# Appendix B

# Evolving Day-Ahead Market Design Presentation

Powerex

August 20, 2019

# Evolving Day-Ahead Market Design

Supply. Flexibility. Commitment.

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# Agenda

**Today's discussion will focus on:**

1. Consequences of fragmented procurement
   - Inappropriately benefits wholesale purchasers, harms wholesale sellers
   - Reduces efficiency and increases production cost
2. Solutions
   - Virtual bidding protects against buyer market power
   - Co-optimized procurement of energy and reserves also necessary
   - **Outstanding**: *No co-optimized procurement of balancing reserves*
3. Do CAISO's DAME proposals appropriately address problems of fragmented procurement?
   - Option 1 vs Option 2
   - Modified Option 2

# Consequences of Fragmented Procurement

# Problem 1: Fragmented Procurement Leads To Discriminatory Compensation For The Same Service

- Market power concerns can arise from either:
  - one (or few) pivotal **sellers**
  - one (or few) pivotal **buyers**

- Most entities aware of measures to address **seller** market power
  - Price Caps, Market-based Rate Authority, Local Market Power Mitigation w/ Default Energy Bids, etc.

- **Buyer** market power also recognized by FERC
  - Buyer market power concerns in early RTO design
  - A few large purchasers could limit DA purchase quantity in order to depress DA prices
  - Virtual bidding is now a standard feature in organized markets, largely due to its ability to counteract efforts to restrict bid-in demand

***Buyer market power outcomes may also arise inadvertently through a central market operator and inefficient market design***

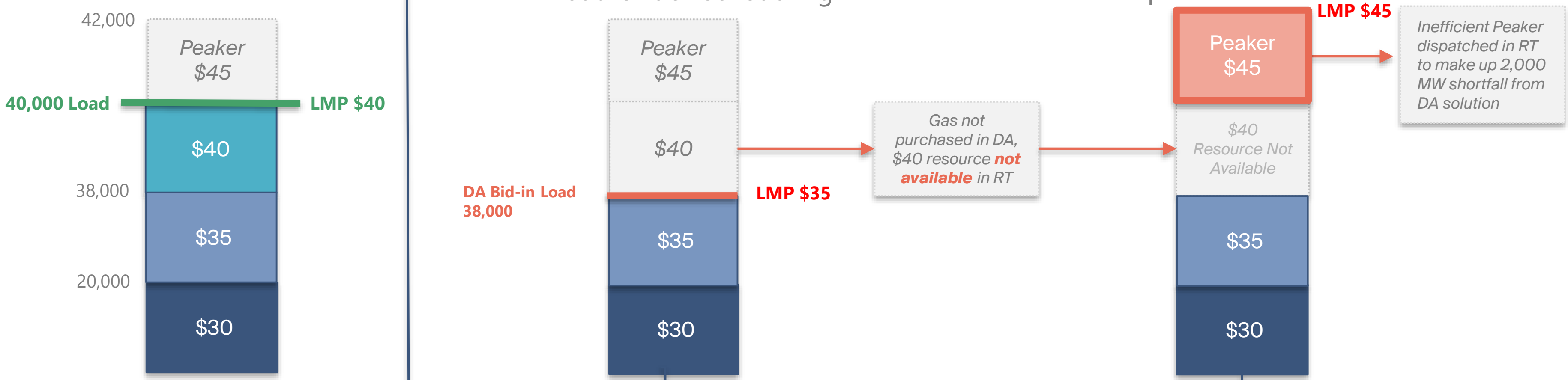
# Buyer Market Power

## Example: Under-scheduling 40,000 MW Load

Optimal Solution

Day Ahead
Load Under-scheduling

Real-Time Incremental
Dispatch

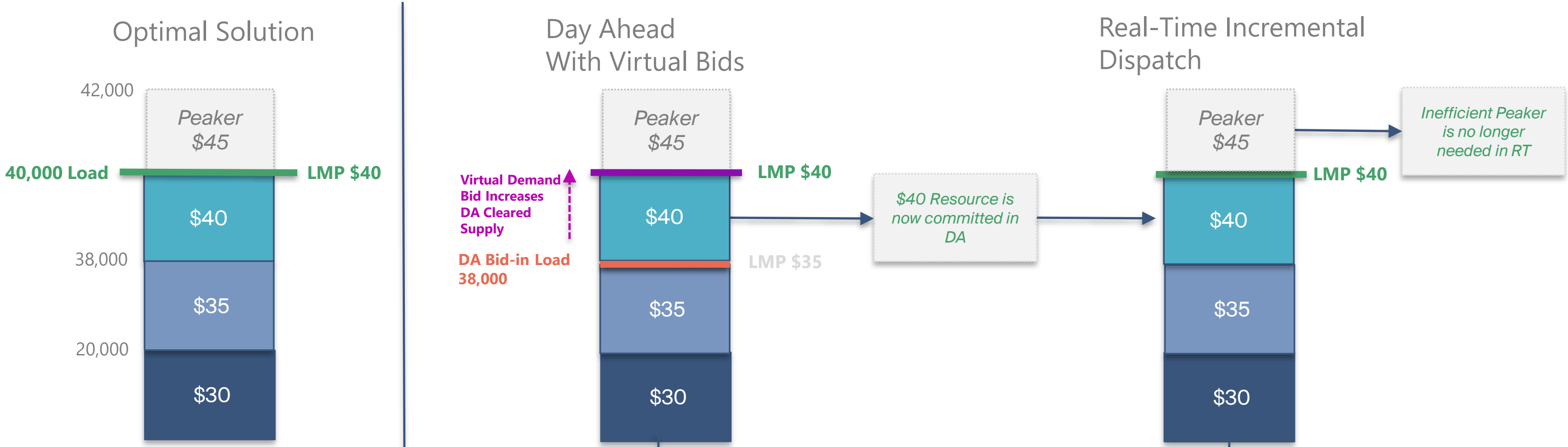



Production Costs: **$1,310,000**
Buyer Costs: **$1,600,000**
Seller Net Revenues **$290,000**

Production Costs: **$1,320,000**
Buyer Costs: **$1,420,000**
Seller Net Revenues **$100,000**

# Virtual Bidding Protects Against Buyer Market Power

## Example: Under-scheduling 40,000 MW Load

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Production Costs: **$1,310,000**
Buyer Costs: **$1,600,000**
Seller Net Revenues **$290,000**
Virtual Bidding Profit: **$0**

# FERC Quotes on Benefits of Virtual Bidding

- Virtual bidding will “increase liquidity, enhance competition, reduce price volatility and protect against LSEs under-scheduling their load in an attempt to manipulate the market.”
  - *New York Indep. Sys. Operator, Inc.*, 97 FERC 61,091 at 61,473 (2001).

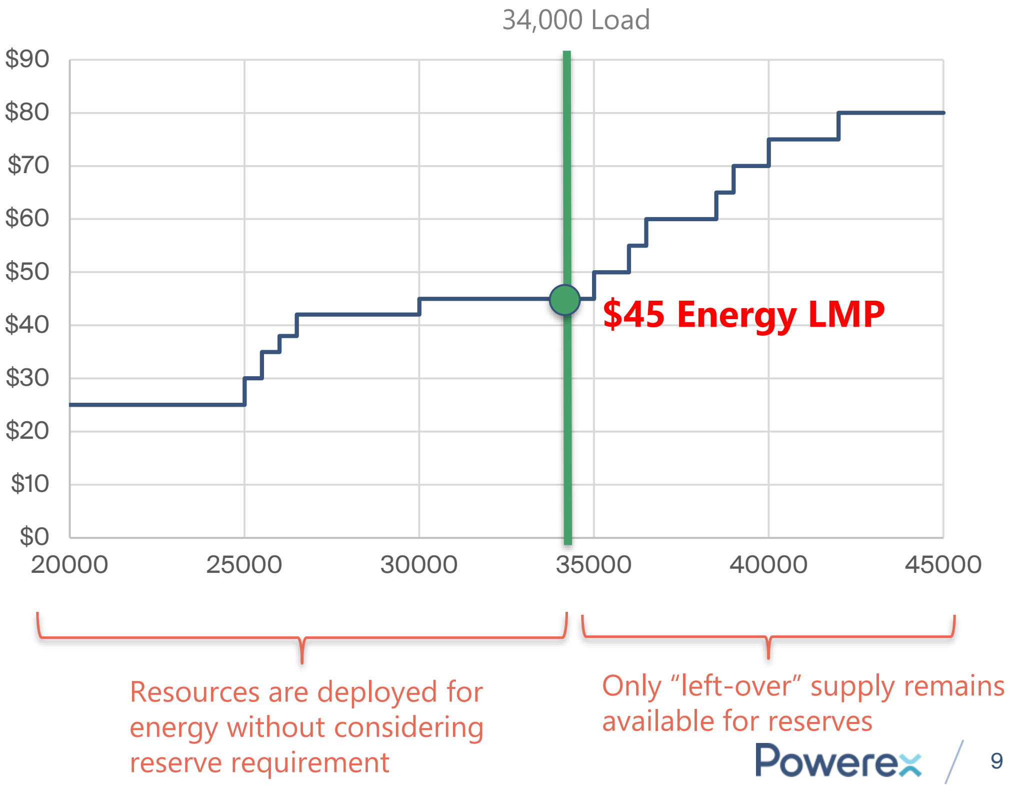
- Virtual bidding will “eliminate the incentive for load to underschedule in the day-ahead markets as a way to manipulate the market clearing price.”
  - *Cal. Indep. Sys. Operator Corp.*, 105 FERC 61,140 at P 148 (2003).

# Problem 2: Inefficient use of physical resources and increased production costs

- Assume load of 34,000 MW and contingency reserve of 2,000 MW

- A sequential approach to purchase energy and reserves would be highly inefficient:

  - Resources dispatched without regard for optimal mix of energy and capacity
  - Energy LMP of $45 is **too low**, as it fails to recognize need to set aside resources to meet reserve requirements
  - Reserves could only be provided by resources that happen to be "left over" after energy optimization takes place

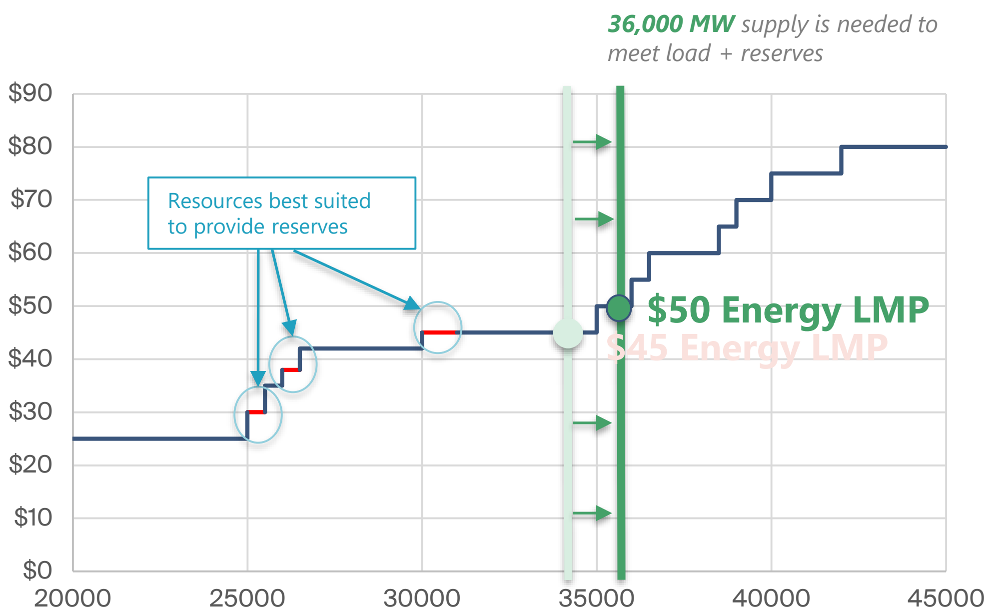


# Problem 2: Inefficient use of physical resources and increased production costs

- Assume load of 34,000 MW and contingency reserve of 2,000 MW

- Co-optimization is necessary:
  - Efficient dispatch by allocating energy and reserve obligations to the right resources
  - Energy LMP of $50 reflects proper marginal cost of meeting load after recognizing need for additional physical resources to be set aside for reserves

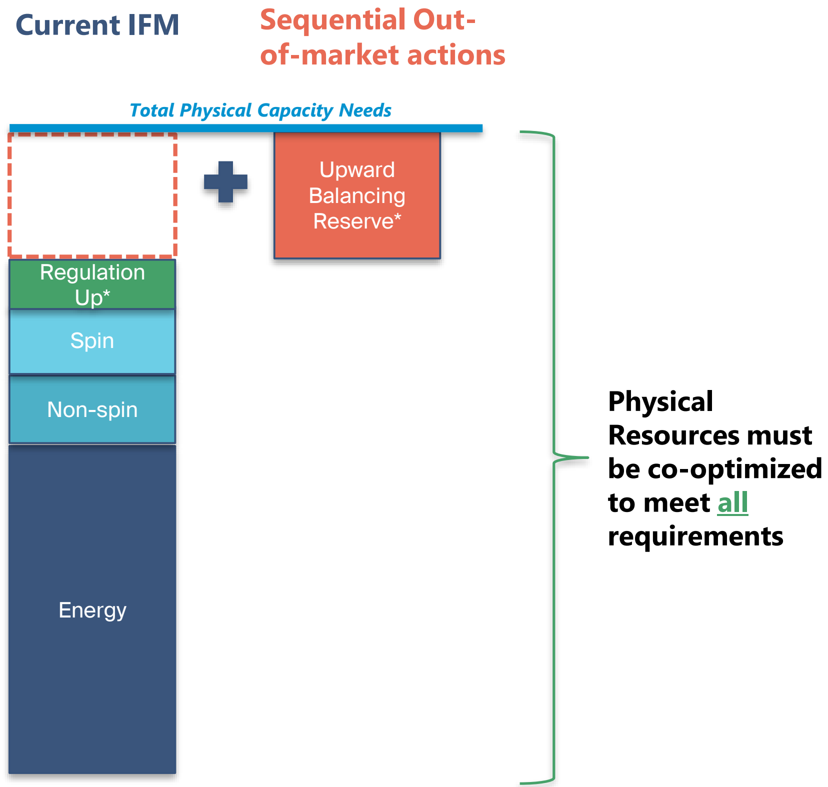
***Efficiency of co-optimizing energy and reserves is widely accepted***



# Co-optimized Procurement Of Energy And All Reserves Also Necessary

# Co-optimized Procurement Of Energy And All Reserves Is Also Necessary

- Fragmentation concerns no different for balancing reserves
  - Regulation only sufficient to balance system changes within each 5-minute dispatch period (plus lead time)
  - CAISO's need for balancing reserves to respond to DA uncertainty in net load is **large** and **growing**
- Current sequential out-of-market actions are **highly inefficient**:
  - Pool of reserves available to provide balancing reserves reflects only what is "left over" after IFM
  - IFM clearing prices are inefficiently **lowered**




*Note: Only upward reserve requirements shown for illustrative purposes. CAISO currently procures Regulation Down through the IFM and proposes a downward Balancing Reserve product (Imbalance Reserve Down).

# Summary

| Activity | Harmful consequences | Currently Addressed By: |
| --- | --- | --- |
| Under-scheduling load | Raises production costs<br><br>Inefficiently transfers rents from sellers to buyers<br><br>Increases reliability risks | Virtual Bidding |
| Under-procuring contingency reserves | Raises production costs<br><br>Inefficiently transfers rents from sellers to buyers<br><br>Increases reliability risks | Define purchase quantity based on NERC standards<br><br>Co-optimize energy and reserves in day-ahead market |
| Under-procuring balancing reserves | Raises production costs<br><br>Transfers rents from sellers to buyers<br><br>Increases reliability risks | Currently None |

# Summary

- Inefficient outcomes can lower total costs for buyers even while increasing production costs
  - ***Inappropriately*** benefits wholesale purchasers, harms wholesale sellers

- Sequential out-of-market purchases for balancing reserves leads to similar outcomes
  - Results in choosing the **wrong** resources
  - Out-of-market operators actions procure and pay for only *additional* capacity that may be needed
  - DA energy price is lowered, resources that provide “bundled” capacity receive no additional compensation

- Goal must be **efficiency** – meaning lowest production cost to reliably meet demand
  - Goal must not be achieving the lowest purchase costs to buyers or highest sales revenues to sellers

- Powerex supports improving DAM design to minimize/eliminate out-of-market actions and to ***procure all required products through the organized market***

# CAISO Day-Ahead Procurement Is Increasingly Fragmented

# CAISO Operators Have Increased Interventions And Out of Market Procurement: Balancing Reserves Are Necessary

## Uncertainty between markets in 2018

| Measures | FMM to Market | FMM to Forecast | FMM to Adjusted Forecast |
|---|---|---|---|
| Percentiles | | | |
| 99.0% | 4082 | 3187 | 2959 |
| 97.5% | 3268 | 2600 | 2399 |
| 95.0% | 2648 | 2096 | 1914 |
| 90.0% | 2095 | 1606 | 1429 |
| 75.0% | 1239 | 879 | 720 |
| 50.0% | 274 | 232 | 71 |
| 25.0% | -794 | -364 | -625 |
| 10.0% | -1953 | -930 | -1473 |
| 5.0% | -2756 | -1295 | -2169 |
| 2.5% | -3475 | -1649 | -2757 |
| 1.0% | -4359 | -2090 | -3397 |

Market cleared net load produced largest amount of uncertainty at P95

California ISO ISO PUBLIC

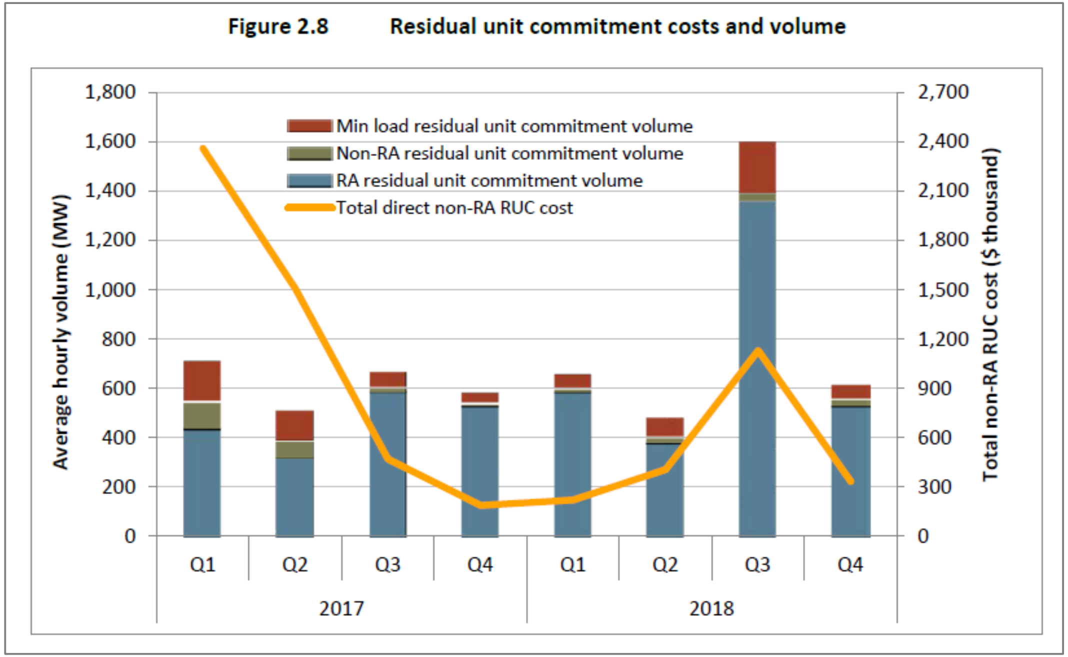
*Source: "Day-Ahead Market Enhancements Stakeholder Workgroup Meeting" (August 13, 2019 Presentation)* at 39.

# CAISO Operators Have Increased Interventions And Out of Market Procurement: Out-Of-Market Actions To Acquire Balancing Reserves

- CAISO operators use at least three different sequential processes for acquiring balancing reserves ahead of Fifteen Minute Market (FMM):

1. ***Residual Unit Commitment (RUC)***
   - Formal post-IFM process to commit and compensate standalone capacity
2. ***Exceptional Dispatch***
   - CAISO contacts individual suppliers and purchases energy out-of-market (internal and external), that is then scheduled in FMM, creating upward headroom on internal generation
3. ***Load Biasing***
   - CAISO operators upward load bias to cause HASP and FMM to dispatch additional HASP energy imports and EIM FMM energy imports, creating upward headroom on internal generation

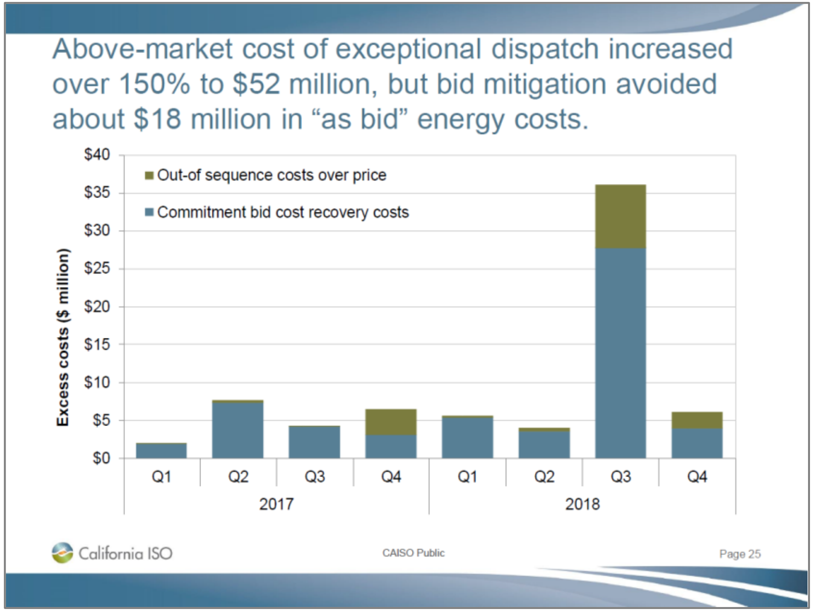
# CAISO Operators Have Increased Interventions And Out of Market Procurement: Residual Unit Commitment

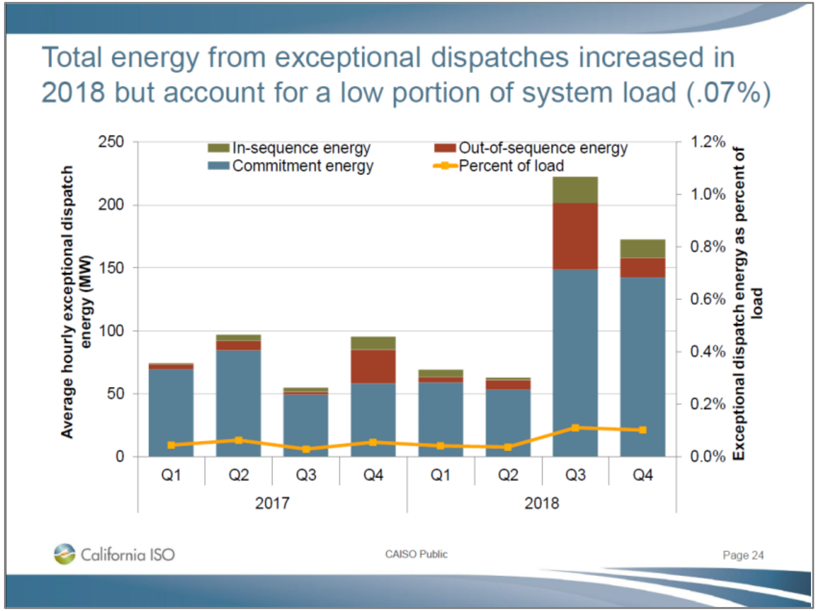



*"The primary reason for the increase in residual unit commitment volumes in 2018 can be attributed to the relatively high operator adjustments and an increase in amounts of cleared net virtual supply in the third quarter of 2018. When the market clears with net virtual supply, residual unit commitment capacity is needed to replace net virtual supply with physical supply."*

Source: CAISO DMM 2018 Annual Report On Market Issues And Performance, at 76.

# CAISO Operators Have Increased Interventions And Out of Market Procurement: Exceptional Dispatch



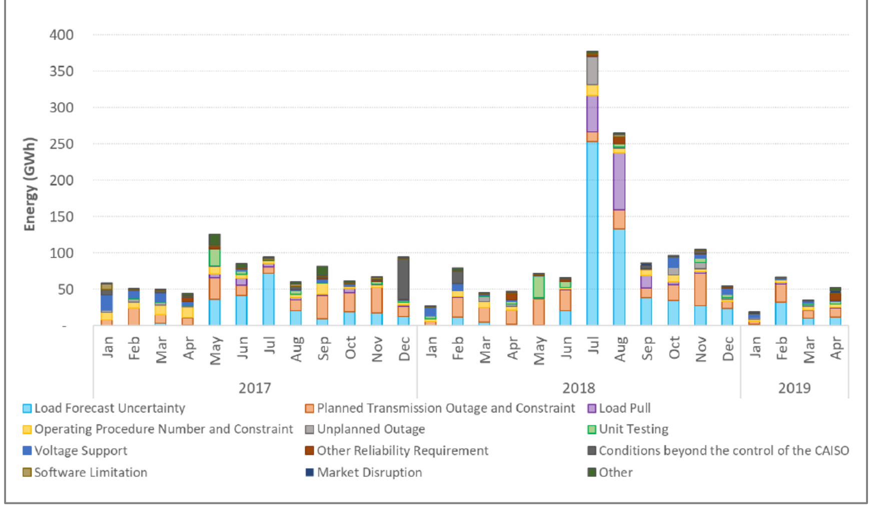




Source: CAISO DMM "2018 Annual Report" (May 23, 2019 Presentation) at 24-25.

# CAISO Operators Have Increased Interventions And Out of Market Procurement: Exceptional Dispatch

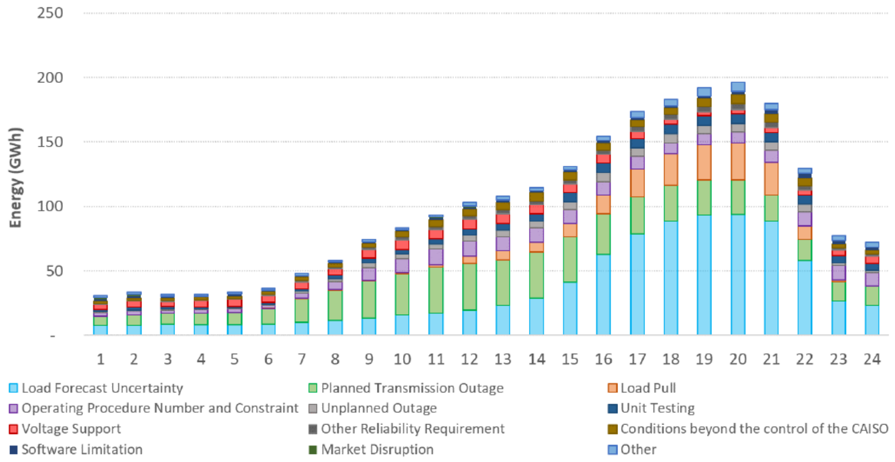
*"The largest volume of [exceptional dispatches] occurred during the summer months."*

Figure 52: Volume of Exceptional Dispatches in the CAISO market



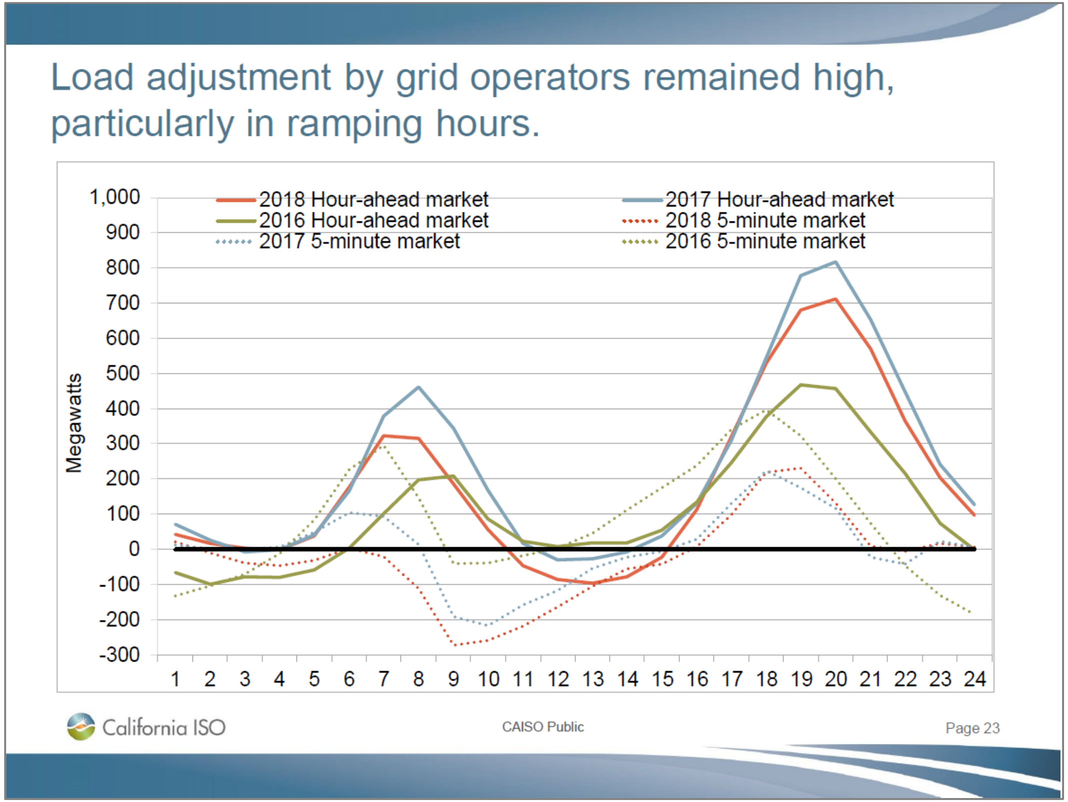

*"Exceptional dispatches are issued in higher volumes during peak hours."*

Figure 53: 2018 Volume of exceptional dispatches in the CAISO market




Source: "Price Performance in the CAISO's Energy Markets" (June 18, 2019 Report) at 46-47.

# CAISO Operators Have Increased Interventions And Out of Market Procurement: "Load Biasing"




*"...load forecast adjustments in the hour-ahead and 15-minute scheduling processes routinely mirror the pattern of net loads over the course of the day, averaging 400 MW to 800 MW during the morning and evening ramping hours. During these hours, **imports made in the hour-ahead process often increase significantly, which allows additional generation within the ISO to be available for dispatch** in the 15-minute and 5-minute markets. These adjustments decreased slightly compared to 2017, but remain high and have **increased dramatically since 2016**."*

*CAISO DMM 2018 Annual Report On Market Issues And Performance, at 9.*

*Source: CAISO DMM "2018 Annual Report" (May 23, 2019 Presentation) at 23.*

# CAISO Operators Have Increased Interventions And Out of Market Procurement: Unintended Consequences

- CAISO operators use of sequential processes for acquiring balancing reserves ahead of Fifteen Minute Market (FMM) also has unintended consequences:
  - Creates systemic profits for virtual supply

**Table 5.1 Convergence bidding volumes and revenues by participant type (2018)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ million) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 697 | 1,122 | 1,819 | -$13.7 | $55.8 | $42.1 |
| Marketer | 397 | 573 | 970 | -$9.9 | $22.3 | $12.5 |
| Physical generation | 0 | 90 | 90 | $0.0 | $1.5 | $1.5 |
| Physical load | 8 | 2 | 10 | -$0.4 | $0.0 | -$0.4 |
| **Total** | **1,102** | **1,787** | **2,889** | **-$24.0** | **$79.6** | **$55.7** |

*"Virtual supply positions were profitable in all quarters during 2018. This trend was primarily* ***driven by sustained average day-ahead market prices greater than real-time market prices in all quarters*** *during the year. Particularly, virtual supply net revenues were* ***greatest in the third quarter at nearly $47 million*** *when system marginal day-ahead prices reached record highs on several days related to a system-wide heat wave and associated high loads."*

Source: CAISO DMM 2018 Annual Report On Market Issues And Performance, at 137-138.

# Discussion Of DAME Proposals

# CAISO DAM Enhancements Proposals (as of August 2019)

Both CAISO's Option 1 and Option 2 recognize need for balancing reserves and would result in co-optimized procurement of Imbalance Reserve in IFM

- **Option 1 – Financial Energy**
  - Energy bids/offers cleared as today (financial), *plus* CAISO will co-optimize procurement of new up- and down-ward Imbalance Reserve capacity (based on historical need)

- **Option 2 – Financial Energy + Physical Capacity Constraint**
  - As above, but CAISO will also enforce a "reliability capacity" constraint, so total energy awards to physical resources equal the CAISO's day-ahead load forecast

# CAISO Option 1: Financial Energy

## Fatally Flawed: Unworkable for CAISO DAM

$$\sum_i EN_{i,t} + \sum_j EN_{j,t} = \sum_i L_{i,t} + \sum_j L_{j,t} + Loss_t \quad \lambda_t$$

Physical Supply + Virtual Supply = Bid-In Load + Virtual Demand + Losses

$$\sum_i IRU_{i,t} \geq IRUR_t$$

$$\sum_i IRD_{i,t} \geq IRDR_t$$

- **Maintains current "energy only" approach**
  - Complete fungibility between firm physical resources (e.g., hydro, thermal), VERs, speculative imports, and virtual supply
- **Will encourage virtual supply to completely "unwind" procured imbalance reserves**
  - Virtual supply will displace physical supply, completely unwinding capacity benefit of imbalance reserve product
  - Will result in continued need for out-of-market actions
- **Will cause virtual supply to earn systemic profits doing so**
  - DA price likely to be systemically higher than RT due to greater imbalance reserves in DA

# CAISO Option 1: Financial Energy

## Fatally Flawed: Unworkable for CAISO DAM

$$\sum_i EN_{i,t} + \sum_j EN_{j,t} = \sum_i L_{i,t} + \sum_j L_{j,t} + Loss_t \quad \lambda_t$$

Physical Supply + Virtual Supply = Bid-In Load + Virtual Demand + Losses

$$\sum_i IRU_{i,t} \geq IRUR_t$$

$$\sum_i IRD_{i,t} \geq IRDR_t$$

- **Undermines Reliability**
  - Unit commitment in other BAA's would be impacted by imports from CAISO BAA
  - But "energy only" imports from CAISO could be supported merely by virtual supply
- **Undermines EDAM benefits of centralized unit commitment**
  - Current out-of-market tools not practical in a regional, voluntary market
  - Will Market Operator be "phoning around" the west to resolve insufficient DA unit commitments ?

# CAISO Option 2: Financial Energy + Physical Capacity Constraint

## Incorporates Critical Elements

$$\sum_i EN_{i,t} + \sum_j EN_{j,t} = \sum_i L_{i,t} + \sum_j L_{j,t} + Loss_t \quad \lambda_t$$

Physical Supply + Virtual Supply = Bid-In Load + Virtual Demand + Losses

$$\sum_i REN_{i,t} = \sum_i \left(EN_{i,t} + RCU_{i,t} - RCD_{i,t}\right) = D_t \quad \xi_t$$

Reliable Energy Schedule = Physical Energy Schedule + Reliability Capacity Up - Reliability Capacity Down = CAISO P50 Demand Forecast

$$\sum_i IRU_{i,t} \geq IRUR_t$$

$$\sum_i IRD_{i,t} \geq IRDR_t$$

- **Adds Physical Capacity Constraint**
  - Eliminates opportunity for virtual to undo physical capacity commitment
  - Improves reliability by ensuring sufficient physical energy commitments to meet operator's P50 demand forecast (plus separate imbalance reserves)
- **But:**
  - Still treats all physical resources the same from capacity perspective
  - VERs incorrectly receive capacity payment for P50 forecast output rather than just for their reliable output (i.e. day-ahead capacity)
  - Resources that provide Imbalance Reserve to back-stop VERs do not receive capacity payment

# Modified Option 2: Financial Energy + Physical Capacity Constraints

## Adds Important Improvements

$$\sum_i EN_{i,t} + \sum_j EN_{j,t} = \sum_i L_{i,t} + \sum_j L_{j,t} + Loss_t \quad \lambda_t$$

Physical Supply + Virtual Supply = Bid-In Load + Virtual Demand + Losses

$$\sum_i EN_{i,t} * CCF_{i,t}^{02.5} + \sum_i RCU_{i,t} + \sum_i IRU_{i,t} \geq D(15)_t^{97.5}$$

Physical Energy * Reliable Capacity Factor (see note) + Reliability Capacity Up + Imbalance Reserve Up ≥ CAISO P97.5 15-Min Demand Forecast

$$\sum_i IRU_{i,t} \geq IRUR_t$$

$$\sum_i IRD_{i,t} \geq IRDR_t$$

- **Properly differentiates resources**
  - Properly recognize the capacity benefit of reliable resource output (e.g., thermal, hydro) compared to uncertain output from VERs and from non-firm/speculative supply
- **Ensures sufficient physical capacity to reliably meet load**
  - Increases Capacity Requirement to P97.5 of 15-minute load
- **Ensures appropriate compensation**
  - Allows resources that provide upward Imbalance Reserve to contribute (and be compensated for) providing capacity

Note: VERs Reliable Capacity Factor would be based on its forecast production in p97.5 Net Load scenario (including diversity credit)

# Modified Option 2: Financial Energy + Physical Capacity Constraints

## Complete Proposal Also Includes a Downward Capacity Requirement

$$\sum_i EN_{i,t} + \sum_j EN_{j,t} = \sum_i L_{i,t} + \sum_j L_{j,t} + Loss_t \quad \lambda_t$$

**Financial Energy** Power Balance

$$\sum_i EN_{i,t} * CCF_{i,t}^{02.5} + \sum_i RCU_{i,t} + \sum_i IRU_{i,t} \geq D(15)_t^{97.5}$$

Upward **Physical Capacity** Requirement

$$\sum_i EN_{i,t} * CCF_{i,t}^{97.5} - \sum_i RCD_{i,t} - \sum_i IRD_{i,t} \geq D(15)_t^{02.5}$$

Downward **Physical Capacity** Requirement

$$\sum_i IRU_{i,t} \geq IRUR_t$$

Upward **Flexibility** Requirement*

$$\sum_i IRD_{i,t} \geq IRDR_t$$

Downward **Flexibility** Requirement*

*Note: more stakeholder discussion is required on calculating appropriate flexibility requirements

# Capacity Contribution Summary:
## *Which Design Is Most Comparable to Western Bilateral Energy Markets?*

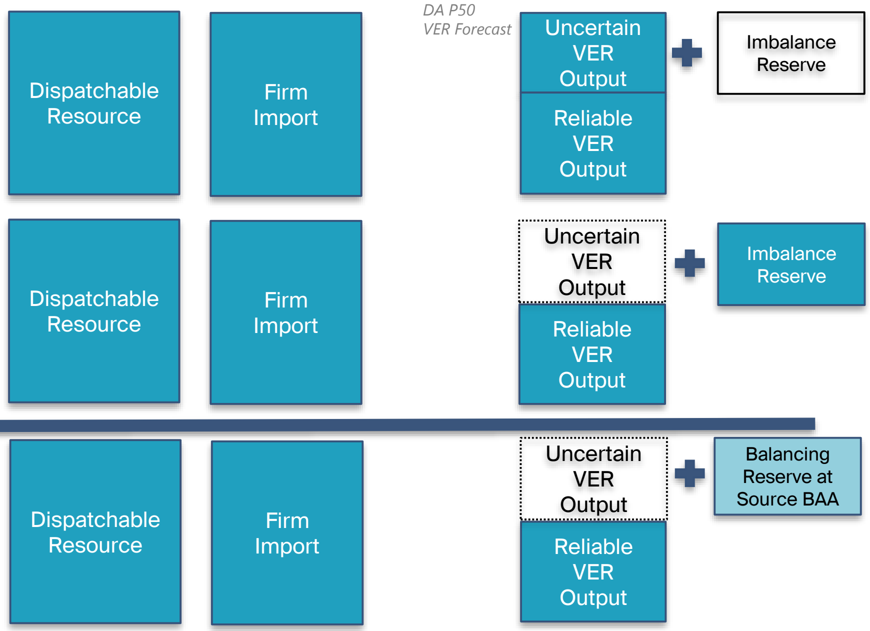
CAISO Option 1:

***Fatal flaw related to virtual bidding; full fungibility between dispatchable resources, VERs, and virtual supply***

CAISO Option 2:

**Modified** Option 2:

Western Bilateral Energy Markets:




CAISO Option 2:

*CAISO procures Imbalance Reserve to Back-stop uncertain VER output*

*VER receives capacity payment for entire P50 forecast (not reliable portion)*

Modified Option 2:

*VER receives capacity payment for reliable portion of P50 forecast*

*Resource providing Imbalance reserve is properly compensated for back-stopping VER*

Western Bilateral Energy Markets:

*VERs must procure sufficient balancing reserves at the Source BAA to enable selling firm bilateral energy*

# Stakeholder Comments Support Option 2 (With Caveats)

| Stakeholder | Option 1 | Option 2 |
|---|---|---|
| DMM | Support w/ caveats | Oppose |
| SCE | Undecided | Oppose |
| LS Power | n/a | Support |
| SDGE | Oppose | Support |
| PPC | n/a | Support w/ caveats |
| BPA | Oppose | Support w/ caveats |
| Chelan | Oppose | Support w/ caveats |
| EWEB | Oppose | Support w/ caveats |
| PGP | Oppose | Support w/ caveats |
| Powerex | Oppose | Support w/ caveats |
| PSE | Oppose | Support w/ caveats |
| SCL | Oppose | Support w/ caveats |
| Tacoma | Oppose | Support w/ caveats |
| Wellhead | Undecided | Support w/ caveats |
| MRP | Undecided | Undecided |
| NVE | Undecided | Undecided |
| PG&E | Undecided | Undecided |
| Six Cities | Undecided | Undecided |
| WPTF | Undecided | Undecided |

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# Thank You

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# Appendix: CAISO's Market Interventions Systematically Depress RT Prices, Ensuring Profits For Virtual Suppliers

**Table 5.1 Convergence bidding volumes and revenues by participant type (2018)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ million) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 697 | 1,122 | 1,819 | -$13.7 | $55.8 | $42.1 |
| Marketer | 397 | 573 | 970 | -$9.9 | $22.3 | $12.5 |
| Physical generation | 0 | 90 | 90 | $0.0 | $1.5 | $1.5 |
| Physical load | 8 | 2 | 10 | -$0.4 | $0.0 | -$0.4 |
| **Total** | **1,102** | **1,787** | **2,889** | **-$24.0** | **$79.6** | **$55.7** |

**Table 5.1 Convergence bidding volumes and revenues by participant type (2017)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ million) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 484 | 750 | 1,233 | $11.3 | $2.9 | $14.2 |
| Marketer | 267 | 415 | 682 | $4.8 | $1.0 | $5.9 |
| Physical generation | 0 | 223 | 223 | $0.0 | -$0.2 | -$0.2 |
| Physical load | 19 | 24 | 43 | $0.9 | $0.2 | $1.1 |
| **Total** | **770** | **1,411** | **2,181** | **$17.0** | **$4.0** | **$21.0** |

**Table 5.1 Convergence bidding volumes and revenues by participant type (2016)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ million) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 725 | 943 | 1,667 | -$0.2 | $13.2 | $13.1 |
| Marketer | 294 | 483 | 777 | $2.3 | $4.5 | $6.9 |
| Physical generation | 51 | 144 | 195 | -$0.9 | $0.9 | $0.1 |
| Physical load | 2 | 283 | 285 | $0.0 | $1.9 | $1.9 |
| **Total** | **1,072** | **1,853** | **2,925** | **$1.3** | **$20.6** | **$21.9** |

**Table 5.1 Convergence bidding volumes and revenues by participant type (2015)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ millions) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 715 | 769 | 1,484 | $0.5 | $14.1 | $14.6 |
| Marketer | 401 | 563 | 964 | $0.9 | $9.0 | $9.9 |
| Physical generation | 70 | 170 | 240 | -$0.5 | $2.1 | $1.7 |
| Physical load | 3 | 269 | 272 | -$0.1 | $2.6 | $2.4 |
| **Total** | **1,189** | **1,771** | **2,960** | **$0.8** | **$27.7** | **$28.6** |

**Table 4.1 Convergence bidding volumes and revenues by participant type (2014)**

| Trading entities | Average hourly megawatts | | | Revenues\Losses ($ millions) | | |
|---|---|---|---|---|---|---|
| | Virtual demand | Virtual supply | Total | Virtual demand | Virtual supply | Total |
| Financial | 964 | 1,008 | 1,972 | -$2.9 | $20.3 | $17.3 |
| Marketer | 294 | 362 | 656 | -$0.5 | $6.2 | $5.7 |
| Physical generation | 150 | 226 | 376 | -$0.6 | $4.2 | $3.7 |
| Physical load | 2 | 267 | 269 | -$0.1 | $3.4 | $3.3 |
| **Total** | **1,409** | **1,863** | **3,273** | **-$4.0** | **$34.1** | **$30.1** |

Virtual Supply profits are ***systemic*** and ***growing***

*Sources: CAISO DMM Annual Report On Market Issues And Performance 2014 – 2018*