



# California ISO Over-Supply: Current Rules and Future Expectations

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# Disclaimer

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- Any reporters, I am happy to be on record, but anyone else who may talk or chat, is off the record.
- The views expressed are my own and do not represent my company, any client, or the Western Power Trading Forum members

# Gridwell Webinars

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- The Western Power Trading Forum (WPTF) is a non-profit trade organization with a mission to encourage **competition and transparency** in western markets. We run the CAISO committee. [www.gridwell.com/wptf](http://www.gridwell.com/wptf)

# Over-supply concerns

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- Over-supply impacts:
  - **Energy market prices and generation dispatch** (scheduling coordinators, asset developers, EIM entities, load serving entities)
  - **Contracts** (renewable asset owners, load serving entities – especially CCAs that are heading toward 100% renewables)
  - **Benefits of expansion** (EIM entities, future day-ahead market participants, environmentalists)
  - **Reliability** (PTOs, regulatory agencies, everyone)

# Renewables and over-supply

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- We're integrating a lot of renewables over the next 12 years. A LOT.
- Over-supply is one way to assess how well California is integrating renewable energy
- What is causing small amounts of over-supply now, will cause large amounts of over-supply later

# Presentation outline

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This builds upon a 2017 over-supply presentation that you can find [here](#).

1. How the market optimization handles over-supply – new stuff on operators and EIM
2. What is impacting curtailment levels and some insights from 2018
3. Initial thoughts on how to improve market as we transition toward 100% renewable future

# Part 1

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OVER-SUPPLY IMPACT ON PRICES -  
UPDATED

# What is over-supply?

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- Over-supply conditions generally reflect a situation where resources that are willing to generate at \$0/MWh or pay to generate are dispatched downward
- Over-supply and curtailment occurs in day-ahead or real-time market
- Curtailment occurs because:
  - Supply/demand imbalance
  - Grid economics
  - *Grid operator expectations*



# How is over-supply measured?

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- Curtailment is shorthand for CAISO backing down solar and wind energy
- The CAISO reports on curtailments, which they define as “the difference between actual production and the forecast when actual production is less than forecast”
- The CAISO will begin to report on a new curtailment, ‘the difference between actual production and *capability*, when actual production is less than *capability*.’

# CAISO curtailment types

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Different wind and solar curtailment categories-

1. System or local curtailment
2. Economic or self-schedule
3. Exceptional dispatch
4. Operator intervention
  - Since last year, the CAISO has clarified their authority for grid operator curtailments that are not exceptional dispatches

# CAISO curtailment

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The *market optimization* will curtail wind and solar resources that have:

- Economically offered in energy at a price
- Self-scheduled their energy into the market as price takers

Economic  
or self-  
schedule  
curtailment

*CAISO operators* will curtail wind and solar resources that have:

- Economically offered in energy at a price
- Self-scheduled their energy into the market as price takers

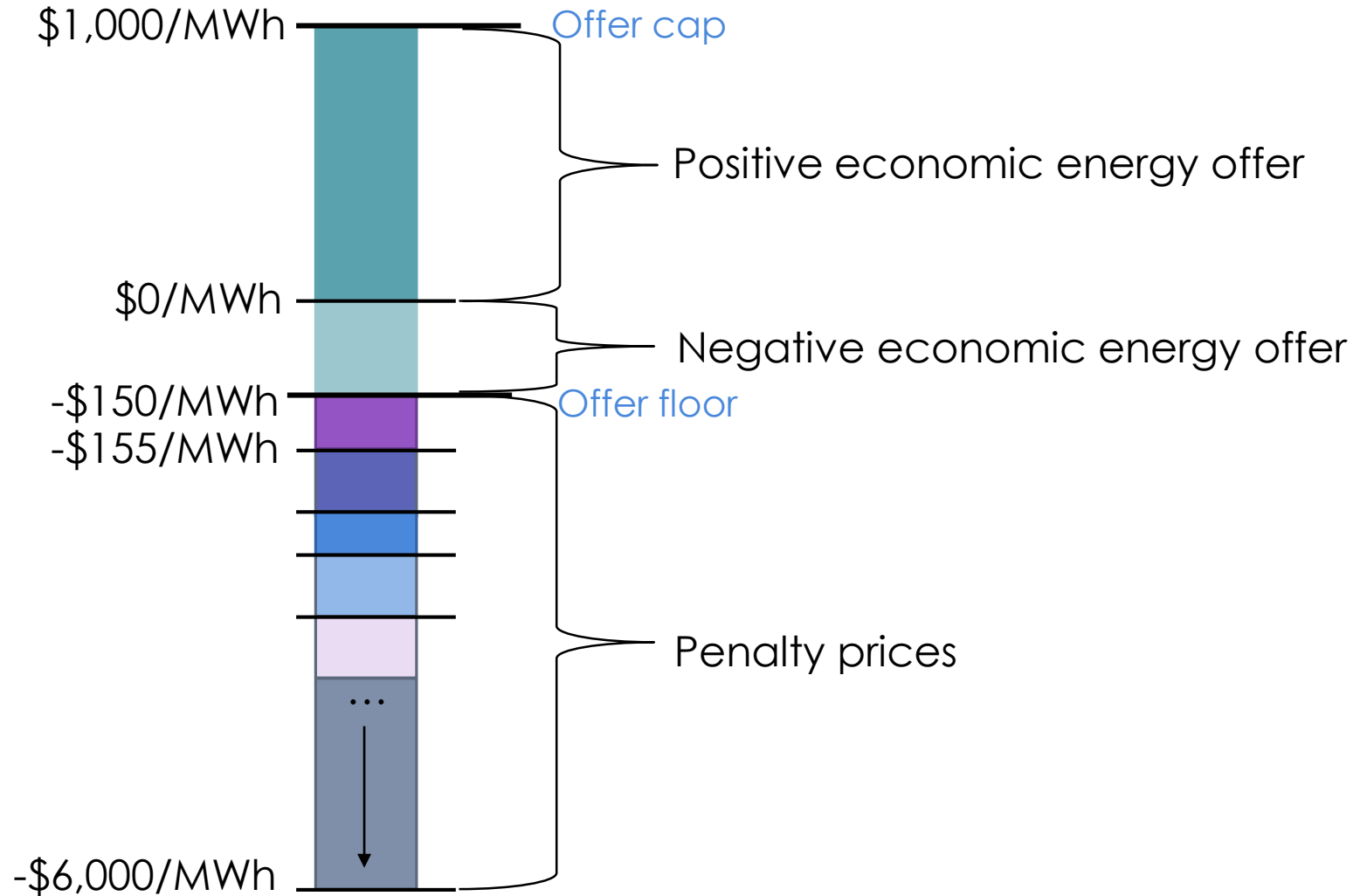
Exceptional  
dispatch or  
operator  
curtailment

# Market optimization: overview

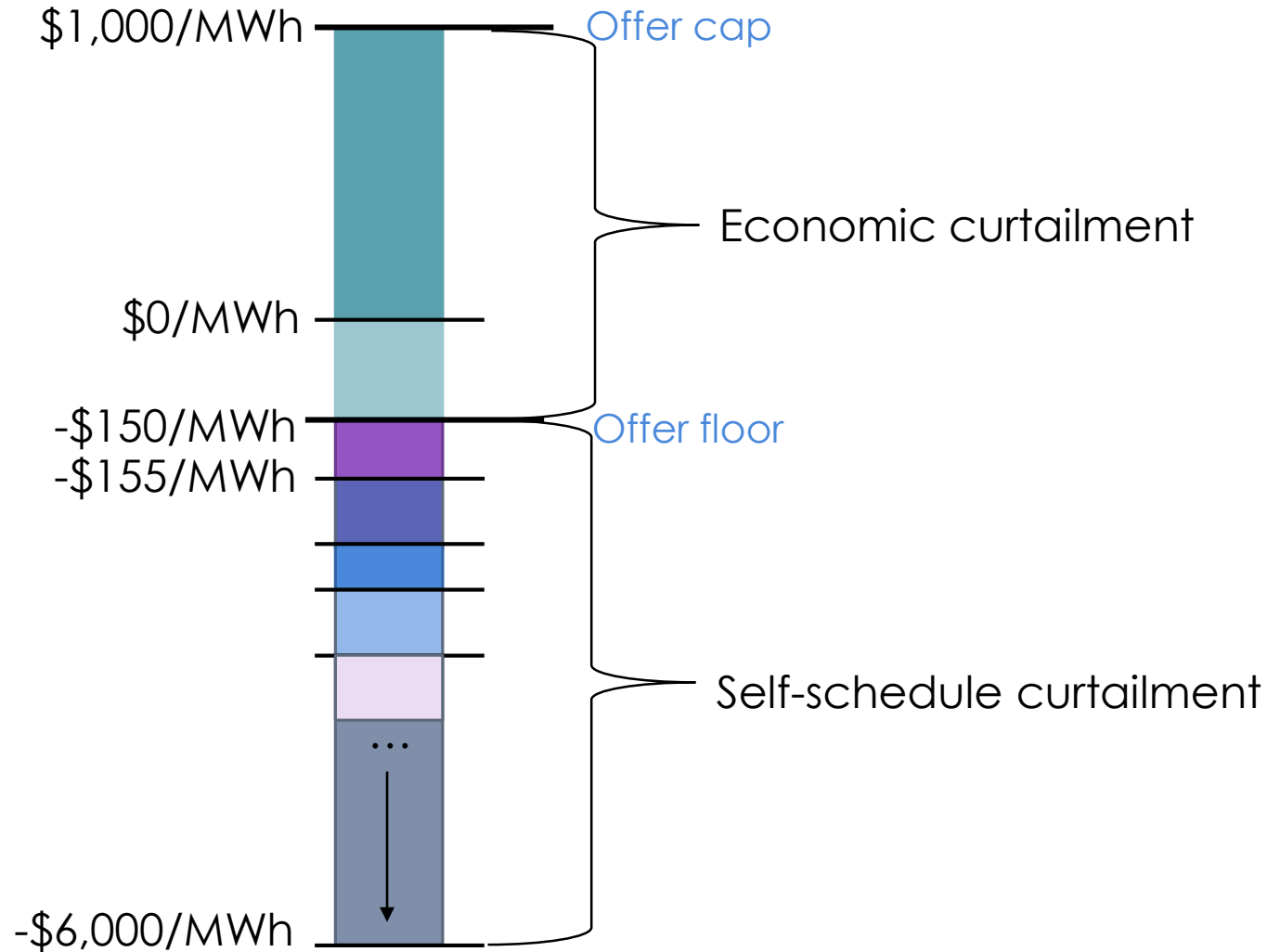
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- The market optimization is a giant cost-minimization problem that ensures supply meets demand at the lowest cost
- Optimization manages congestion using:
  - Economic offers (between  $-\$150/\text{MWh}$  and  $\$1,000/\text{MWh}$ )
  - Assigned parameter costs or “penalty factors”
    - Self-schedules are price takers and thus assigned a penalty factor
    - Ancillary services, RMR resources, transmission constraints, etc. are all assigned different penalty factors

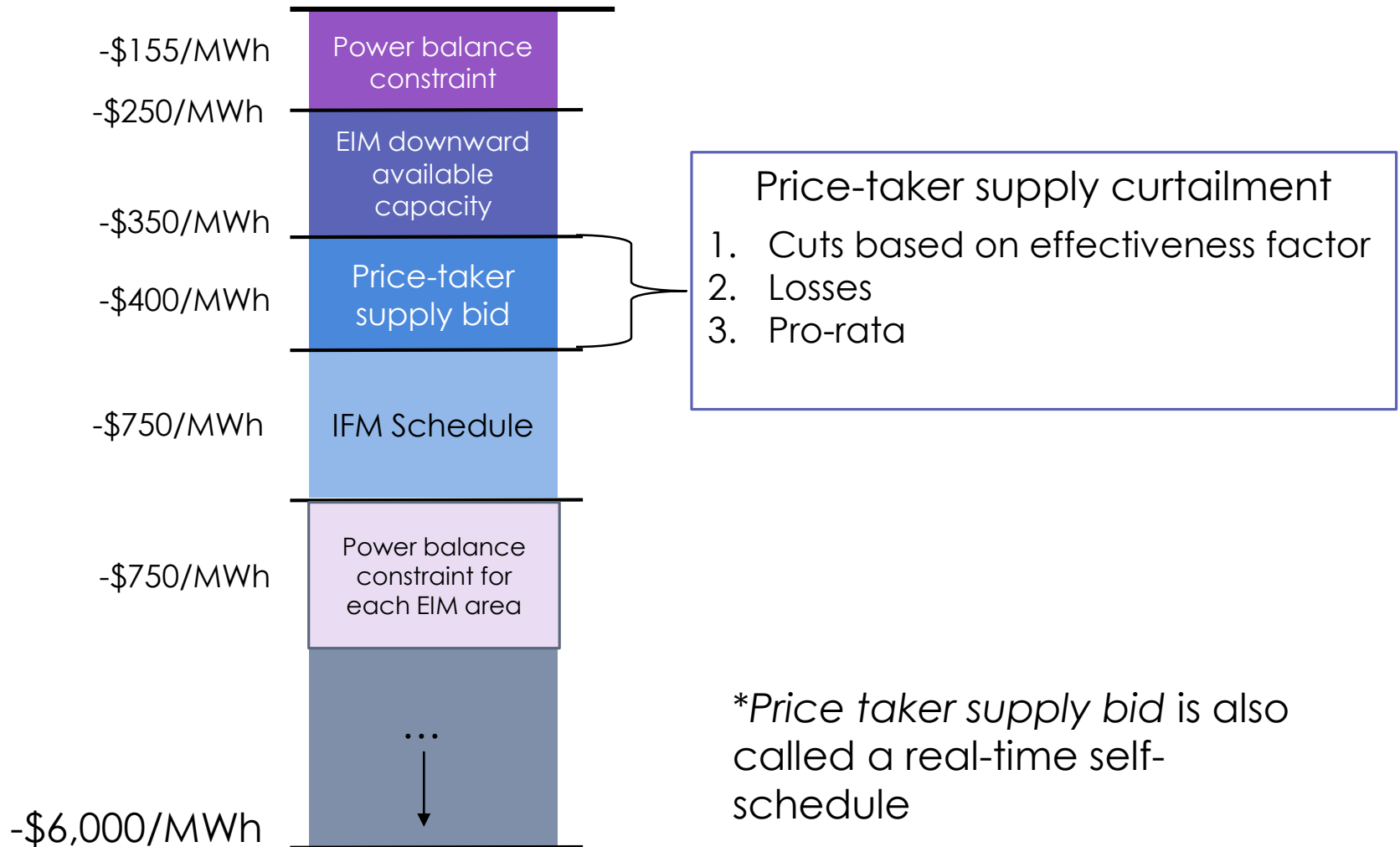
# Market optimization is based solely on economics



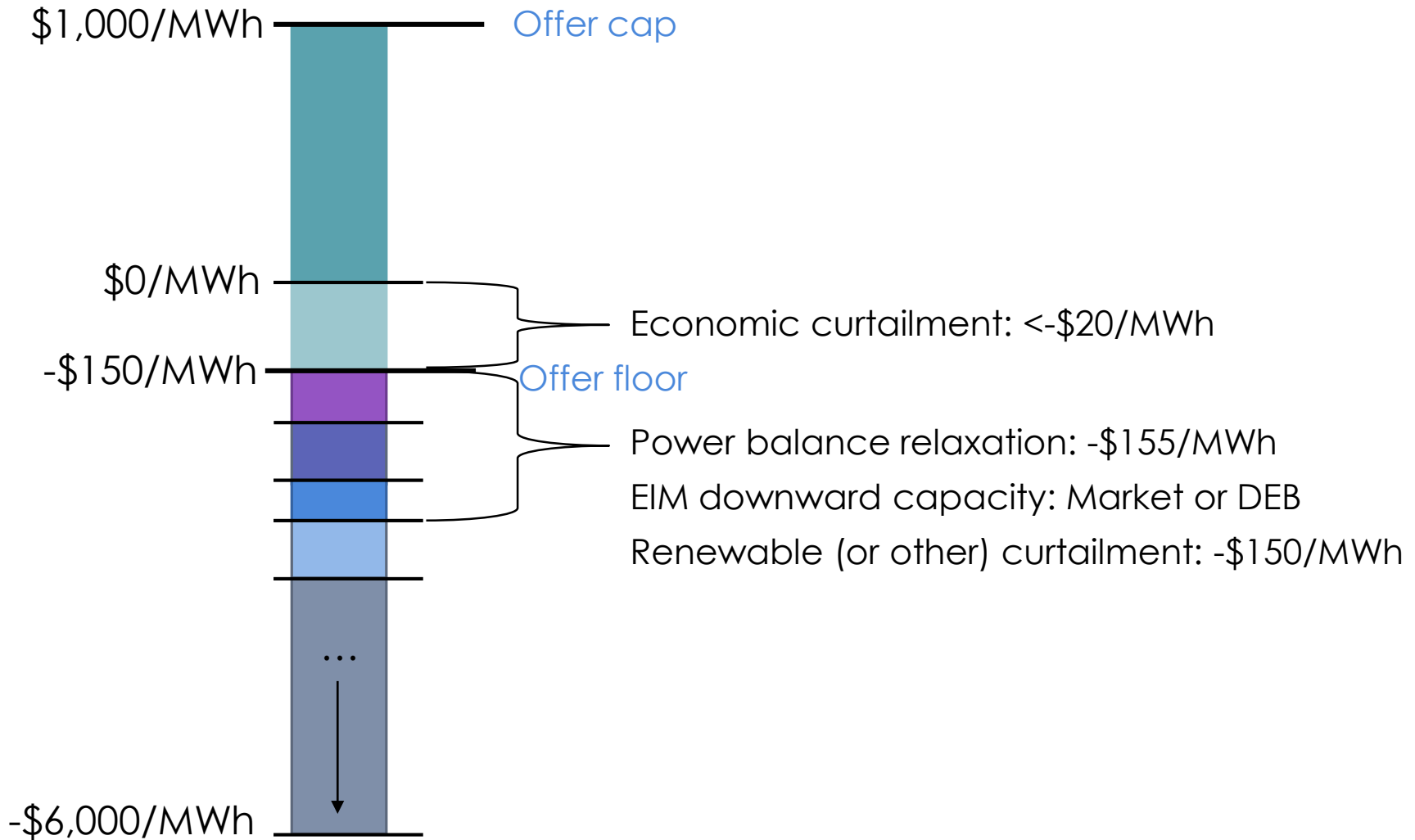
# Market optimization curtailment types



# Market optimization self-schedule curtailment



# Pricing impacts of curtailment





# Non-market curtailment

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- Exceptional dispatch curtailment – *dispatch* instruction by CAISO to decrease or increase output (cannot set LMP)
- Operator curtailment – *operating* instruction to not generate higher than their schedule
  - New curtailment type that acknowledges VERs may generate higher than their forecast, but at times the CAISO operators see over-supply conditions and need to curtail
  - The CAISO should use up all economic bids before issuing operator curtailment
  - The CAISO has committed to make operator curtailments transparent

# Local and system curtailment

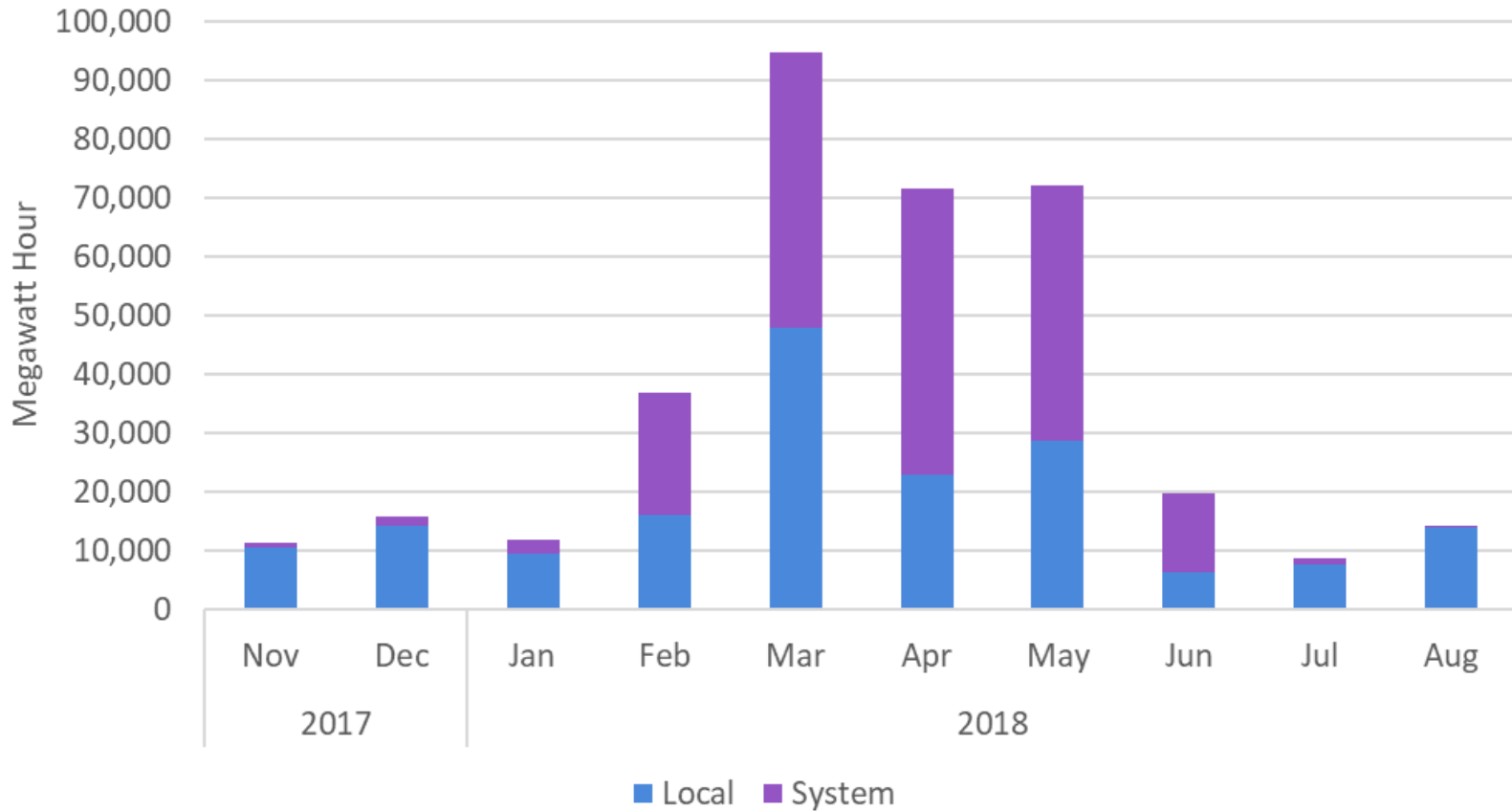
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- System curtailment implies an excess of supply across the entire grid
- Local curtailment implies there is transmission congestion and supply cannot reach demand

$LMP = \text{Energy} + \text{Congestion} + \text{Losses}$

- System curtailment will show up in energy component of LMP
- Local curtailment will show up in congestion component of LMP

# Monthly VER curtailment in 5-minute market



# Curtailment impact on market prices

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## Economic

- Negative prices between \$0/MWh and -\$150/MWh

## Self-schedule

- Negative -\$150/MWh price

## Exceptional dispatch

- Unpriced in market

## Operator intervention

- Unpriced in market

# Curtailment impact on renewable payments and incentives

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## Economic Curtailment

- Economic curtailment
- Self-schedule curtailment
- Exceptional dispatch

## Reliability Curtailment

- Self-schedule curtailment
- Over-generation procedure 2390
- Exceptional dispatch
- Operator intervention

# Take-aways

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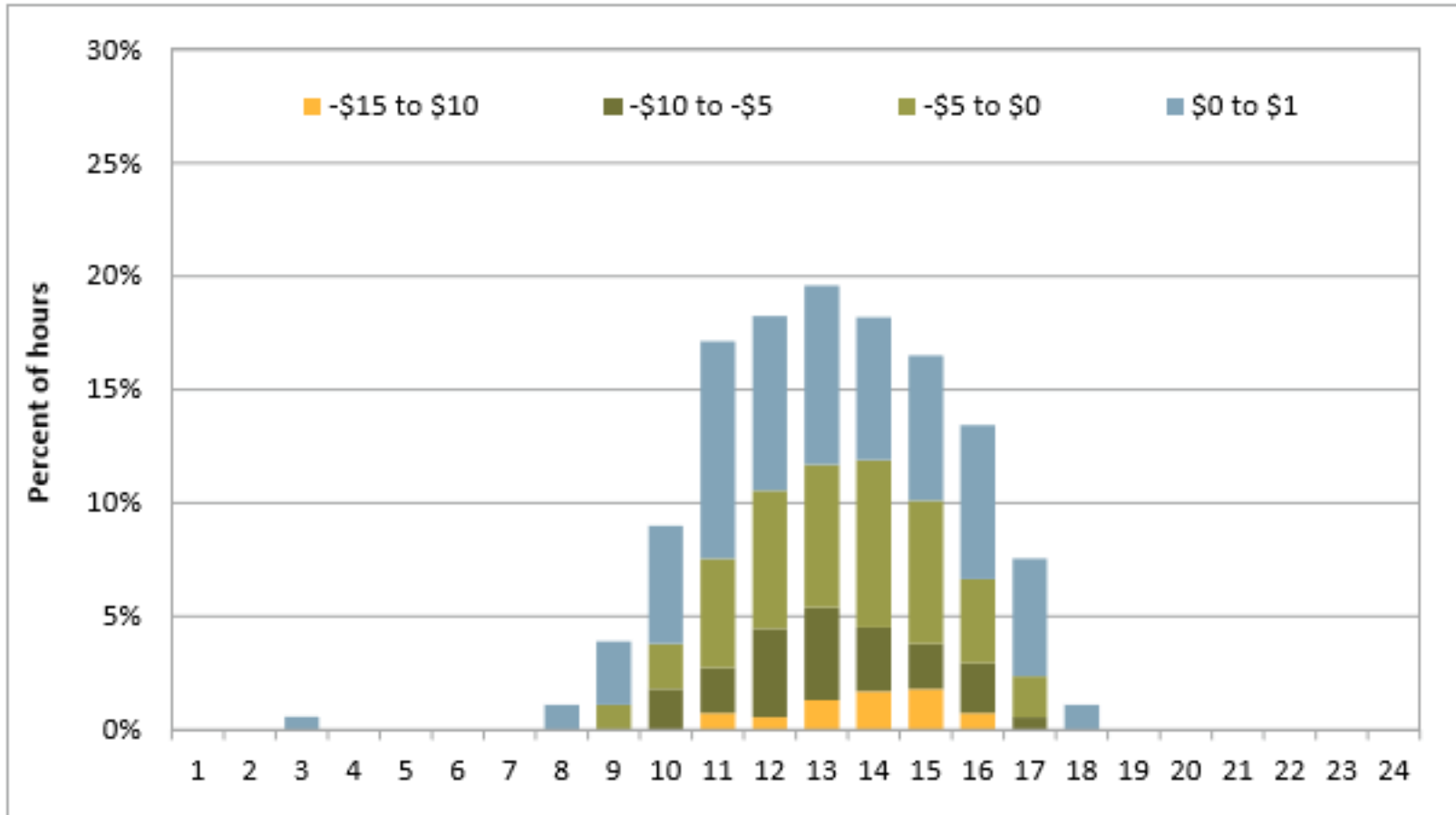
- How over-supply impacts market prices
- No standard definition for different curtailment types (and this should probably be fixed before massive curtailments start happening)
- EIM can help integrate renewables even during extreme over-supply conditions
- Efficient, reliable operations at the CAISO continue
  - Need to think about how market optimization is making tradeoffs between reliability, renewables, and EIM
  - Need to clarify “curtailment” before contract disputes

# Part 2

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OVER-SUPPLY IN 2018

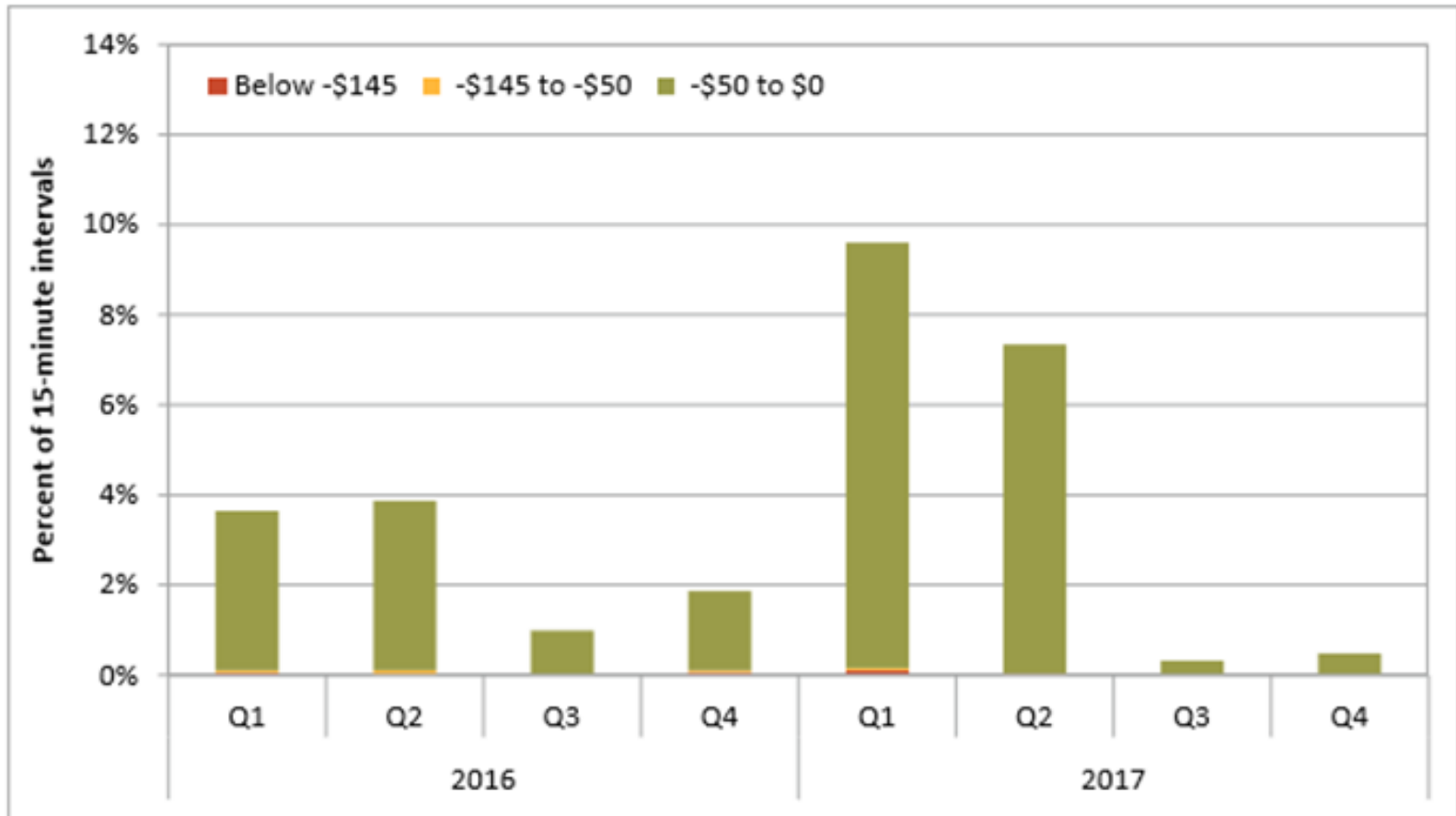
# Let's go back to 2017...Day-ahead prices



- Only includes day-ahead prices from January – June 2017



# Let's go back to 2017 . . . 15-minute prices

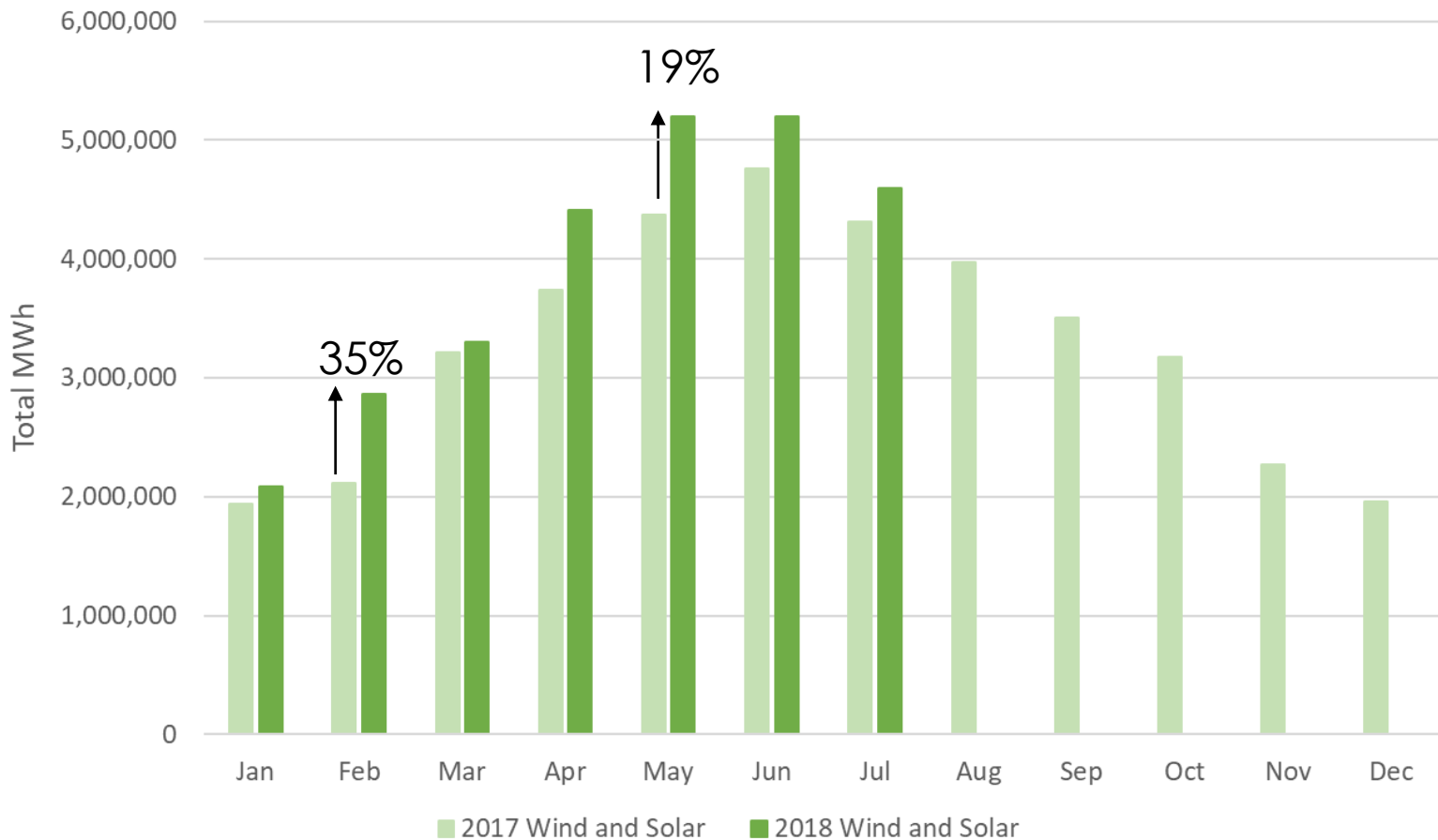


# What's new in 2018?

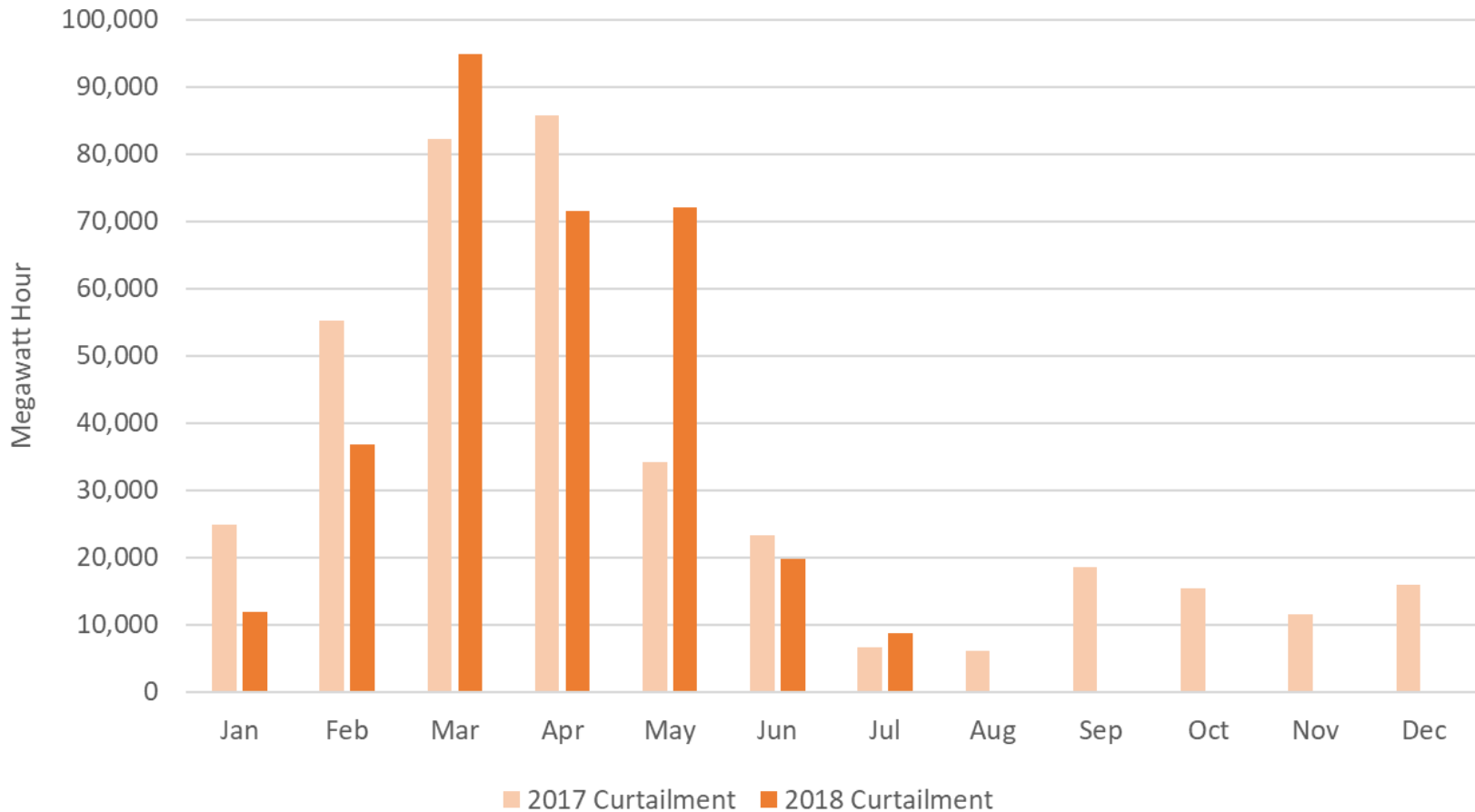
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1. Persistency based VER forecasting reduced real-time forecast error (4/18)
2. Under-scheduling of wind in day-ahead has not improved
3. Hydro-generation overall down by 1,500 MW
  - Reservoirs higher (but this is only 8% of hydro)
  - Run-of-river lower
4. Additional EIM entity participation – Idaho and Powerex

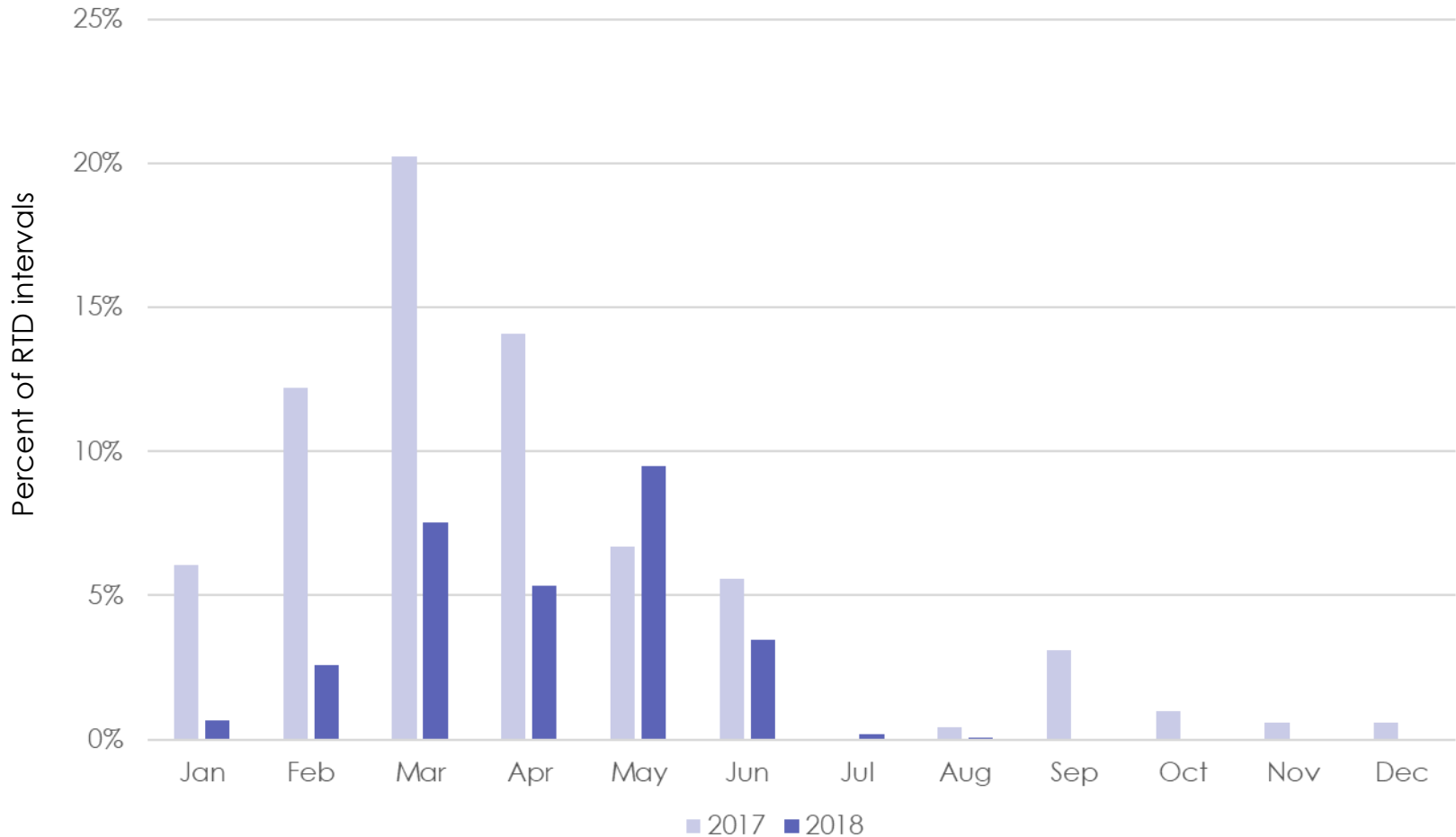
# Wind and solar generation – 2017 & 2018



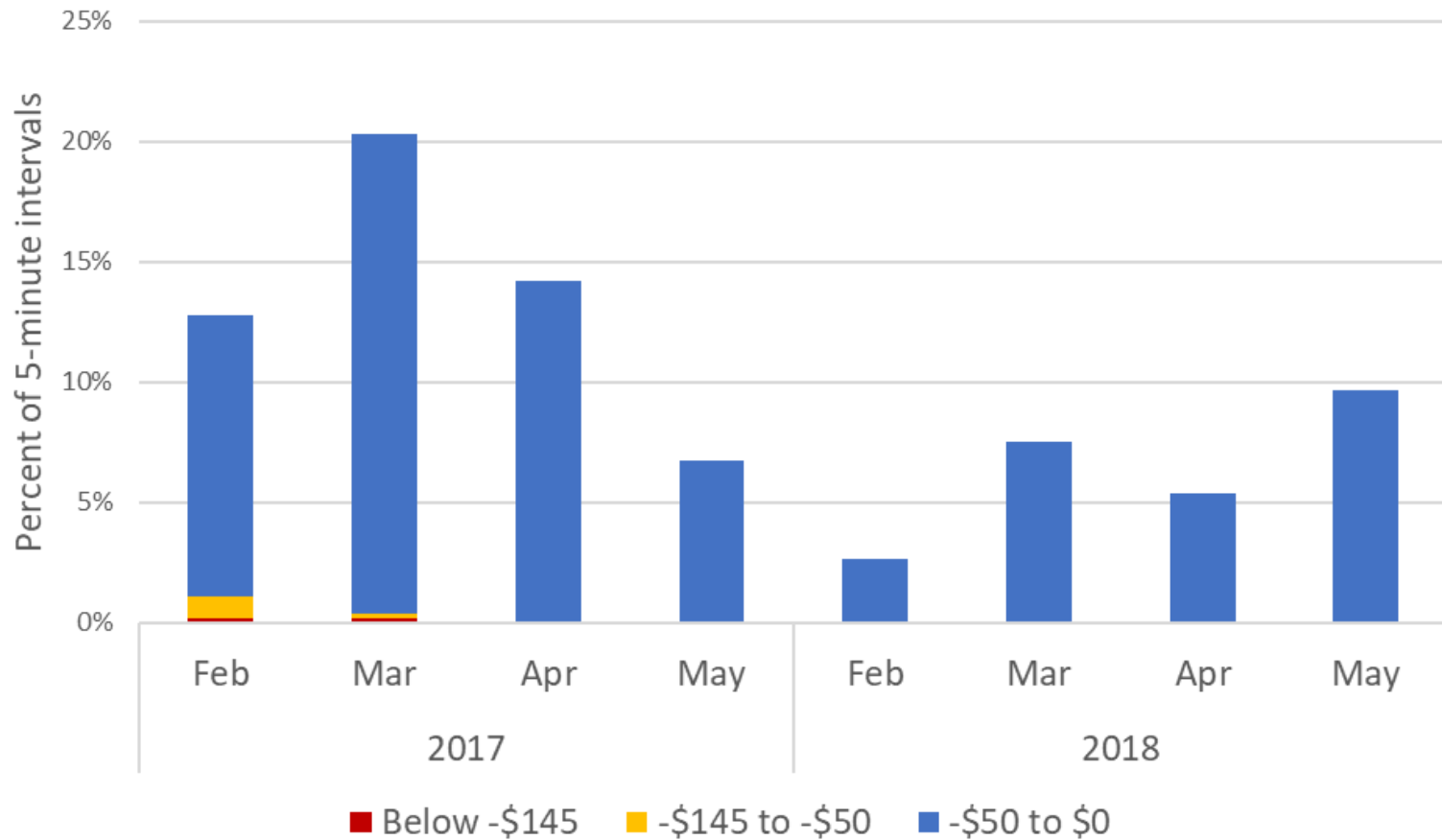
# CAISO curtailments – 2017 & 2018



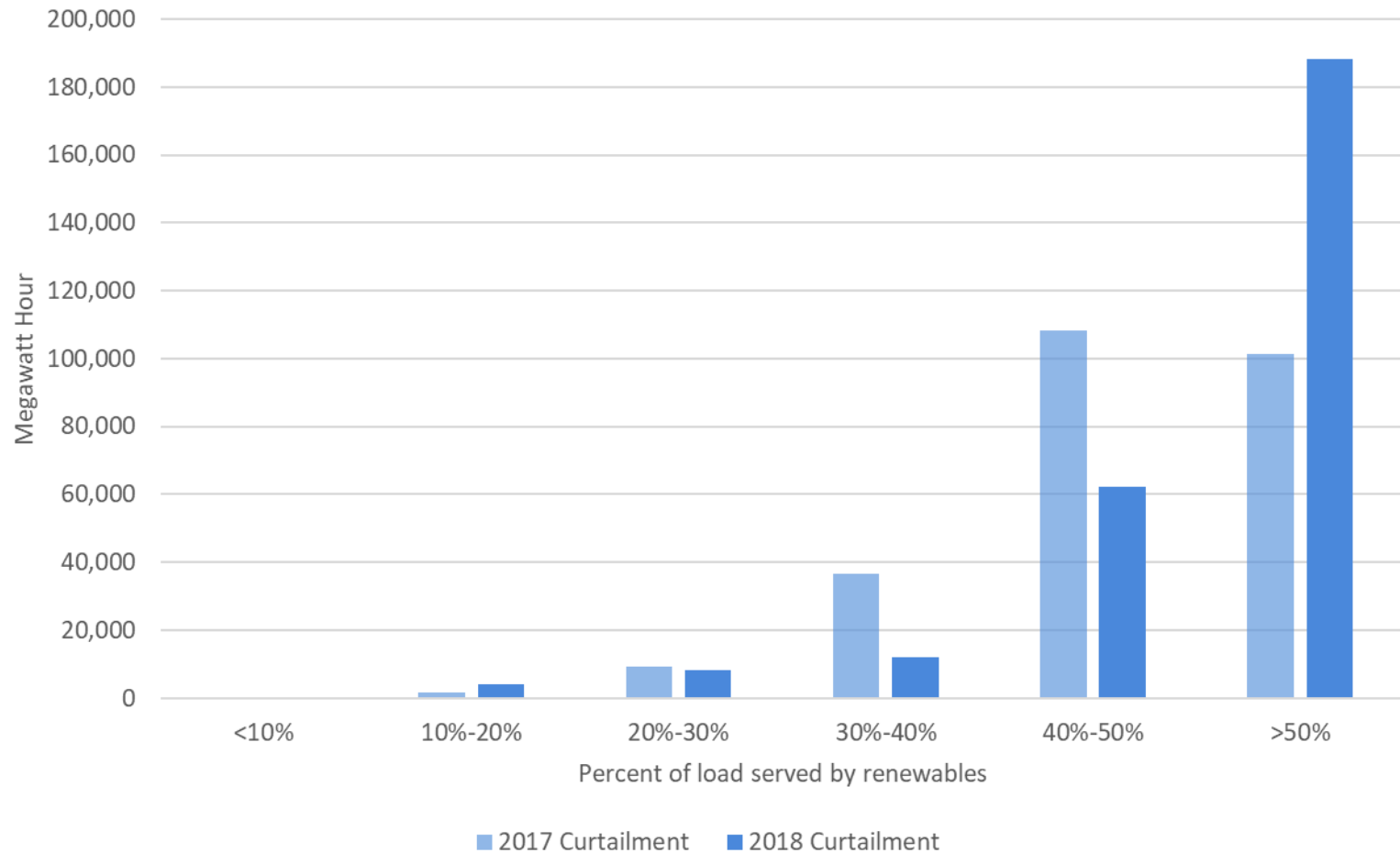
# Negative 5-minute prices – 2017 & 2018



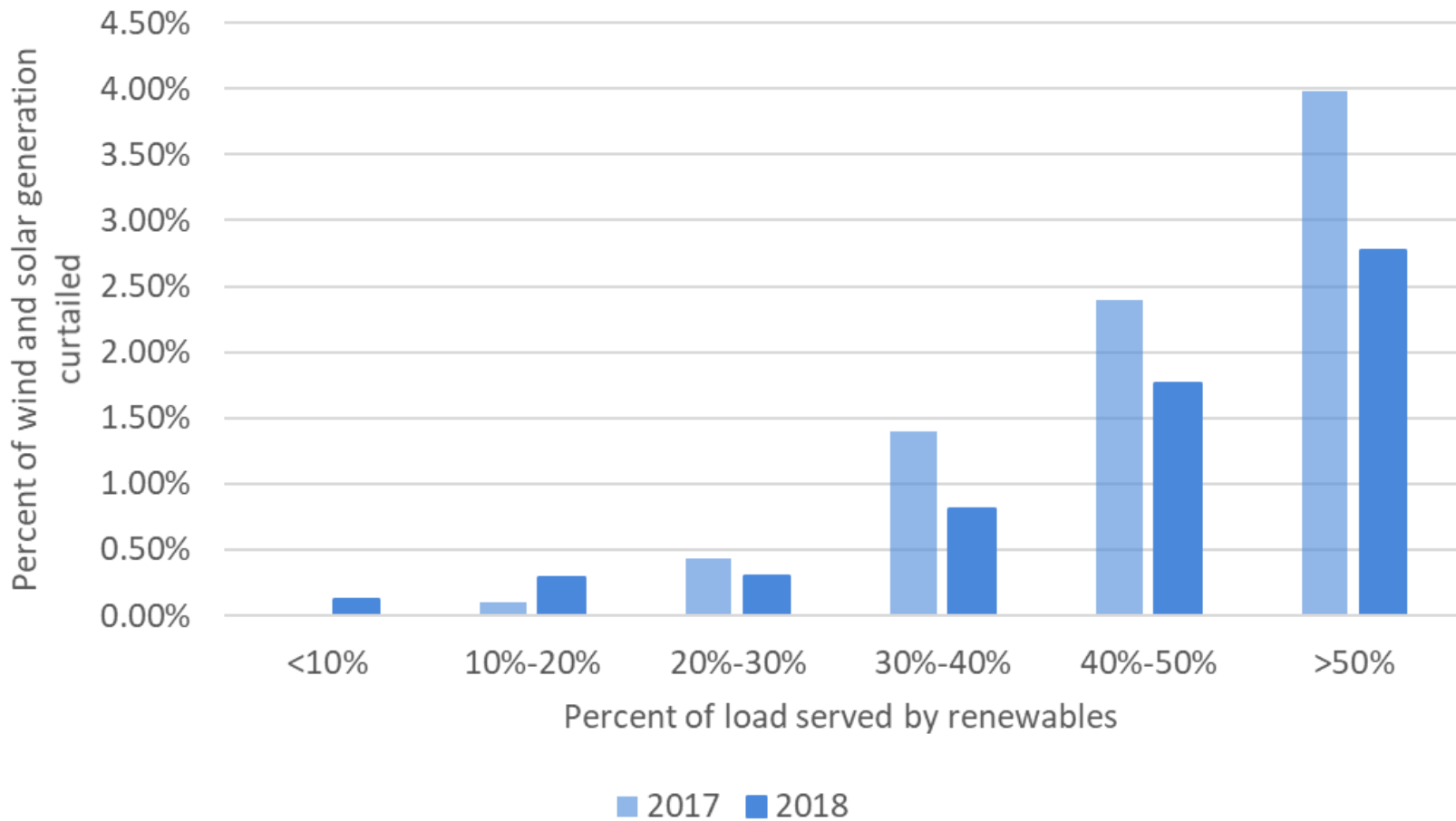
# Frequency of negative 5-minute system marginal energy prices by month



# CAISO curtailments – February through May 2017 and 2018

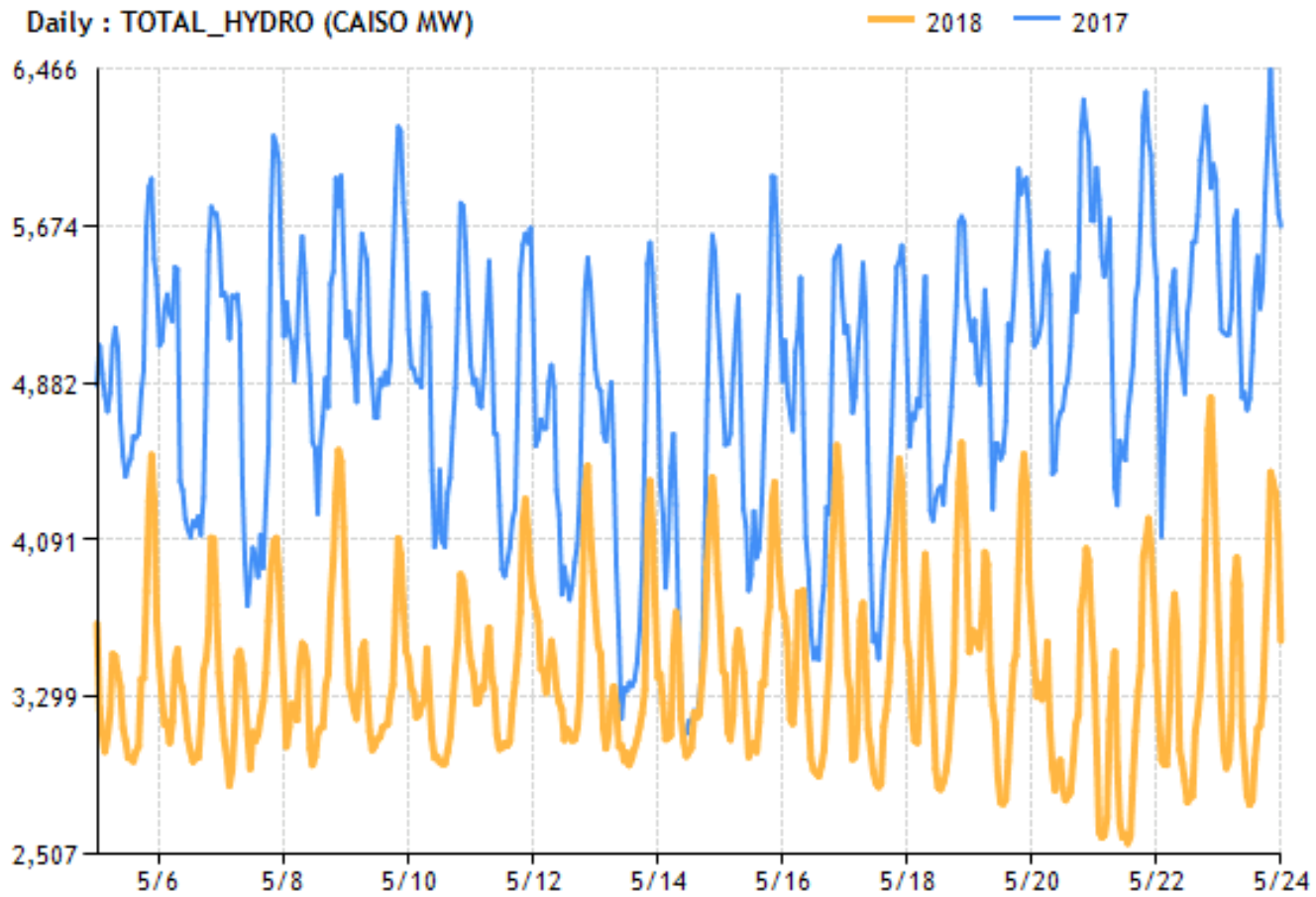


# CAISO curtailments as a percentage – February through May 2017 and 2018

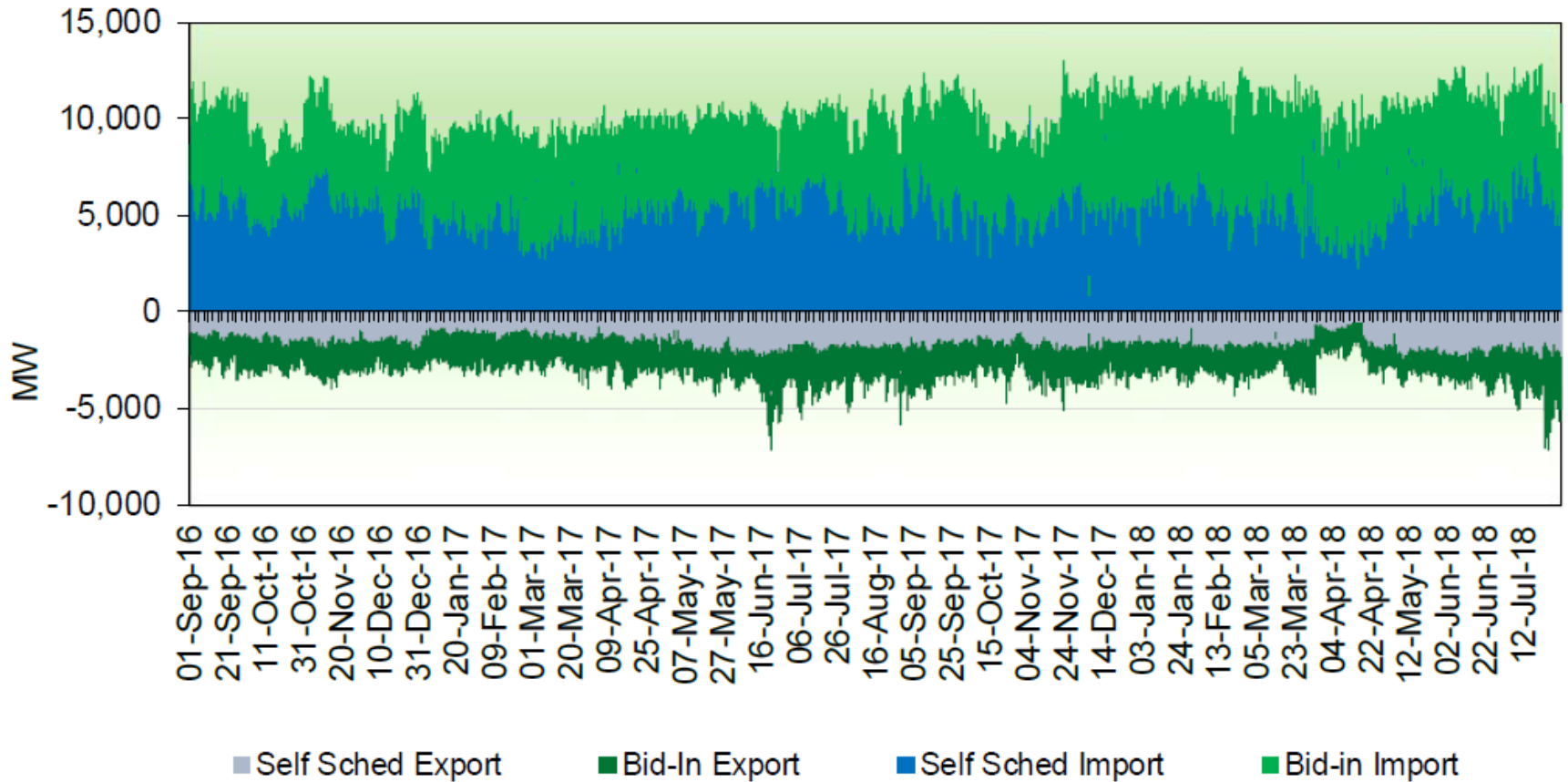




# Hydro generation (CAISO)

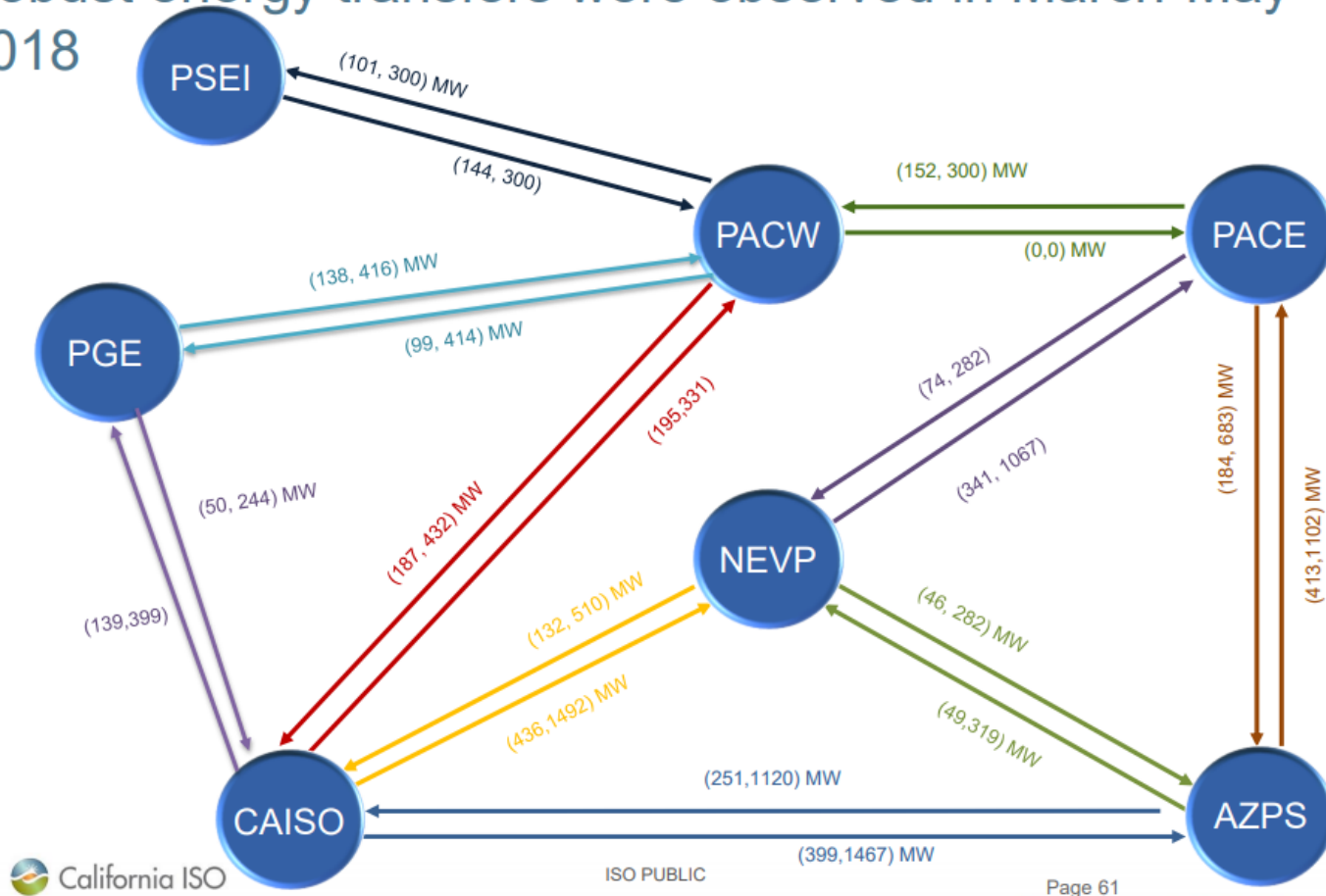


# Self-scheduled imports remain high, but slightly more price responsive

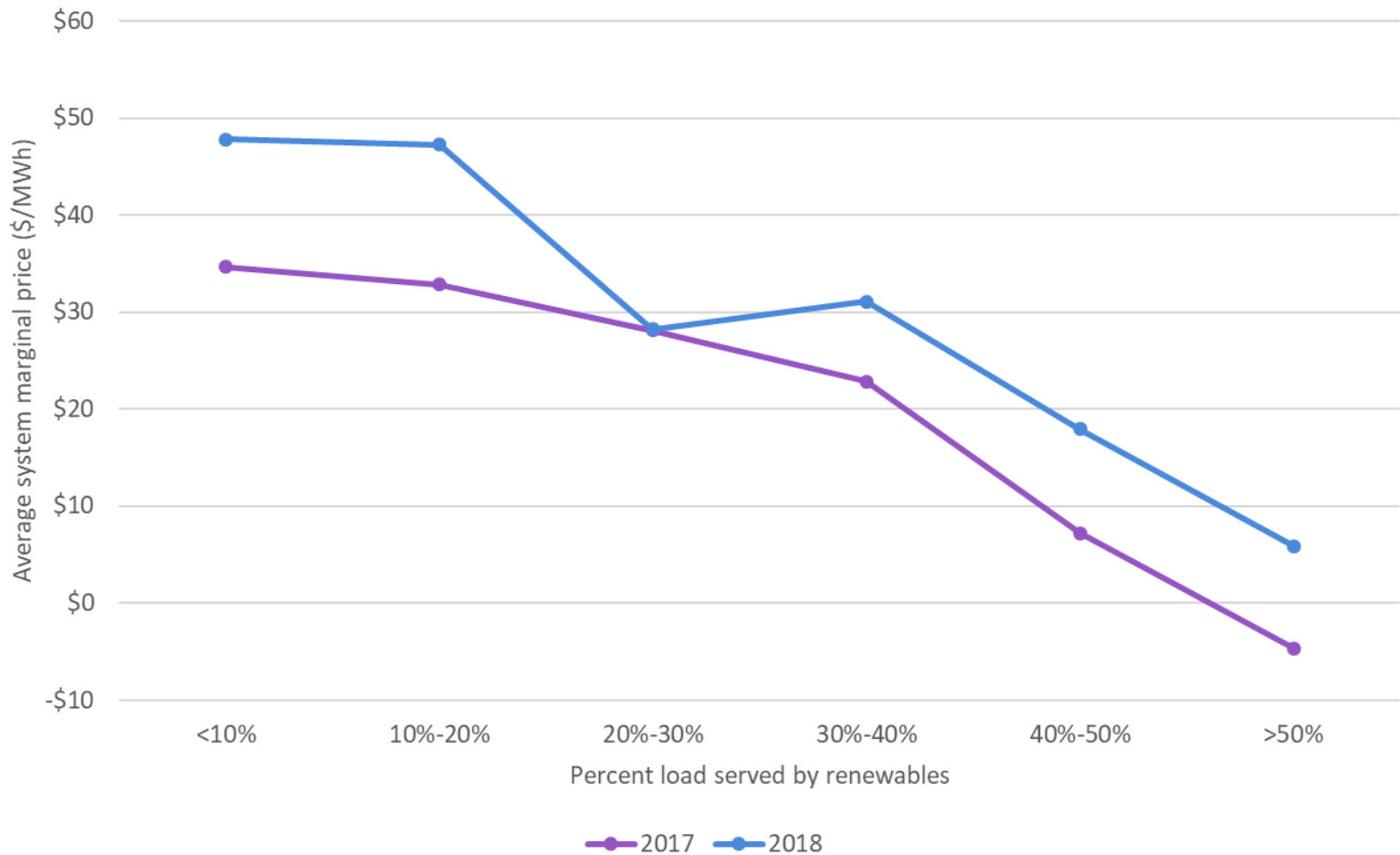


# EIM participation

Robust energy transfers were observed in March-May 2018



# Real-time average system marginal energy – February through May



# Take-aways

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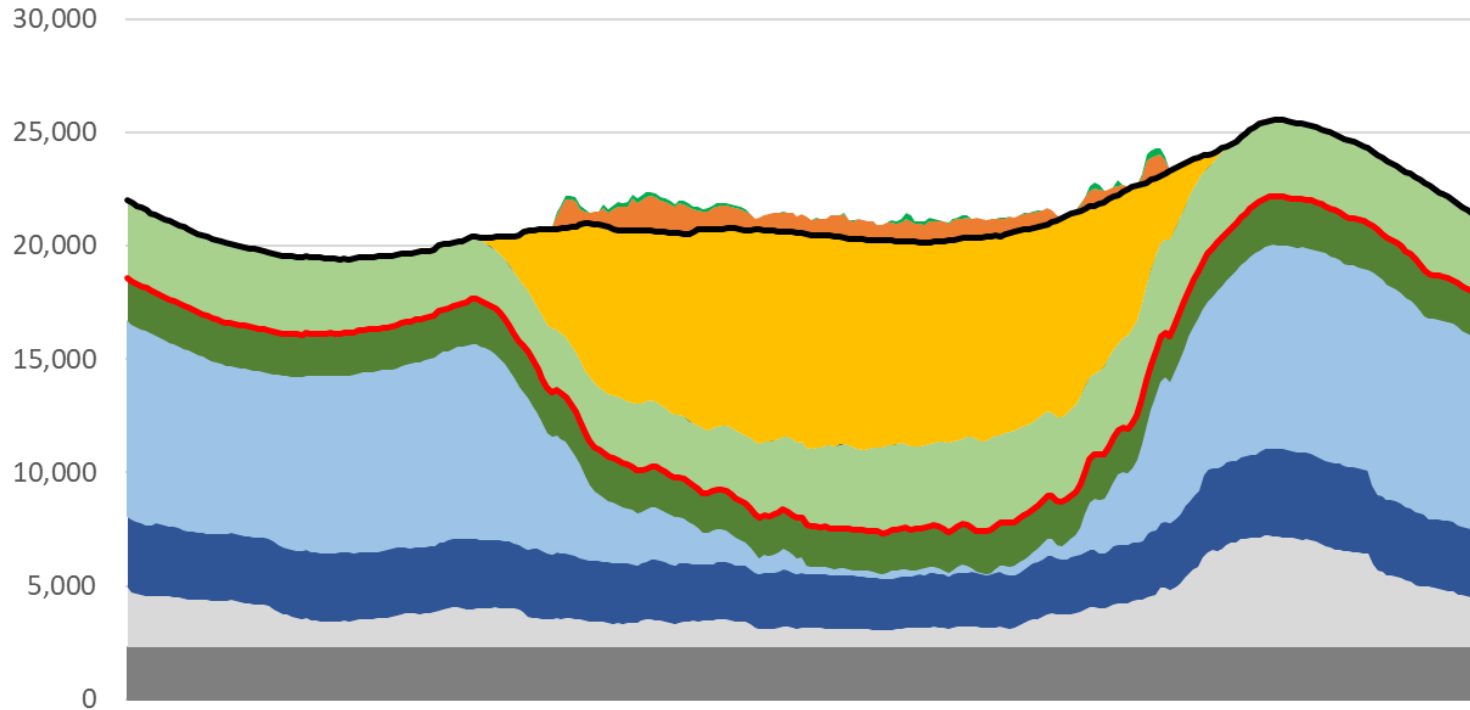
- Low snowpack significantly reduced over-supply concerns due to lowered hydro
- Level of curtailments significantly impact market prices
- 2018 reveals an important pattern
  - Exponential wind and solar curtailments as additional load is served by renewables

# Part 3

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SOME BRIEF THOUGHTS ON POLICY

# April 28, 2018



# Self-schedules and physically inflexible capacity increase curtailment

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- Interties during ramp down and ramp up (5,000 MW)
- Large Hydro (~3,000 MW)
- Nuclear (~2,280 MW)
- Thermal (~750 MW)



# Low Hanging Fruit

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- Lower energy bid floor
  - Make it painful to import during negative hours
- Increased EIM participation
- Forecast improvements (e.g. behind-the-meter)
  - CAISO always looking to improve short-term forecasting

# Longer term policy goals

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- Strategic improvements in existing thermal fleet
  - Thermal generation with high flexibility and low pmin burden
  - “As we navigate the transition to a 100% renewable future we need the gas fleet to become faster and more flexible (lower minimum load level, short start-ups). Like what Edison did with their EGT’s by adding batteries to their Peakers. We need more solutions like that...” – Mark Rothleder
- Gridwell’s Hybrid EGT Report
  - <https://www.gridwell.com/projects>

# Longer term policy considerations

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- Extending day-ahead market to EIM entities/regionalization
  - Increase transfer capabilities from CAISO to other BAAs during over-supply generation (market)
- Creating day-ahead flexible ramping product to better set up generation

# Questions?

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# More information?

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- Ask Gridwell partners, Carrie and Kallie:
  - [cbentley@gridwell.com](mailto:cbentley@gridwell.com)
  - [kwells@gridwell.com](mailto:kwells@gridwell.com)
- Sign up for Energy GPS newsletters/products
  - <https://www.energygps.com/Home/Product>
- Call-into to next webinar
  - EIM focused
  - Lower bid floor in depth discussion
  - Wind, solar, and battery optimal bidding examples by contract type