiting procurement of the full share of the system requirement in another LAP
Changes to nodal deliverability proposal (3 of 3)

• Since deployment scenarios are not included in the day-ahead market, virtual supply and demand will not be settled for congestion from the deployment scenarios in real-time
  – Systematic difference in MCC between day-ahead and real-time
  – In real-time, FRU deployment scenario (P97.5) could have congestion while base deployment (P50) would not.
  – Virtual supply would be profitable even though unable to converge with P97.5 scenario, only P50.
  – Will continue to evaluate in the development of the DAME if this settlement treatment remains
NODAL DELIVERY OF FRP – EXCEL SOLVER
Nodal Delivery of FRP – Excel Solver

FLEXIBLE RAMP PRODUCT REQUIREMENT ENHANCEMENTS
Executive Summary

The ISO proposes a quantile regression approach (Q) for FRP, comparing to current histogram (H), the benefits of Q includes:

1. Q provides similar accuracy than current histogram approach, e.g., CISO 96.7% (H) vs. 96.1% (Q)

2. Q is closer to the RTD uncertainty profile, e.g., CISO 595.46 (H) vs. 540.99 (Q)

A table in a later slide will report these benefits in a simulation study
Presentation Flow

The Presentation is very detail, consists of the following steps:

1. Terminology and Notations for quantile regression
2. Quantile regression for components: solar, load, and wind
3. Challenge and Proposal: MOSAIC quantile regression
4. Bound the MOSAIC output
5. Simulation setup and Performance measures
6. Daily Graphs for visualizing the gained benefit
7. Summary
8. Other models considered
Quantile Regression

Ordinary Regression

Quantile Regression

Generic Y

Generic X

y r_y

y q_y
Quantile Regression

• Quantile Regression (Q) is a natural tool for Flexible Requirement.
  
  – Quantile Regression: find a good (curved) line to fit a percentile (e.g. 5%) over input variable(s) X
  – Flexible Requirement: Control the chance (e.g. 5%) of the variation over the preset value

• Histogram (H) is a special case of Quantile Regression
Net Load Requirement

- Net Load (NL) = Load (L) – Wind (W) – Solar (S)

- Variation to anticipate: rtd binding forecast – rtpd advisory forecast

- Next, use S component to show Q has clear advantage over H,
  where S = solar variation
Solar

H vs. Q

H vs. Q by Month

RTPD Solar Forecast

Solar Uncertainty

RTD - RTPD  H  Q
Solar (S) Component

- One stone for two birds!
  - When solar is forecasted to be at full or low output, the requirement will be small;
  - otherwise, the requirement will be large.
- $S_Q$ can better use input variables, e.g. month;
- $S_Q$ is a better stone than $S_H$
Wind and Load

Wind

Load

RTPD Wind Forecast

RTPD Load Forecast
Model for Components

• Quantile Regression models (sqr = square):
  - $S_Q = \text{RTPD}_\text{Solar} \cdot \text{RTPD}_\text{Solar}_\text{sqr}$
  - $W_Q = \text{RTPD}_\text{Wind} \cdot \text{RTPD}_\text{Wind}_\text{sqr}$
  - $L_Q = \text{RTPD}_\text{Load} \cdot \text{RTPD}_\text{Load}_\text{sqr}$

• $S_Q$ is a better stone than $S_H$
• $W_Q$ better than $W_H$, $L_Q$ better than $L_H$, in varying degrees
Net Load Variation by Components

Load

Wind

Solar

RTPD Load Forecast

RTPD Wind Forecast

RTPD Solar Forecast

Net Load Variation

Net Load Variation

Net Load Variation
Challenges and Proposal

• Challenges
  o Well seen fit in component graphs are muted when net load uncertainty is of interest
  o Modelling interactions among L, W, and S are complicated

• Proposal
  o Quantile Regression using MOSAIC input variable which blending three good stones $S_Q$, $W_Q$, and $L_Q$
The MOSAIC Model

• What is MOSAIC made of?
  ➢ $L_H$, $W_H$, $S_H$, and $NL_H$ for histogram:
  ➢ $L_Q$, $W_Q$, and $S_Q$ for quadratic models:
  ➢ $NL_H$ is the ISO current requirement

• Let $MOSAIC = NL_H - (L_H - W_H - S_H) + (L_Q - W_Q - S_Q)$

• Quantile Regression Model $NL_Q = MOSAIC$
Bounded Mosaic

- Mosaic $NL_Q$ are centered around Histogram $NL_H$
- Bound the Mosaic output to
  - Have more reasonable flexible ramping requirement
  - Ensure reliable grid options
- Bounded the Mosaic output:
  \[ NL_Q = \min(\gamma_2, \max(\gamma_2, NL_Q)) \]
  where $\gamma_1$ and $\gamma_2$ are configurable parameters
Bounded Mosaic

NL_Q vs. NL_H

NL_Q Bound vs. NL_H

ISO Public
Mosaic: Adapt Requirement by Forecast

![Graphs showing solar RTPD forecast and net load imbalance with different imbalance symbols.](image-url)
Mosaic: Adapt Requirement by Forecast
Simulation Setup

• Estimate RT flexible requirement (15m to 5m)
• Simulation period (01jan2019-31dec2019)
• Six EIMs: AZPS, CISO, IPCO, NEVP, PACE, and PACW
• For each day, use last 40 days of the same day type (workday, weekends)
• Simulation granularity: hour
• $\gamma_1 = \min (NL_H)$, $\gamma_2 = \max (NL_H)$
Performance Measures

• Criteria for performance measurements:
  o Coverage (e.g., 97.5%): accuracy rate
  o Average Requirement
  o Closeness with actual uncertainty profile
  o Average MW when imbalance exceeding requirement
## Simulation Results (H vs. Q)

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<tr>
<th></th>
<th>Coverage</th>
<th>Requirement</th>
<th>Closeness</th>
<th>Exceeding</th>
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<tr>
<td></td>
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<td>H</td>
<td>H</td>
<td>H</td>
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<tr>
<td>BAA</td>
<td></td>
<td><em>H</em> H 96.87%</td>
<td><em>Q</em> 96.17%</td>
<td><em>H</em> 122.72</td>
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<tr>
<td>AZPS</td>
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<tr>
<td>PACV</td>
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|       |          | _H_ 96.17% | _Q_ 117.17 | _H_ 122.72 | _Q_ 117.17 | _H_ 144.24 | _Q_ 139.08 | _H_ 49.56 | _Q_ 45.65 |
| PACE  |          | _H_ 108.79 | _Q_ 107.11 | _H_ 110.65 | _Q_ 109.08 | _H_ 36.86  | _Q_ 33.97  |           |           |
| PACV  |          | _H_ 59.33  | _Q_ 53.81  | _H_ 58.40  | _Q_ 52.70  | _H_ 23.51  | _Q_ 18.35  |           |           |
Day to Day Operation: Solar

Solar: 19Jan2019

Solar: 03Dec2019
Day to Day Operation: Wind

Wind: 04Apr2019

Wind: 10Oct2019
Summary

- MOSAIC provided nice curvature for RTPD Solar, Wind, Load, as well as along Net Load.
- It has similar coverage as H
- The fact it has smaller exceeding MW, it will help to reduce the fluctuation of the ISO grid operation.
- The MOSAIC methodology can be applied to all percentiles
- The demand curve can be constructed on different percentiles
Other Models Considered

1. \( NL_Q = \) RTPD_Solar RTPD_Solar_sqr + RTPD_Wind RTPD_Wind_sqr + RTPD_Load RTPD_Load_sqr

2. \( NL_Q = \) RTPD_Net_Load RTPD_Net_Load_sqr

3. \( NL_Q = NL_H - (L_H - W_H - S_H) + (L_Q - W_Q - S_Q) \)

The ISO has selected MOSAIC (3) based on its superior performance
Next steps

<table>
<thead>
<tr>
<th>Item</th>
<th>Date</th>
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<tbody>
<tr>
<td>Post Draft Final Proposal</td>
<td>May 8, 2020</td>
</tr>
<tr>
<td>Stakeholder Conference Call</td>
<td>May 18, 2020</td>
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<tr>
<td>Stakeholder Comments Due</td>
<td>June 2, 2020</td>
</tr>
<tr>
<td>BPM Language within a Proposed Revision Request – Buffer, Minimum, Requirement</td>
<td>Aligned with Fall 2020 release</td>
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<tr>
<td>Complete Business Requirement Specifications and Tariff Development</td>
<td>October 2020</td>
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<tr>
<td>EIM Governing Body Briefing</td>
<td>November 4, 2020</td>
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<tr>
<td>ISO Board of Governors Decision</td>
<td>November 18-19, 2020</td>
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