Flexible Ramping Product Refinements Draft Final Proposal

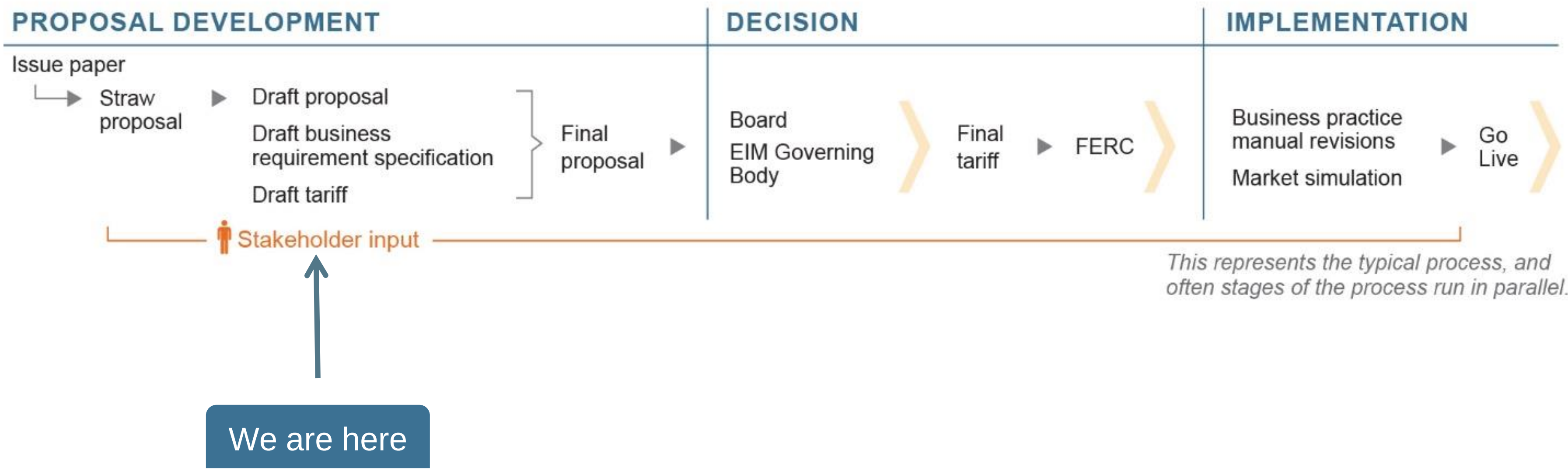
Stakeholder Call

5/18/20

Agenda

Time	Topic	Presenter
1:00 – 1:10	Welcome	Isabella Nicosia
1:10 – 1:50	Changes from Revised Straw Proposal	Don Tretheway
1:50 – 2:50	Nodal Delivery of FRP – Excel Solver	George Angelidis
2:50 – 3:50	Requirement Calculation	Hong Zhou
3:50 – 4:00	Next Steps	Isabella Nicosia

ISO Policy Initiative Stakeholder Process



CHANGES FROM REVISED STRAW PROPOSAL

Changes from Revised Straw Proposal

Issue	Change from revised straw proposal
Proxy demand response eligibility	Changed implementation to Fall 2021
Ramp management between FMM and RTD	None
Minimum FRP requirement	(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.
Deliverability enhancement	(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.
FRP demand curve and scarcity pricing	None
Scaling FRP requirement	None

Minimum BAA requirement for Fall 2020 implementation requires BPM changes

- If a BAA is >= 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

- http://www.caiso.com/InitiativeDocuments/Solver-FlexibleRampingProductDeploymentScenarios-FlexibleRampingProductRefinements.xlsx

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)

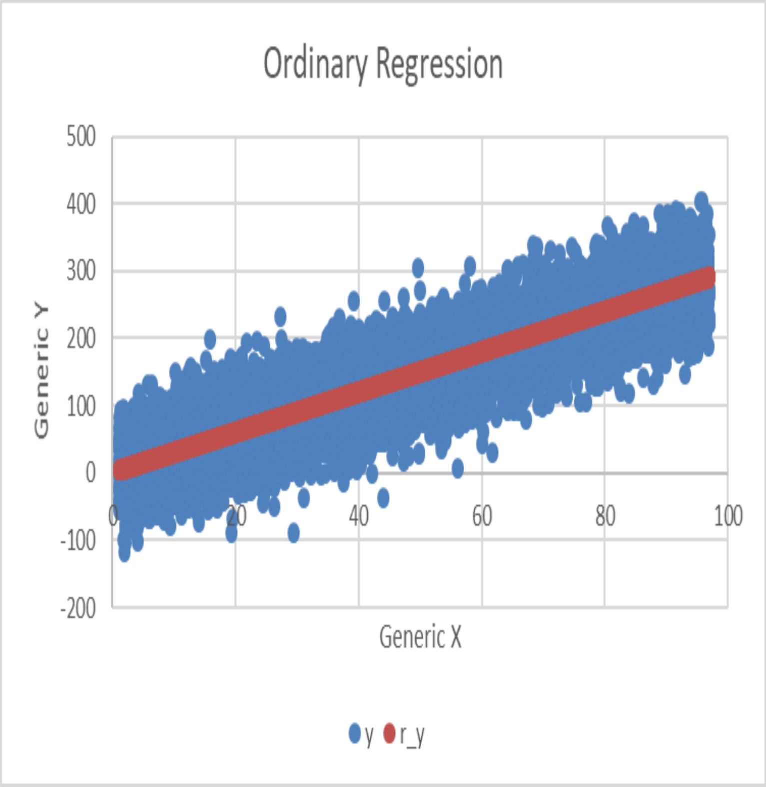
A table in a later slide will report these benefits in a simulation study

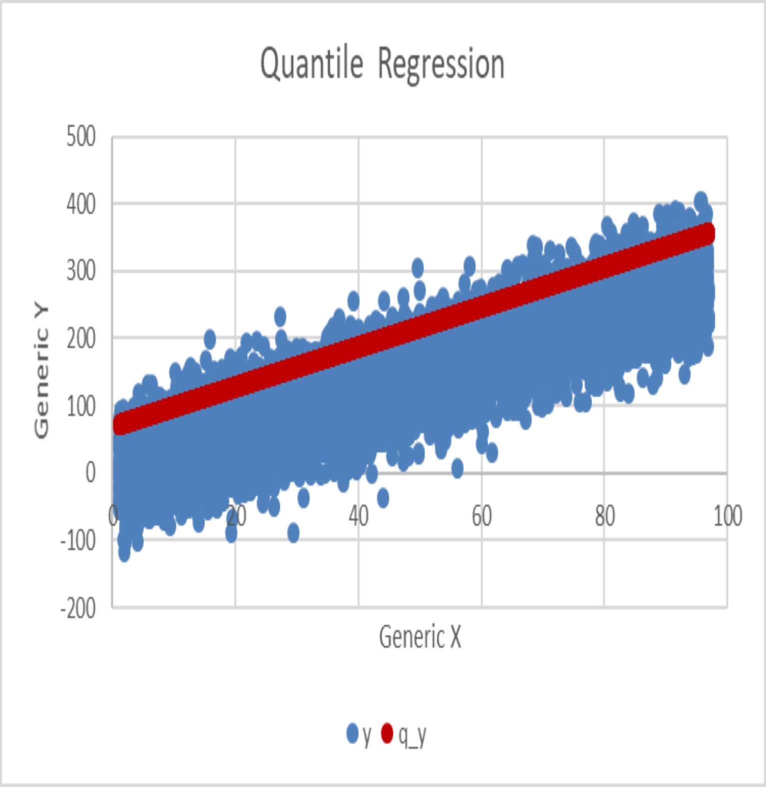
Presentation Flow

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





Quantile Regression

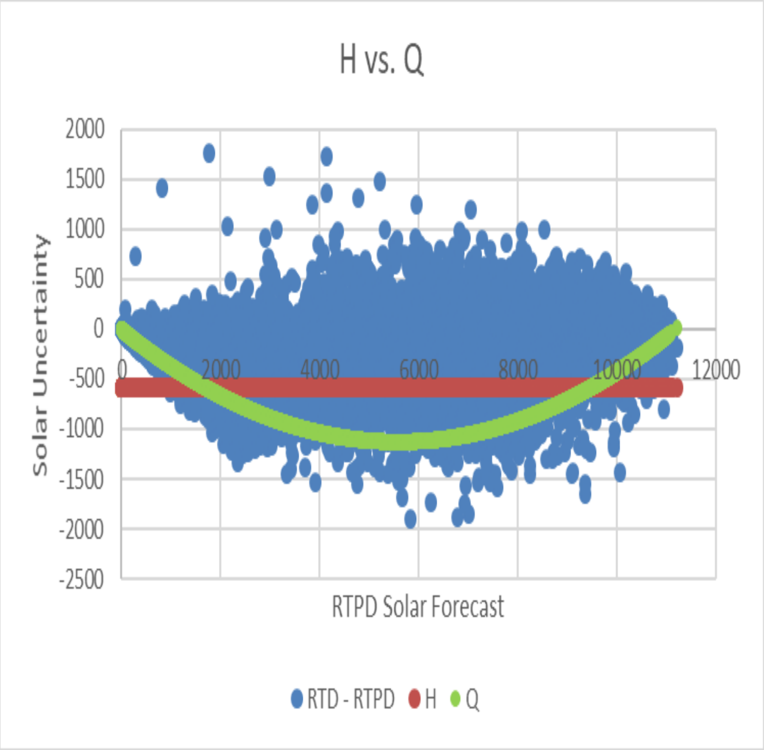
- Quantile Regression(Q) is a natural tool for Flexible Requirement.
  - Quantile Regression: find a good (curved) line to fit a percentile (e.g. 5%) over input variable(s) X
  - Flexible Requirement: Control the chance (e.g. 5%) of the variation over the preset value
- Histogram(H) is a special case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

Net Load Requirement

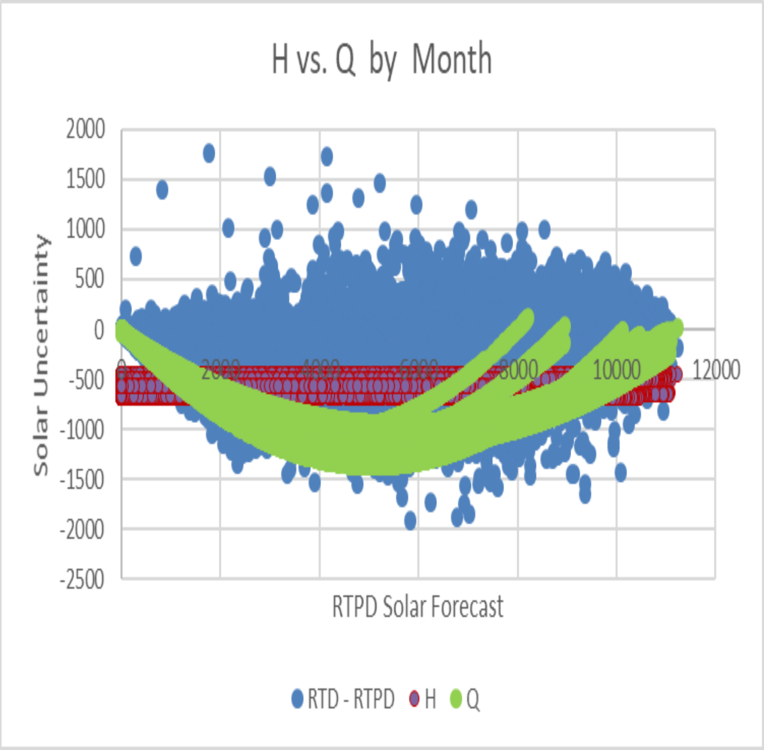
- Net Load (NL) = Load (L) – Wind (W) – Solar(S)
- Variation to anticipate: rtd binding forecast – rtpd advisory forecast
- Next, use S component to show Q has clear advantage over H,

  where S = solar variation

Solar



H vs. Q
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
0
2000
4000
6000
8000
10000
12000
Solar Uncertainty
RTPD Solar Forecast
RTD - RTPD
H
Q

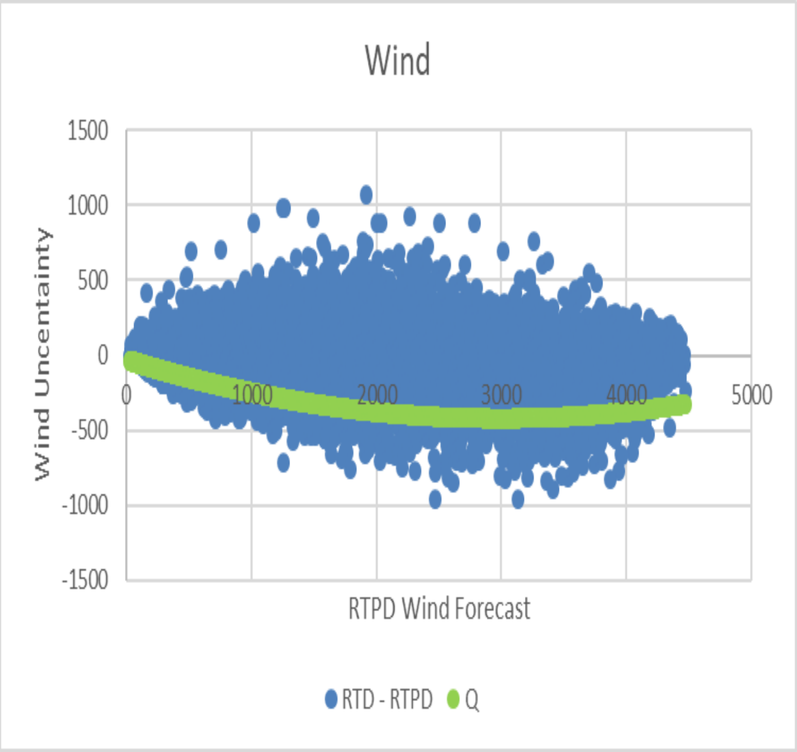


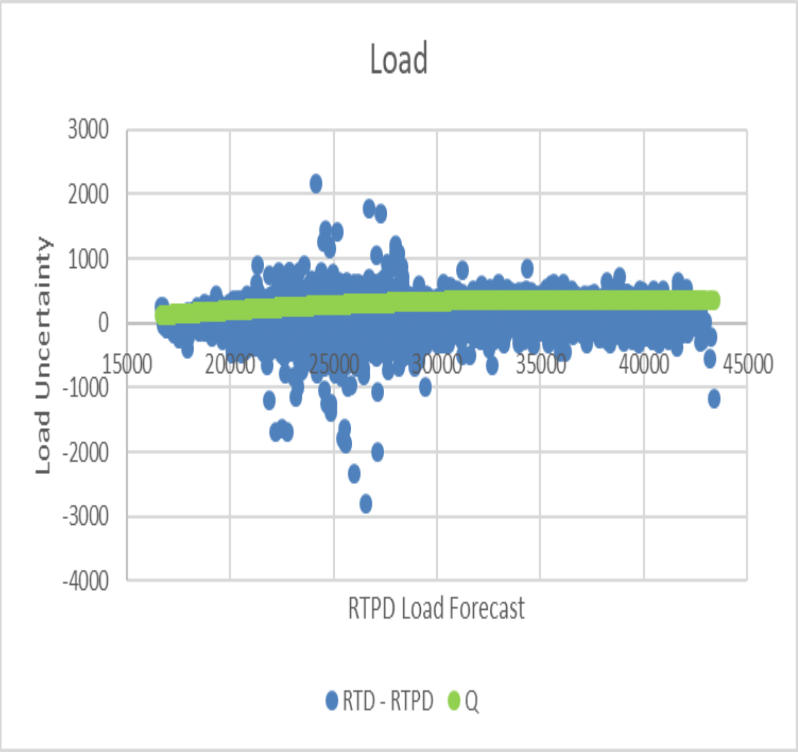
H vs. Q by Month
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
10000
12000
Solar Uncertainty
RTPD Solar Forecast
RTD - RTPD
H
Q

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



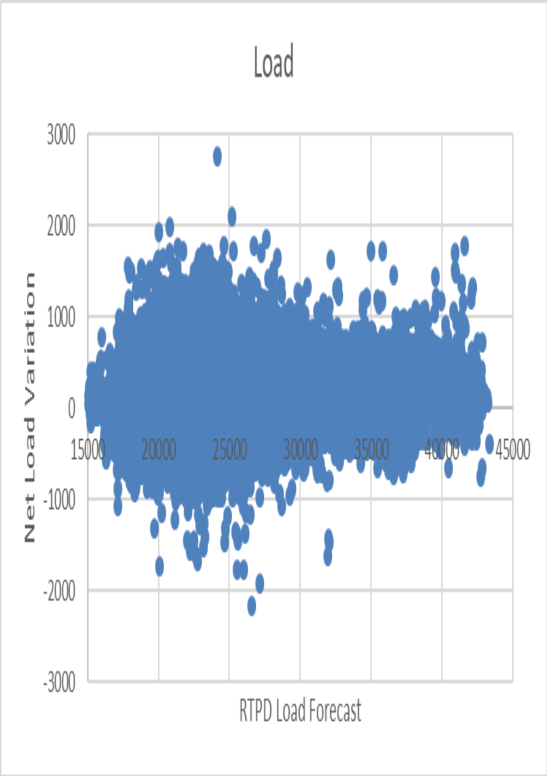


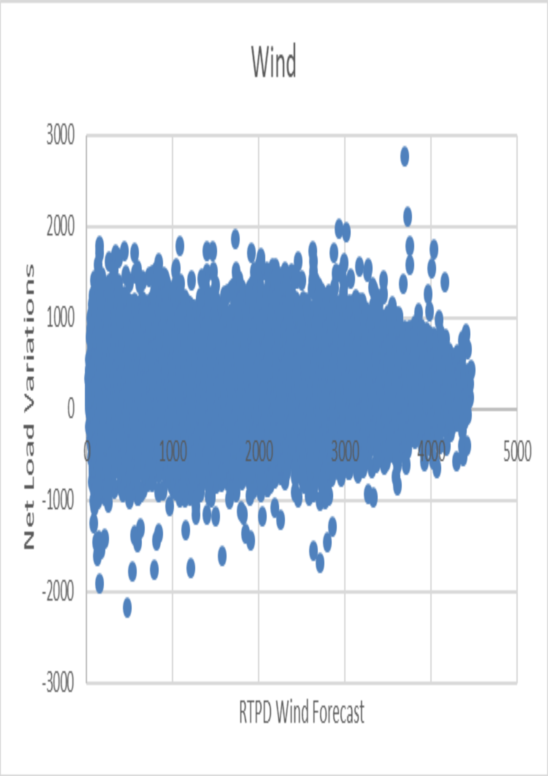
Model for Components

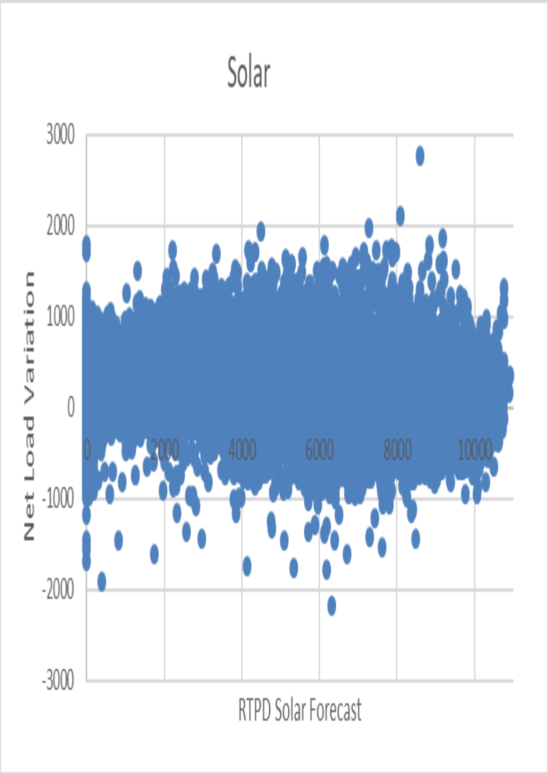
- Quantile Regression models (sqr = square):
  - S_Q = RTPD_Solar RTPD_Solar_sqr
  - W_Q = RTPD_Wind RTPD_Wind_sqr
  - L_Q = RTPD_Load RTPD_Load_sqr

- 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







Challenges and Proposal

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

- Proposal
  - 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 $\text{MOSAIC} = NL_H - (L_H - W_H - S_H) + (L_Q - W_Q - S_Q)$

- Quantile Regression Model $NL_Q = \text{MOSAIC}$

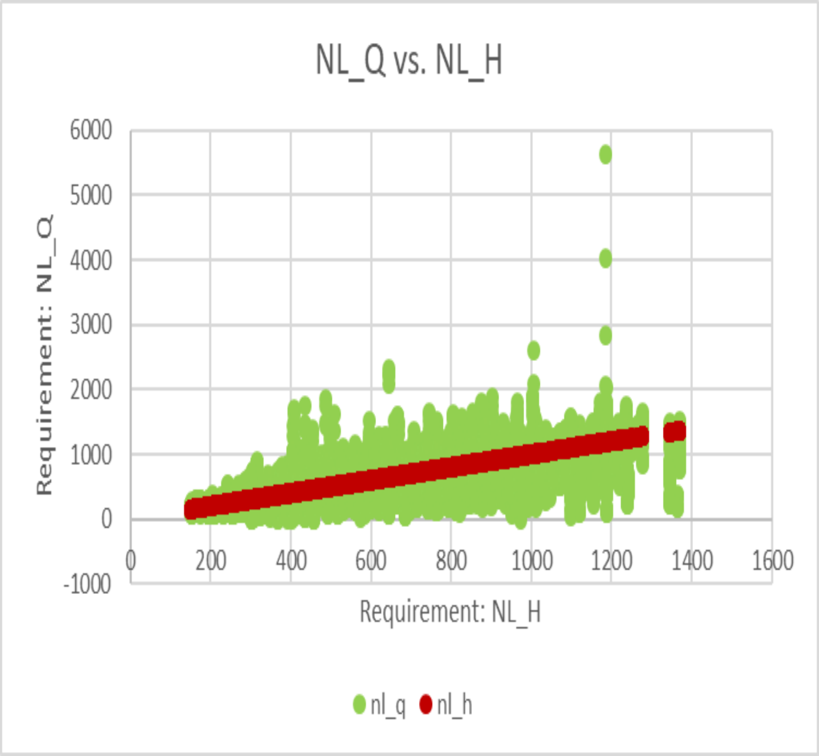
Bounded Mosaic

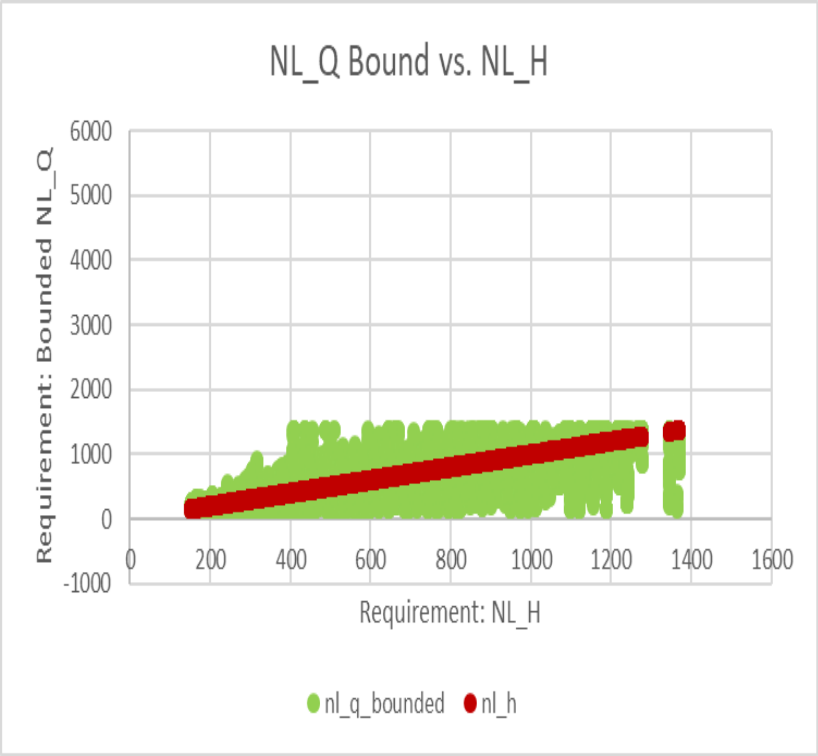
- Mosaic NL_Q are centered around Histogram NL_H
- Bound the Mosaic output to
  - Have more reasonable flexible ramping requirement
  - Ensure reliable grid options
- Bounded the Mosaic output:

$$NL_Q = \min(\gamma_2, \max(\gamma_2, NL_Q)) ,$$

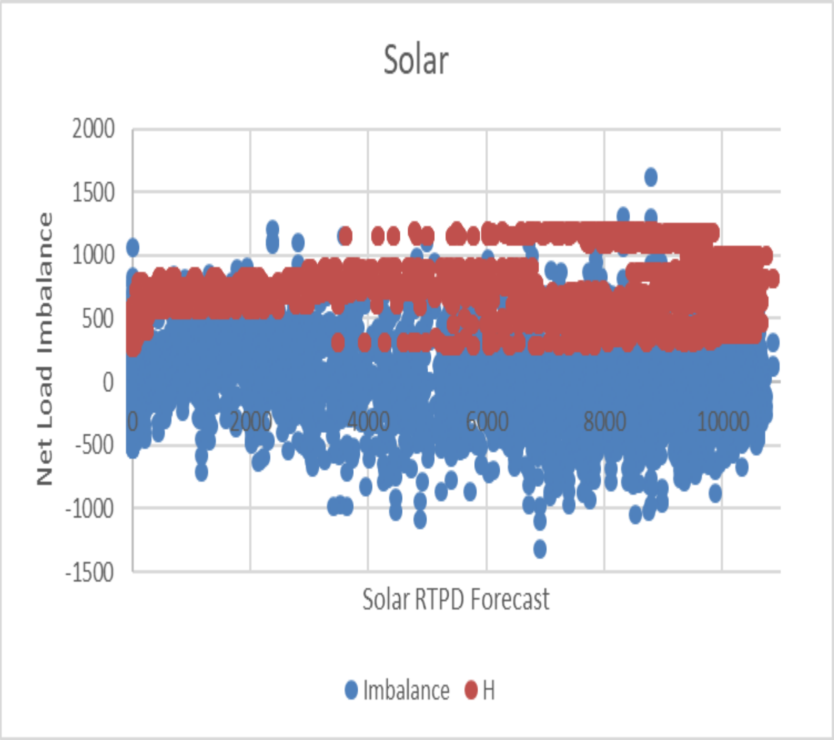
where γ_1 and γ_2 are configurable parameters

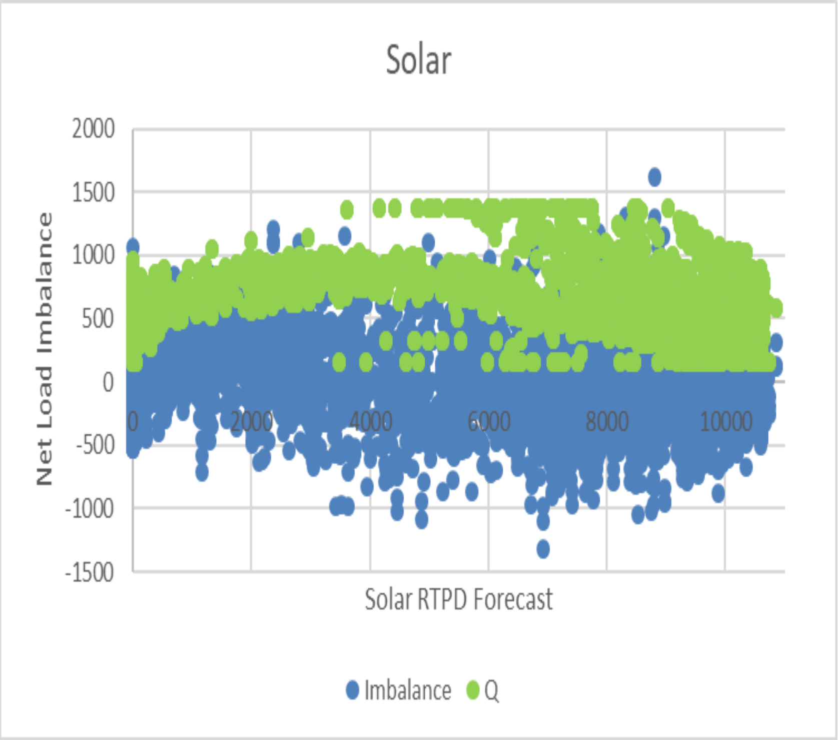
Bounded Mosaic



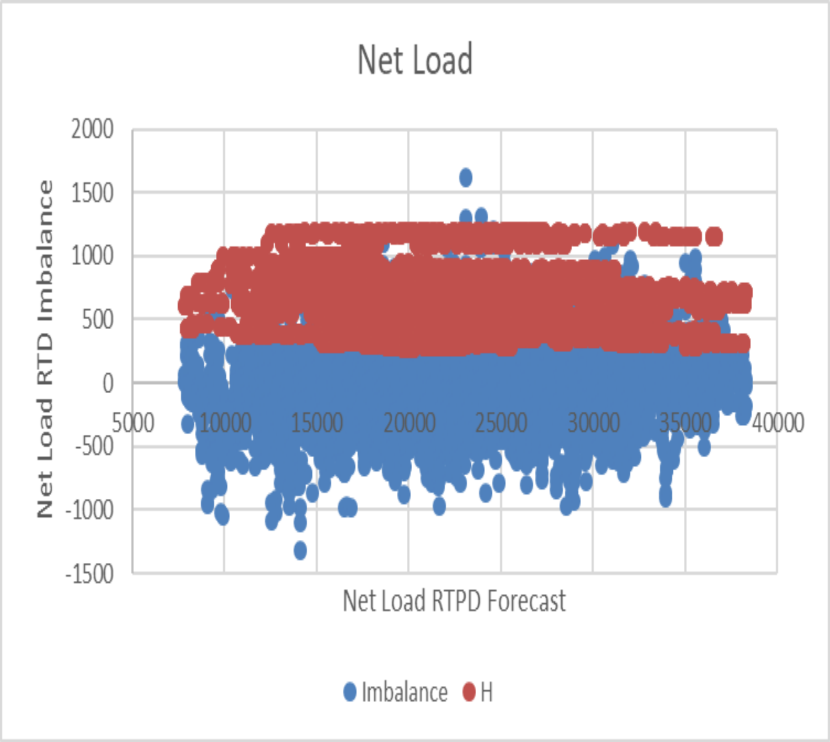


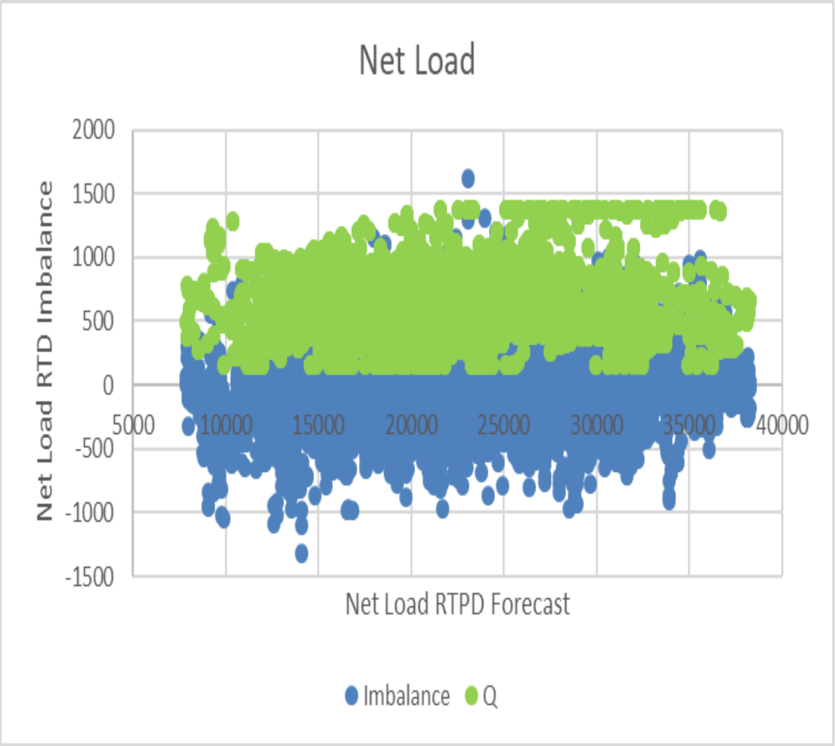
Mosaic: Adapt Requirement by Forecast





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
- γ_1 = min (NL_H), γ_2 = max (NL_H)

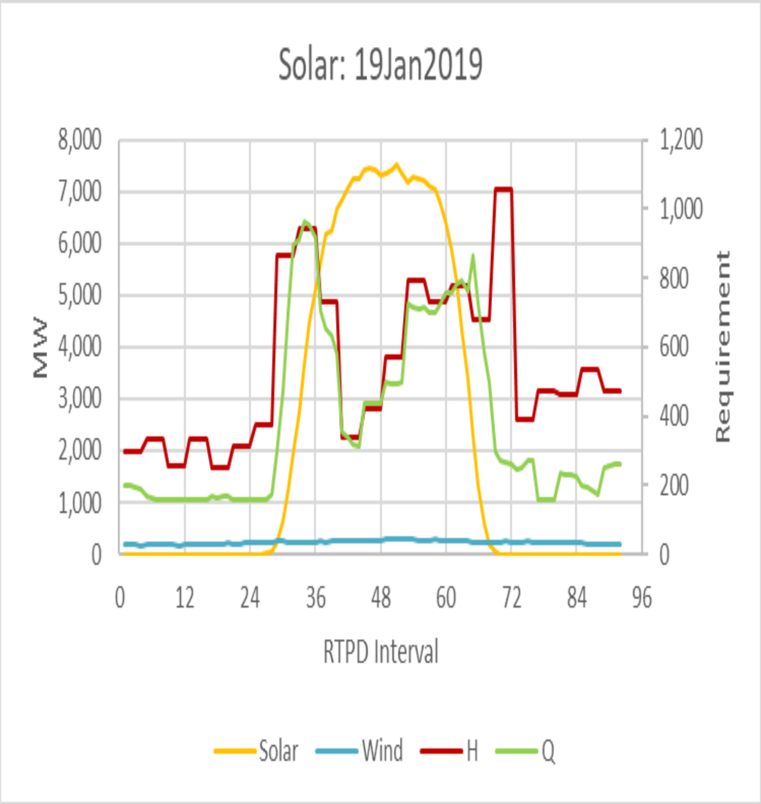
Performance Measures

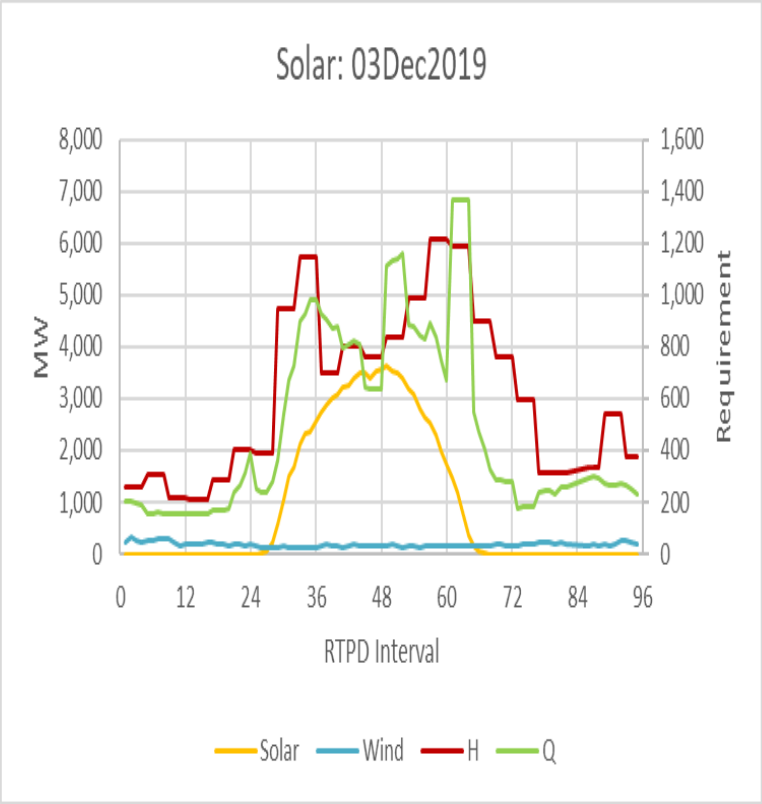
- Criteria for performance measurements:
  - Coverage (e.g., 97.5%): accuracy rate
  - Average Requirement
  - Closeness with actual uncertainty profile
  - Average MW when imbalance exceeding requirement

Simulation Results (H vs. Q)

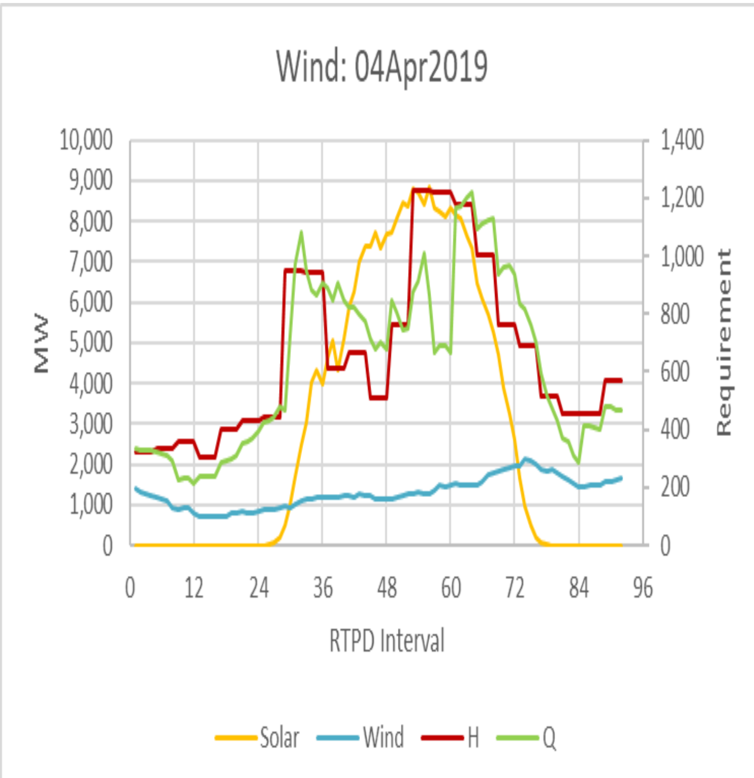
	Coverage		Requirement		Closeness		Exceeding	
BAA	H	Q	H	Q	H	Q	H	Q
AZPS	96.87%	96.17%	122.72	117.17	144.24	139.08	49.56	45.65
CISO	96.71%	96.10%	602.85	547.13	595.46	540.99	175.07	163.74
IPCO	97.16%	96.80%	66.02	61.58	67.61	63.08	24.84	20.75
NEVP	97.00%	96.08%	70.63	62.02	78.05	69.79	29.10	26.77
PACE	96.99%	96.57%	108.79	107.11	110.65	109.08	36.86	33.97
PACW	97.19%	96.86%	59.33	53.81	58.40	52.70	23.51	18.35

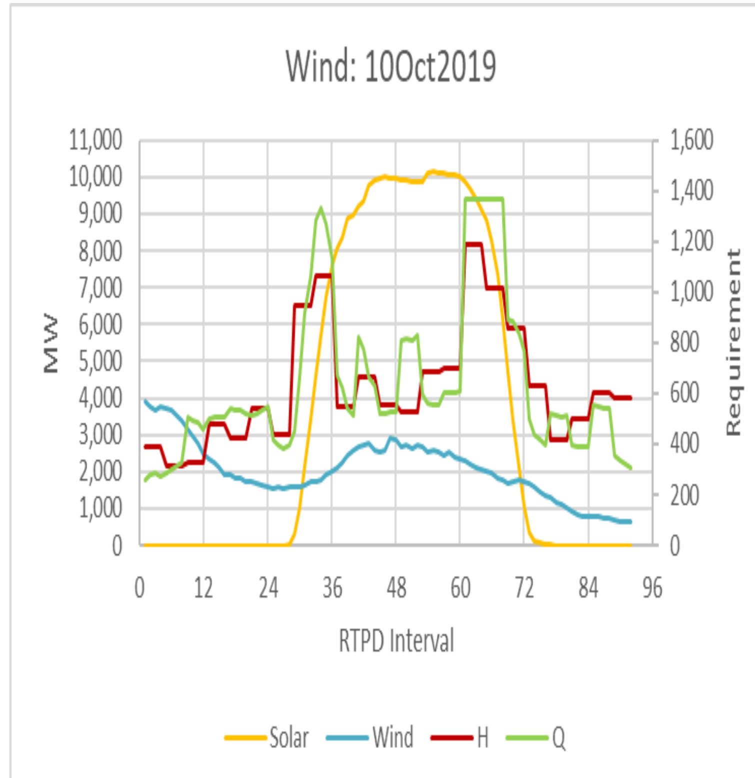
Day to Day Operation: Solar





Day to Day Operation: Wind





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. $NL_Q = \quad \text{RTPD\_Solar} \quad \text{RTPD\_Solar\_sqr} \; +$

   $\text{RTPD\_Wind} \quad \text{RTPD\_Wind\_sqr} \; +$

   $\text{RTPD\_Load} \quad \text{RTPD\_Load\_sqr}$

2. $NL_Q = \text{RTPD\_Net\_Load} \quad \text{RTPD\_Net\_Load\_sqr}$

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

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

Please send written comment using the comments template available on the initiative webpage to initiativecomments@caiso.com.