



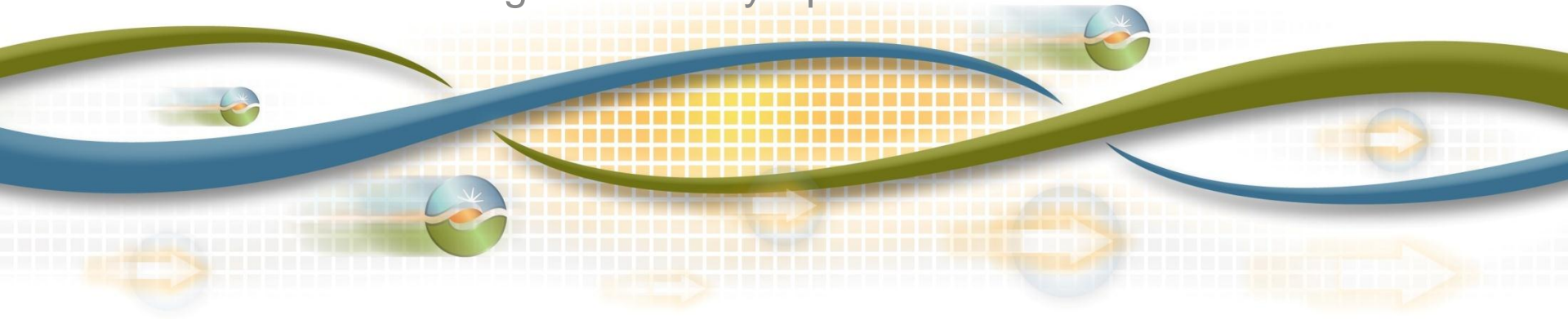
California ISO  
Shaping a Renewed Future

# Flexible Ramping Product

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Lin Xu, Ph.D.  
Senior Market Development Engineer

Don Tretheway  
Senior Market Design and Policy Specialist

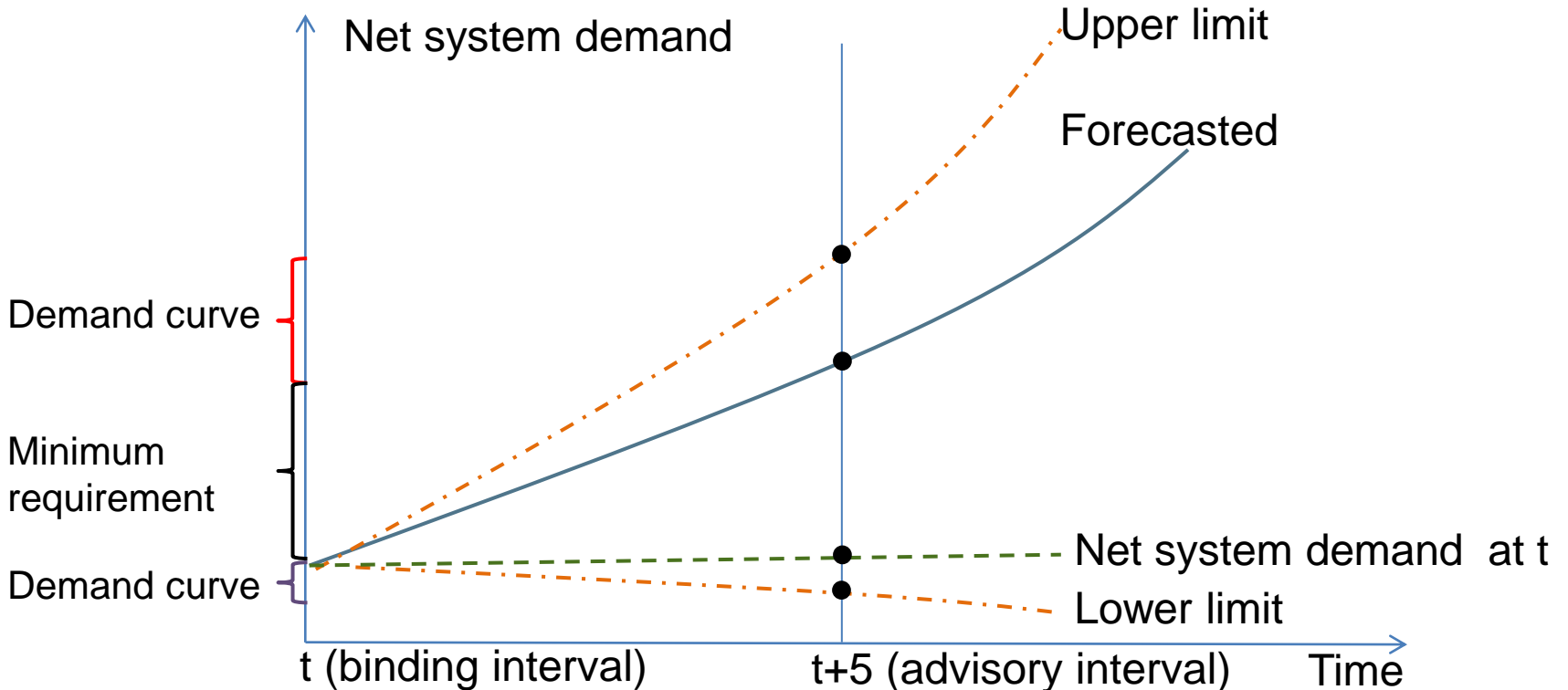


# MSC Discussion

- FRP Real Ramp
- Capacity Bids in RT and DA
- DA Procurement Target
- Combined IFM RUC
- Cost Allocation
- Empirical review of constraint

# Flexible Ramping Product to meet Real Ramping Need

Net system demand = load + export – import – internal self-schedules - supply deviations



## Real ramping need:

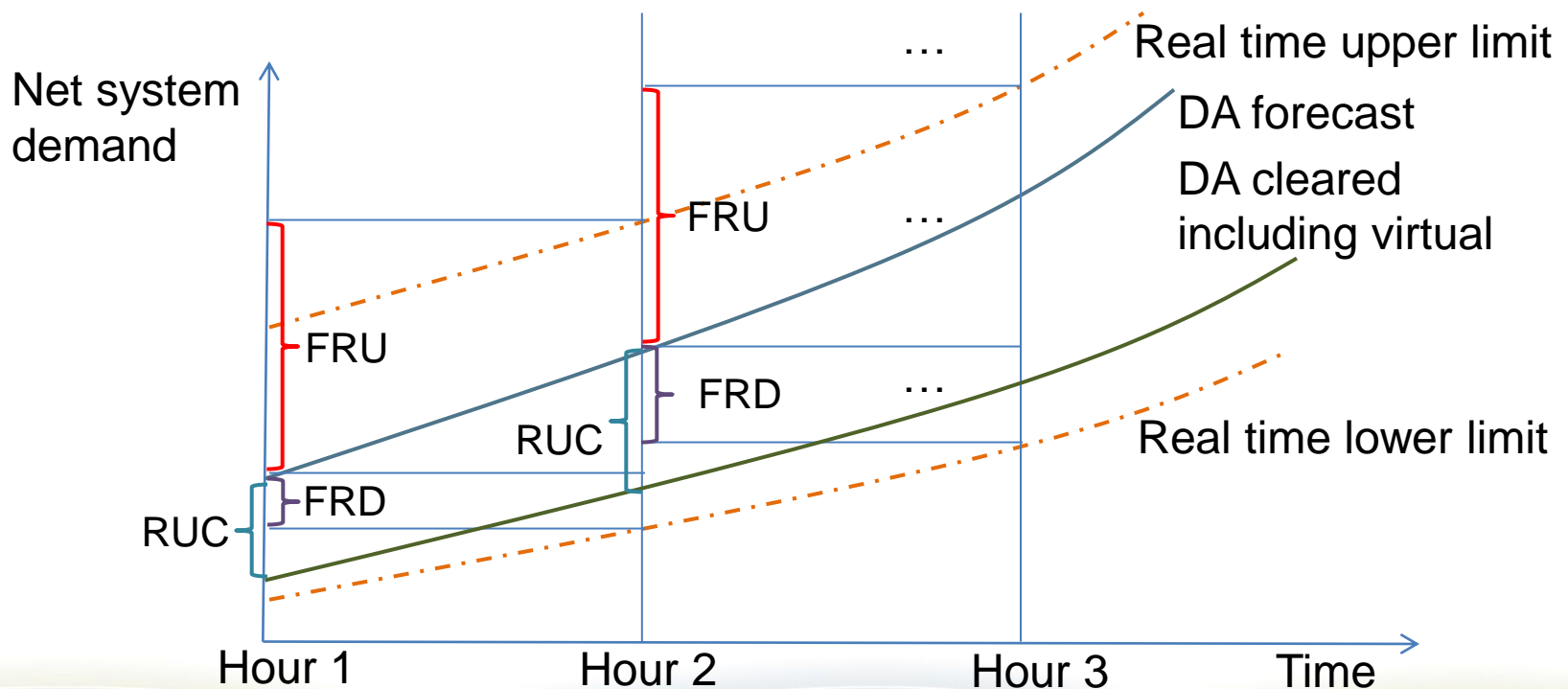
Potential net load change from interval t to interval t+5  
(net system demand t+5 – net system demand t)

# Allow FRP capacity bids in both upward and downward direction

- Any 5-minute dispatchable resource with energy bids can provide flex ramp
- Bid cap \$250, bid floor \$0
- Do not allow self providing flex ramp
- In real-time markets, a flex ramp bid only applies to incremental award from the day-ahead award
  - In real-time markets, day-ahead flex ramp award will be assumed to have a zero bid
- Two settlement system
  - DA flex ramp award will be paid the day-ahead flex ramp price
  - RTD flex ramp incremental/decremental award from the day-ahead award will be paid/charged the RTD flex ramp price
  - Unavailable flex ramp will be charged the RTD flex ramp price

# Day-ahead maximum procurement

- Flex ramp covers potential net movement between net demand forecast in hour  $t$  and real-time band in hour  $t+1$
- RUC covers the difference between day-ahead net demand forecast and the cleared net demand in hour  $t$
- Flex ramp capacity reserved on top of RUC schedule



# Combined IFM and RUC needed for Day-Ahead FRP procurement and improved market efficiency

- DA FRP procurement is based upon forecasted real-time demand and real-time uncertainty not cleared IFM and day-ahead uncertainty
- Allows resources committed in RUC to meet FRP requirement
- RUC committed resources receive a binding IFM energy schedule

# Cost Allocation – Align movement and metering

1. DA and RT FRP costs initially split in to three categories based upon net movement
  
2. Allocate each category
  - A. Load (hourly meter) category allocated to gross UIE
  
  - B. Supply (10 minute meter) category allocated to gross deviations and self-schedule changes
  
  - C. Fixed Ramp category is allocated to SC's net static imports/exports

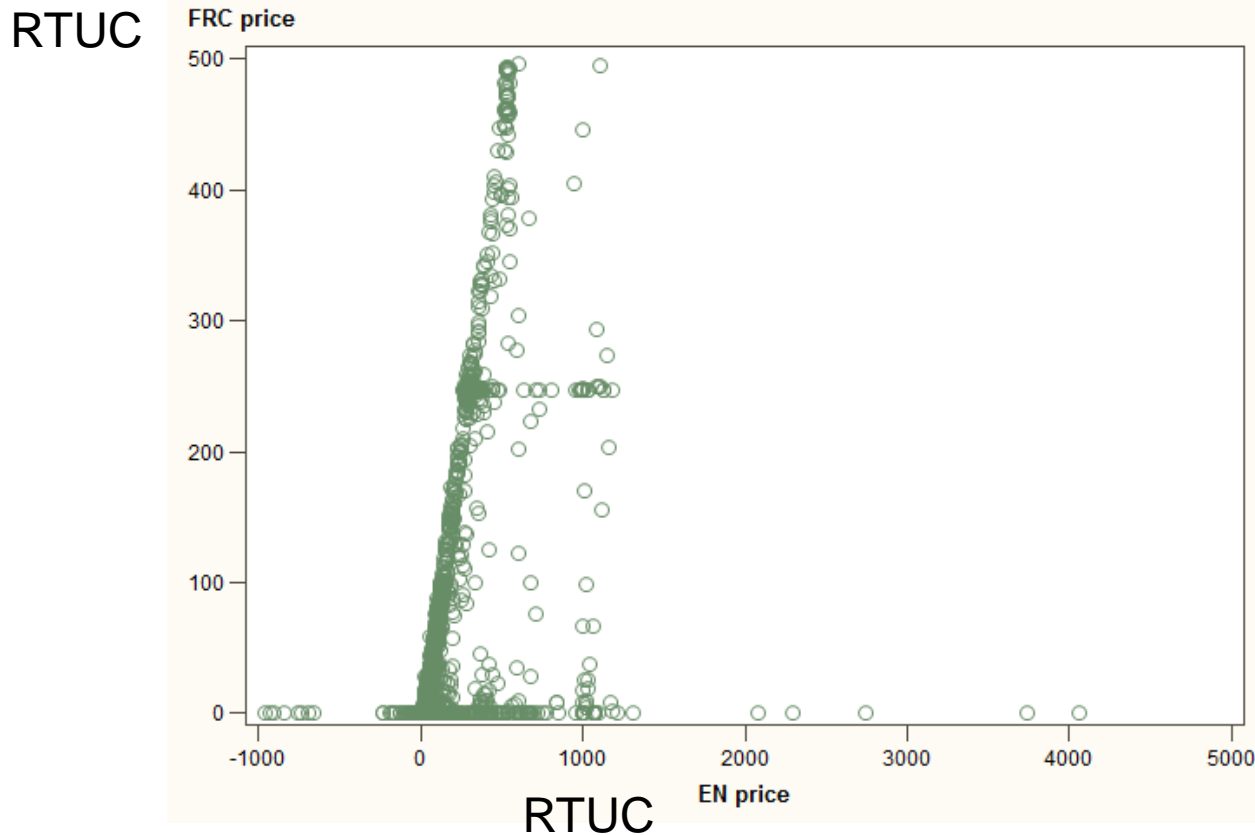
# Allocation of each category

		Baseline	Actual	Deviation	Allocation
1	Load	Day-Ahead Schedule	Metered Demand	UIE	Gross Deviation
2	Variable Energy Resource	15 Minute Expected Energy	10 Minute Meter	Baseline - Actual	Gross Deviation Outside Threshold
	Generation with Instructed Energy	Instruction	10 Minute Meter	UIE1 + UIE2	Gross UIE Outside Threshold
	Generation with Self Schedule	N/A	N/A	UIE + Hourly SS Change / 6	Gross Deviation Outside Threshold
	Dynamic Transfers	Instruction	10 Minute Meter	UIE1 + UIE2	Gross UIE Outside Threshold
3	Fixed Ramp Interties	Ramp Modeled	Assumed Delivered	Net Movement	Gross by SC

No netting across settlement intervals.



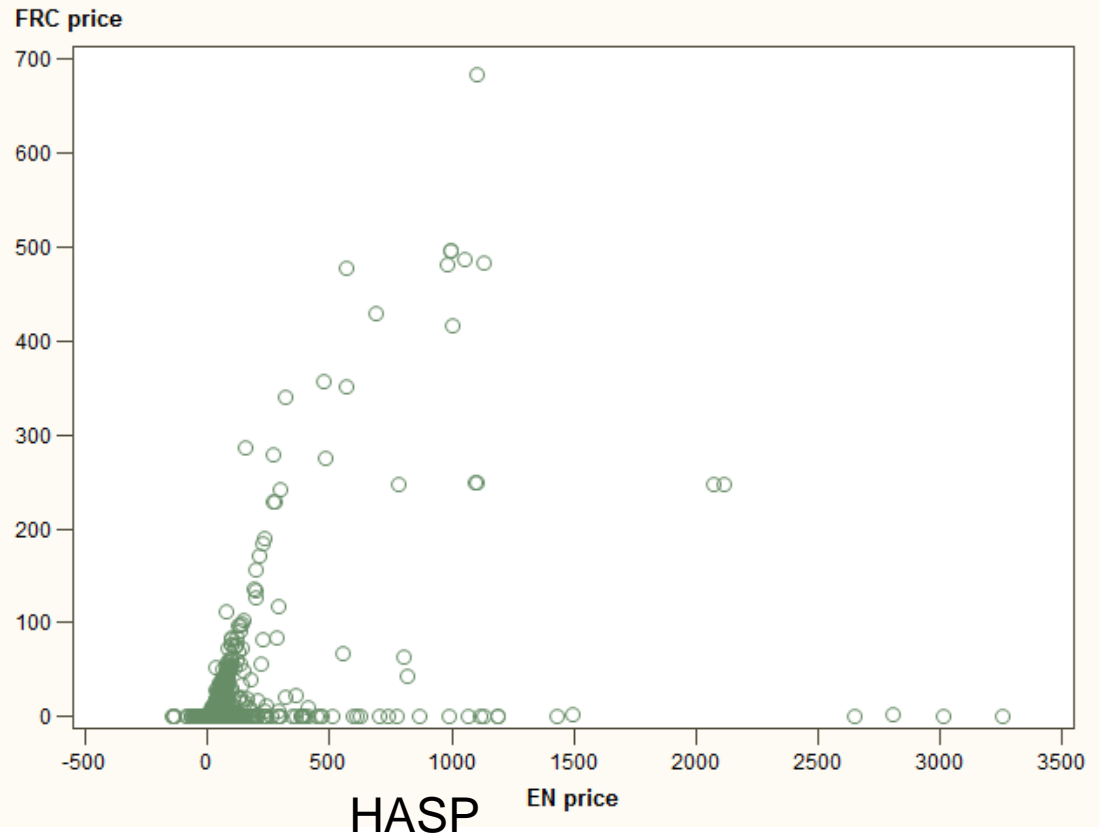
# Price correlation between flex ramp constraint and energy



- Overall, good correlation between RTUC flex ramp price and RTUC energy price
- The correlation would extend to negative prices with the downward flex ramp product

# Price correlation between flex ramp constraint and energy

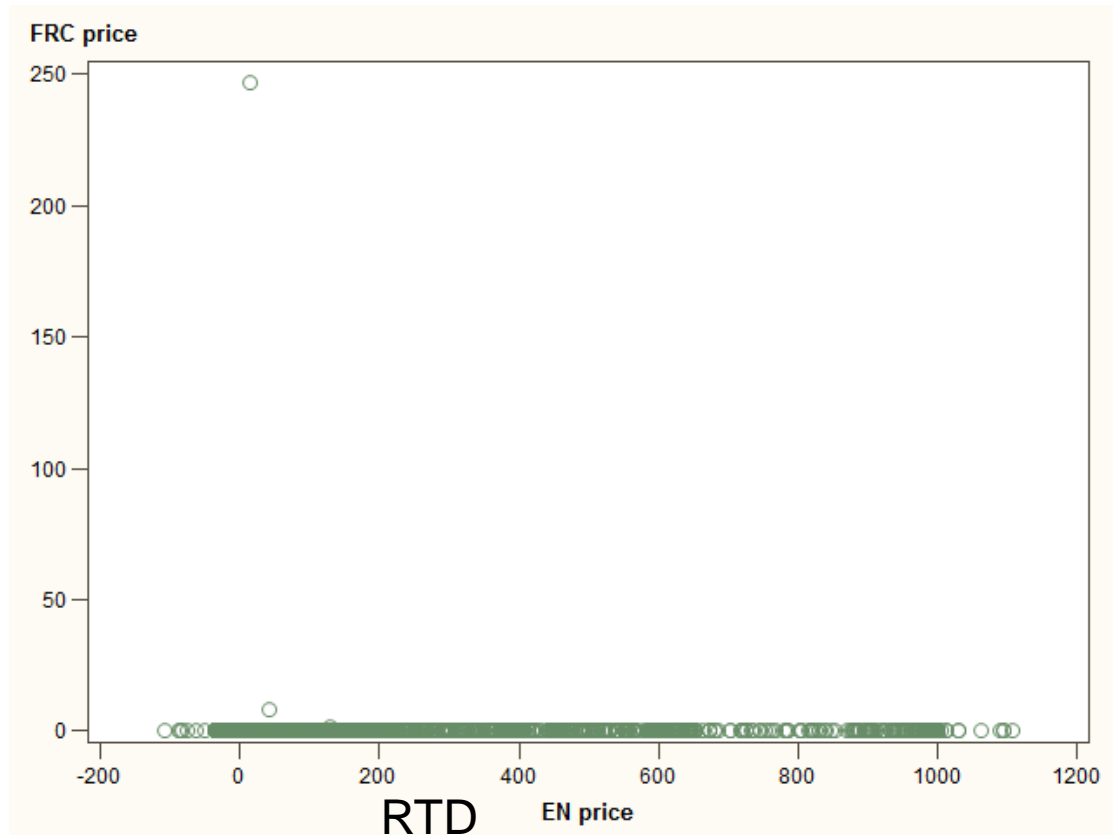
HASP



- Overall, good correlation between HASP flex ramp price and HASP energy price, but prices are lower than RTPD
- For the same interval, the advisory conditions are different from the binding conditions, which have impacted the unit commitments

# Price correlation between flex ramp constraint and energy

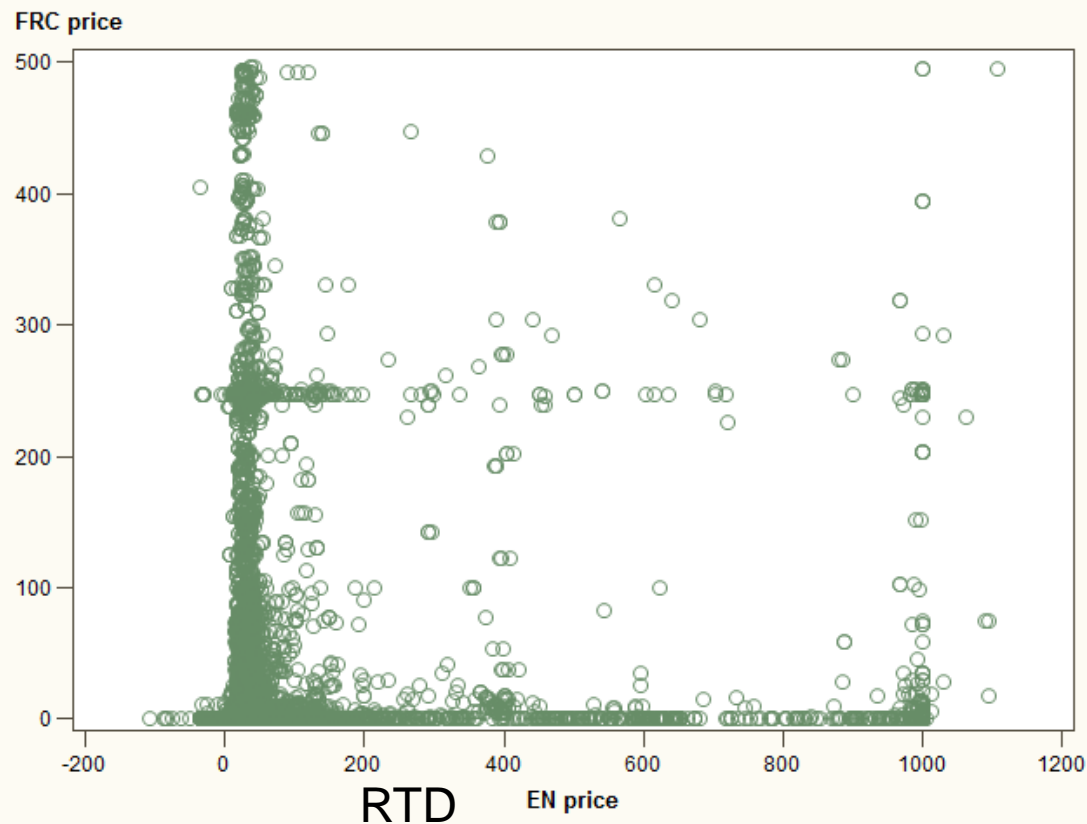
RTD



- No correlation between RTD flex ramp price and RTD energy price because zero requirement is enforced for the binding RTD interval

# Price correlation between flex ramp constraint and energy

RTUC



- Poor/no correlation between RTUC flex ramp price and RTD energy price raises the concern of over/under procurement and poor deployment
  - Over procurement: FRC price high, energy price low
  - Under procurement: FRC price low, energy price high
  - Poor deployment: use up capacity unnecessarily, and get short when real need comes

# Questions

Product design:

Lin Xu

[lxu@caiso.com](mailto:lxu@caiso.com)

916-608-7054

Cost Allocation:

Don Tretheway

[dtretheway@caiso.com](mailto:dtretheway@caiso.com)

916-608-5995