Resource Specific Option
Version 2.0

CAISO EDAM Team

EDAM Working Group 3

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Agenda

- CAISO Resource Specific Option 2.0 (Anja Gilbert)
- EDAM RSE Optimization Model as the Base Schedule for Secondary Dispatch Accounting (George Angelidis)

CAISO RESOURCE SPECIFIC OPTION 2.0

Market Design and GHG Policy

- The CAISO's market design effort is not seeking to reshape GHG accounting or reduction policy objectives at the state or federal level, or to change state or federal laws.

- Our efforts are to ensure accurate accounting of GHG emission costs incurred by sellers of power, reflect those costs in our least cost dispatch, and to the extent possible facilitate any required GHG reporting by market participants. We are undertaking this effort cognizant of federal and state laws as well as existing and developing GHG emission reduction programs, and ultimately we will need to align our market design with these laws and programs.

- If we identify elements of our market design that do not align with these laws or programs we expect to engage relevant authorities to discuss options to bring the market design and program(s) into alignment.

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I. General Accounting: Area and Availability

- Area: GHG Regulatory Area within a BAA: The CAISO will associate resources with a GHG Regulation Area within their BAA
  - Enables GHG accounting for BAAs which span multiple states, but may operate within different GHG Regulatory Areas

- Transmission alignment: GHG transfers are distinct from BAA transfers

- Availability: Optional, based on hourly GHG bid submitted

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I. General Accounting: Costs optimized

- **Costs being optimized:**
  - Included: GHG cost of compliance
  - Excluded: Clean energy policies (e.g., RPS and CES)/procurement policies

- **Bid:**
  - Quantity: MW
  - Price: $/MWh
  - Frequency: Hourly basis

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I. General Accounting: Emissions Attribution

- Resource specific attribution
- Emissions rate
  - ◆ EDAM BAA
    - Specified Resource (resource specific emissions rate)
  - ◆ Non-EDAM BAA
    - Unspecified Resource (default emissions rate)
      - ➢ CARB: 0.428 mTCO$_2$e/MWh
      - ➢ WA Department of Ecology: 0.437 mTCO$_2$e/MWh
    - Asset Controlling Supplier (ACS) emissions rate
      - ➢ Average emissions rate based on their areas, as approved by CARB

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I. General Accounting: Participation Options

Participation Option	Emissions Attribution
Imports at EDAM Boundaries	Subject to WG 2 discussion on external resource participation
Pseudo-ties	Included in the GHG Regulation Area they are pseudo-tied to
Wheels through GHG compliance area	N/A
Virtual bids	Excluded, as GHG attribution is limited to physical supply
Energy storage	Included, if they submit a GHG bid for discharging
Jointly owned units	Included, if within GHG Regulation Area
Self-scheduled resources	Included, if they submit a GHG bid and energy bid

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I. General Accounting: Multiple GHG Zones

Bidding Structure Between Zones <u>with</u> Linkage

	Linked GHG Zone	Non-GHG Zone
Resource in GHG Zone	GHG cost embedded in energy bid	N/A
Resource in Non- GHG Zone	GHG bid adder	N/A

Bidding Structure Between Zones <u>without</u> Linkage: Initial Iteration

	GHG Zone 1 (CA) (Cost A)	GHG Zone 2 (WA) (Cost B)	Non-GHG Zone
Resource in GHG Zone 1 (CA)	GHG cost embedded in energy bid	N/A*	N/A
Resource in GHG Zone 2 (WA)	N/A*	GHG cost embedded in energy bid	N/A
Resource in Non- GHG Zone	GHG bid adder – Cost A	GHG bid adder – Cost B	N/A

In the initial phase of implementation the CAISO is not proposing to build functionality to support cross regulation area GHG attribution

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II. Approach Specific Issues

- The CAISO proposes to use the EDAM RSE optimization model as the base schedule for secondary dispatch accounting (slides 15-22)

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III. Secondary Dispatch and Other Consequences

- Every GHG proposal in EDAM will have to solve the issue of secondary dispatch
- The CAISO does not have estimates of secondary dispatch in EDAM, but recognizes that the volume of MW will be higher that roll over to real time
- Secondary dispatch in the CAISO's proposal will be limited by:
  - Transfer limits
  - Net export of a BAA
  - The difference between the Upper Economic Limit and the Base Schedule

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IV. Reporting and Settlement: Reporting

- E-Tags: Not tagged on account for GHGs; rather, GHG attribution is reported by the Market Operator (MO) and the Scheduling Coordinator (SC)

- GHG Attribution: Rolls over from EDAM to the Real Time Market

- Regulatory Reporting: The CAISO will report Real Time (RTD) GHG attributions to regulatory agencies, no change from EIM

- Informational Reporting: The CAISO anticipates it could support sharing information on:
  - GHG resource specific information with WREGIS, depending on reporting requirements
  - Quantity of secondary dispatch

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IV. Reporting and Settlement: Settlement

- Settlement: Day Ahead GHG attribution settlement followed by an incremental GHG attribution settlement for any deviation in FMM and RTD

- Compensation: Generators outside of a GHG Regulatory Area with a GHG bid will be compensated based on the marginal cost difference between serving load in a GHG Regulation Area and serving load outside of the GHG Regulation Area.

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V. Miscellaneous

- EDAM Schedule→ EIM Base Schedule
- Bidding changes allowed between EDAM and EIM:
  - GHG Quantity (MW): Yes
  - GHG Price ($/MWh): No
- Reflection of cost reference level (DEBs and proxy costs):
  - Within GHG Regulation Area: Included based on prevailing GHG index price and the resource's specific characteristics (GHG emissions rate, heat rate, etc.).
  - External GHG Regulation Area: Cap based on GHG index price

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EDAM RSE OPTIMIZATION MODEL AS THE BASE SCHEDULE FOR SECONDARY DISPATCH ACCOUNTING

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Objective

- **Use the submitted resource energy bid range (no bid prices)**
  - ◆ Calculate for each EDAM BAA a feasible hourly resource schedule profile over the Trading Day that meets demand forecast and uncertainty requirements, as adjusted by bucket-1 transfers
  - ◆ To minimize hourly failures
  - ◆ Subject to
    - Energy bid limits
    - Ramp rate capability limits
    - VER forecast, for VER
    - Daily energy limits, for hydro resources
    - State of charge limits, for storage resources

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Simplification to allow on-demand execution

- No transmission constraints or scheduling limits of any kind
- No startup time, minimum up/down time, or daily starts
    - If bids are submitted, the resource is online, otherwise it is offline
    - Startup time from initial condition considered
- No MSG states or transition times
    - Model MSG as a single state with continuous energy bid range
- Ignore ancillary services and imbalance reserves
    - Separate test for AS/IR bid sufficiency to meet AS/IR requirements
- Use a weighted-average flat ramp rates

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Notation

i	Resource index	LEL/UEL	Lower/Upper economic limit
t	Time period index (0 for initial condition)	LOL/UOL	Lower/Upper operating/regulating limit
EN	Energy schedule	RRU/RRD	60min ramp rate up/down capability
IRU/IRD	Imbalance Reserve Up/Down award	E	Daily energy limit
RU/RD	Regulation Up/Down award	SOC	State of charge
CR	Contingency Reserve award	η	Charging efficiency
ENP/IRUP/IRDP	Energy & imbalance reserve up/down bid price	$\overline{}, \underline{}$	Denotes upper/lower limit
RUP/RDP/CRP	Regulation up/down & contingency reserve bid price	$^{(+)}, ^{(-)}$	Denotes discharging/charging schedule
D	Demand forecast*	v, w	Upward/downward capability shortfall
IRUR/IRDR	Imbalance reserve up/down requirement*	u	Discharge binary variable
RUR/RDR/CRR	Regulation up/down & contingency reserve requirement*	α, β, δ	Shared ramp capability constraint coefficients

*adjusted for bucket-1 energy/imbalance reserve/regulation/contingency reserve transfers

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Requirement constraints

- Power balance requirements

$$\sum_i EN_{i,t} + v_t - w_t = D_t, \forall t$$

- Imbalance reserve requirements

$$\left\{ \sum_i IRU_{i,t} \geq IRUR_t, \quad \sum_i IRD_{i,t} \geq IRDR_t \right\}, \forall t$$

- Ancillary services requirements

$$\left\{ \sum_i RU_{i,t} \geq RUR_t, \quad \sum_i RD_{i,t} \geq RDR_t, \quad \sum_i CR_{i,t} \geq CRR_t \right\}, \forall t$$

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Capacity and ramp capability constraints

- **Capacity constraints**

$$\left.\begin{array}{c} EN_{i,t} + IRU_{i,t} \leq UEL_{i,t} \\ EN_{i,t} - IRD_{i,t} \geq LEL_{i,t} \\ EN_{i,t} + IRU_{i,t} + CR_{i,t} + RU_{i,t} \leq UOL_{i,t} \\ EN_{i,t} - IRD_{i,t} - RD_{i,t} \geq LOL_{i,t} \end{array}\right\}, \forall i,t$$

- **Ramp capability constraints**

$$\left.\begin{array}{c} EN_{i,t} - EN_{i,t-1} \leq RRU_i(EN_{i,t-1}) - \\ \alpha\, RU_{i,t} - \beta\, CR_{i,t} - 4\,\delta\, IRU_{i,t} \\ EN_{i,t} - EN_{i,t-1} \geq -RRD_i(EN_{i,t-1}) + \\ \alpha\, RD_{i,t} + 4\,\delta\, IRD_{i,t} \end{array}\right\}, \forall i,t$$

- **Energy constraints**

$$\underline{E_i} \leq \sum_t EN_{i,t} \leq \overline{E}_i, \forall i$$

$$\underline{SOC_i} \leq EN_{i,t} \leq \overline{SOC}_i, \forall i,t$$

- **Energy storage model**

$$\text{SOC}_{i,t} = \text{SOC}_{i,t-1} - \left(\text{EN}_{i,t}^{(+)} + \eta_i\, \text{EN}_{i,t}^{(-)}\right)$$

$$\text{EN}_{i,t} = \text{EN}_{i,t}^{(+)} + \text{EN}_{i,t}^{(-)}$$

$$0 \leq \text{EN}_{i,t}^{(+)} \leq u_{i,t}\, UEL_{i,t}$$

$$\left(1 - u_{i,t}\right) LEL_{i,t} \leq \text{EN}_{i,t}^{(-)} \leq 0$$

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Objective function alternatives

- Minimize upward and downward capability shortfall

$$\min \sum_t (v_t + w_t)$$

- Minimize bid cost with high penalty for violating requirements

$$\min \sum_t \left(\sum_i \begin{pmatrix} EN_{i,t} \; ENP_{i,t} \; + \\ IRU_{i,t} \; IRUP_{i,t} \; + \\ IRD_{i,t} \; IRDP_{i,t} \; + \\ RU_{i,t} \; RUP_{i,t} \; + \\ RD_{i,t} \; RDP_{i,t} \; + \\ CR_{i,t} \; CRP_{i,t} \end{pmatrix} + v_t \; M_v + w_t M_w \right)$$

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Properties

- Executed for each BAA separately
  - In parallel for all BAAs
- Single test for upward and downward capacity and flexibility
  - Simultaneous upward and downward test
  - Ramp capability constraints are enforced
- Hourly failures and hourly shortfalls are identified
- Optimal schedule minimizing bid cost can be used as counterfactual for GHG resource-specific attribution

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