Terra-Gen, LLC

Hybrid Resources

CAISO Storage Design and Modeling Initiative

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Paired Resources/Hybrid Resource Background

- Two types of CAISO paired resources, Hybrid and Co-Located
  - Co-located Resources – Multiple Resource IDs behind a single point of interconnection
    - Each resource is modeled and submits bids to CAISO independently
    - CAISO models storage State of Charge (SOC), Variable Energy Resource (VER) forecasts, and thermal heat rates independently as appropriate
  - Hybrid – Single Resource IDs, with multiple mixed-fuel components behind a single point of interconnection
    - Resource is modeled as a single resource, Scheduling Coordinator (SC) submits one bid curve that includes any internal optimization, i.e., charging/discharging decisions, and SOC is not modeled in the CAISO market
    - Hybrids are expected to always be able to respond to CAISO dispatch instructions as a dispatchable resource
- Hybrid resources are subject to the same market principles as other resources
  - Bid a single bid curve in both the DA and RT markets and are required to respond to dispatch instructions from CAISO
    - Hybrids must be able to maintain output level to meet dispatch instructions, incorporating storage component SOC management and grid charging restrictions and VER component fuel availability, i.e., generating capability variability

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Hybrid Resources & Dynamic Limits Background

- CAISO developed "dynamic limits" in the hybrid resources initiative (circa 2020)
  - Informs CAISO's market and operators regarding changes to hybrid output capability due to less VER generating capability, storage charging decisions, and SOC management to allow hybrid resources' SCs to signal updated availability to the market
- Dynamic limits allow changes to hybrid resource upper and lower economic limits between bid submission (at T-75) and Real-Time Dispatch (RTD)
  - Mitigates unreliable or infeasible dispatch instructions and Real-Time market awards
- Dynamic limits are available for use by hybrid resources in Real-Time market and designed to allow a hybrid resource's dynamic limits to be updated up to every five minutes over a rolling 6-hour period
  - Hybrid dynamic limits can be submitted up to 10 minutes before associated RTD market interval (i.e., up to T-10 minutes) but are not intended for equipment failure or other traditional outages that should be notified through Outage Management System (OMS) outage submissions
- Hybrids are awarded/dispatched based on bids submitted in Day-Ahead market and using both bids and dynamic limits in the Real-Time market

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Hybrid Resource Default Energy Bids (DEB) and Dynamic Limits Interactions

- Hybrid resource DEBs – CAISO had indicated would be needed to allow hybrids to bid above the soft offer cap ($1000/MWh) following prior Order 831 bid cap changes, subsequently to be included in the initial scoping of this Storage Design and Modeling initiative
  - Terra-Gen recommended the dynamic limits concept should be discussed in coordination with any effort to develop a hybrid DEB formulation or applying mitigations to hybrids
- Hybrid components with two fuel types requires a more complex DEB formulation
  - Any hybrid DEB proposal should consider the need to manage SOC outside of the market (CAISO does not model hybrid SOC in market), VER fuel availability, and managing grid charging restrictions
  - Also combining two different technologies with different marginal and variable costs confuses the potential for fair application of a DEB methodology, not to mention the dynamic nature of these costs for these resources which could vary over days, hours, and even sub-hourly
- If CAISO intends to develop hybrid resource DEB methodology, SCs need the ability to utilize dynamic limits to be unequivocally allowed for SOC management purposes
  - Mitigation can result in lack of control/mismanagement of storage component SOC, as well a potential for impacting ability of SC to observe grid charging limitations or meet CAISO dispatch instructions
  - Allowing dynamic limits to be used for SOC management should be explicit in tariff and BPMs

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Application of Dynamic Limit Use

- Appropriate use case/applications of dynamic limits should be discussed in an open stakeholder initiative – Existing provisions from the Tariff and BPM:
  - Tariff language contemplates use of dynamic limits
    - Section 30.5.6.2 Hybrid Resource Bids
      - " …. Hybrid Dynamic Limits should reflect resource availability based on operating capabilities such as State of Charge and forecasted output from the variable component of a Hybrid Resource. Scheduling Coordinators may also use Hybrid Dynamic Limits to **manage onsite charging of an energy storage component of a Hybrid Resource**. …."
  - BPM for Market Operations
    - 2.1.21.1 Market Processes for Hybrid Resources
      - "Scheduling coordinators may submit hybrid dynamic limits to reflect four scenarios: 1) ambient unavailability, 2) unavailability of renewable generation due to lack of fuel resource (e.g. wind, sun) 3) unavailability due to state of charge or 4) **to reflect onsite charging**."
      - "Resource operators will need to manage the state of charge of any storage component through typical (Price, MW) bid submissions."
    - CAISO removed prior terminology explicitly referencing "SOC management" – consider that "reflecting onsite charging" and "manage onsite charging" are functions/actions related to SOC management

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Ancillary Services Provision Issues

- Provision of Ancillary Services (AS) by hybrids was only briefly noted in prior discussion
- Dynamic limit functionality was not built into CAISO Automated Generator Control (AGC) system during initial implementation changes
  - Subsequent experience shows CAISO's expectations has evolved over time to require using outages
  - Hybrids providing Regulation are required to submit outages through OMS to signal availability due to VER variability or SOC limitations
    - Issue: Significant time-lag from submission of outage to flow through market process and be reflected in subsequent awards/dispatch instructions (~45 minutes)
  - CAISO should consider implementing the use of dynamic limits for AS availability instead of being forced to use outage cards
    - This approach requires implementation within AGC logic – CAISO should investigate the feasibility of this modified approach
- Issue: AS procurement in RT is only performed in the Fifteen Minute Market (FMM)
  - 15-minute granularity procured 45-minutes in advance results in challenges regarding communicating hybrid resource availability for AS, with no way to indicate this change to CAISO other than calling RT Operations desk
  - CAISO has indicated that SCs cannot set dynamic limits below AS award amount to manage this

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Other Hybrid Outage Card Issues

- Sub-Resource ID level outage information should be considered
  - CAISO should explore the ability and impact of updating OMS for sub-resource ID component level outage or derate submissions
- VER Forecast implementation for hybrid resources – VER component outages and derates do not flow into the CAISO VER forecast used by the market for Hybrids
  - CAISO uses VER forecasts for setting RUC procurement targets
  - If CAISO is not utilizing outages or derates to update VER forecast of hybrids it impacts system-wide RUC forecasts and the anticipated RUC need and ultimate RUC procurement levels
  - Negatively impacts our ability to forecast RUC procurement and pricing (RUC and energy prices) leading to inefficient, as well as overly conservative bidding and resource management
  - CAISO should explore implementation feasibility for OMS component level submissions and hybrid VER component forecasting to flow into market processes
- Resource Adequacy (RA) related concept of Unforced Capacity (UCAP) is currently being contemplated for storage capacity accreditation by CPUC and CAISO
  - UCAP is an additional key driver for consideration of component-level information for hybrid resource derates or outages
  - Hybrid component level data is needed to effectuate any fair resource specific application of UCAP concept for hybrids in the future

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Clarifications and Consideration of the Applications of Dynamic Limits Needed

- Further stakeholder/CAISO discussions and feedback should be pursued on:
  - Clarification for the appropriate use of outage cards through CAISO's Outage Management System versus the utilization of dynamic limits concept for real-time participation
    - Consider the use of dynamic limits for both energy and AS availability and updating current implementation approach for AS (AGC)
  - Clarification on the appropriate use of dynamic limits for management of SOC
  - Consider how dynamic limits should be utilized when resources are mitigated
    - What Tariff and BPM clarifications would provide better guidance/assurance?
  - Discussion on use of dynamic limits for standalone storage as a solution to allow SCs to better manage SOC and reflect constraints that are not currently modeled
  - Others?

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