Dispatchable Demand Response Functionality in MRTU

Introduction

The CAISO's intent is to fully support Dispatchable Demand Response ("DDR") in its MRTU software design. In many cases, the needs of price-responsive Demand can be met simply by participation in the CAISO's Energy market, which allows price-responsive Demand bids at Load Aggregation Points in the Day-Ahead Market and settles Real-Time deviations from Day-Ahead schedules at the Real-Time Imbalance Energy price for the Load Aggregation Points, with no Uninstructed Deviation Penalties for Load.

Alternatively, Participating Load, load that participates in the CAISO's imbalance energy and ancillary services markets and pumped storage facilities, are types of DDR resources that are modeled with added functionality in the CAISO's MRTU software. In the initial release (Release 1) of the MRTU software, Participating Load will be able to participate in the wholesale energy and ancillary service markets with certain limitations based on software functionality. The CAISO is working to address some of these limitations in its Release 1 and intends to develop a more robust and comprehensive integrated solution for participation of DDR resources in Release 2 of its MRTU software.

Following is a more detailed description of the design challenge and a comparison of the CAISO's intended approach to incorporate DDR in Release 1 and Release 2 of its MRTU software.

Description of Limitations

A full DDR model is not contemplated for Release 1 of the MRTU software. In 2005, consultants to the CAISO identified a design flaw related to Participating Load that would have resulted in inequities between prices settled at Load Aggregation Points and those settled at individual nodes. Based on this finding, the CAISO deferred the full implementation of DDR to Release 2, realizing the need to give the entire issue further thought and to get the design, rules and validation "right." However, recognizing that most of the existing Participating Loads are large hydro pumps, the CAISO will support participating pump load (or other Participating Load that can operate like a pump) by implementing a pump/storage model in Release 1 of the MRTU software. While the pump/storage model is able to provide some desired attributes of a DDR model (e.g., multi-part bids and some inter-temporal constraints), it has limitations including an inability to aggregate loads that share common metering. Therefore, as an alternative to the pump/storage model, the CAISO is also prepared to support Participating Loads using the same Energy bid structure as non-participating Loads, and to support the Participating Loads' eligibility to provide

Non-Spinning Reserve through a manual work-around, provided that metering and the network topology support this arrangement.

The Pump/Storage Model- Release 1

The pump/storage model models a pump as a negative generator when in the pump mode and as a normal generator when in the generator mode. For a simple pump or demand response resource, the negative generator mode of the pump/storage model would be used.

The full DDR model would allow a pump to curtail a portion of its base load in the Day-Ahead market. The pump/storage model, however, will only allow for a pump to bid to buy/pump in the Day-Ahead Market at its full capability, and only allow curtailment in the Real-Time Market based on its Day-Ahead schedule. If the pump was not scheduled in the Day-Ahead Market, it could offer to buy/pump in the Real-Time Market.

In addition, the full DDR model will support bids at different operating levels and incorporate a variety of inter-temporal operating constraints, while the pump/storage model supports only a single on/off state in pump mode (as a negative generator) with inter-temporal constraints limited to (1) minimum pumping time, (2) the maximum pumping energy per day, and (3) the maximum number of pumping cycles.

Extended Non-Participating Load with Non-Spinning Reserve Eligibility Model - Release 1

For some market participants, the attributes of a full DDR model are critical (e.g., multi-segment bid curves or aggregation of multiple loads). The CAISO will offer an alternative model to these market participants, allowing them to submit Energy bid curves as if they are non-participating Loads, and also to bid in the Non-Spinning Reserve market. The CAISO will work with individual market participants to ensure that the metering arrangements and the CAISO's network model can be configured appropriately. This alternative involves adding a pseudo-generator to the CAISO's network model to support bidding and dispatch as Non-Spinning Reserve. In the case of aggregated Loads, the CAISO must also be able to add a System Resource to its network model that will allow Energy bids to be modeled using the same functionality as exports from the CAISO.

Full DDR Model- Release 2

Table 1 below draws a comparison between Release 2, the full DDR model and Release 1, the initial proposed pump/storage model.

Table 1: Compare & Contrast- Release 2 vs. Release 1

Attribute	Full Dispatchable Demand Response Model (Release 2)	Pump/Storage Model (Release 1)	Extended Non-Participating Load Model (Release 1)
Model	• Base Load as Price-Taker	• Pump model as negative generator	• Load operates as non-participating Load

	• Logical Generator represents generator dispatch capability from Base Load	mode of pump/generator model where positive generator mode is not used	• Manual work-around by CAISO allows participation as Non-Spinning Reserve
Number of operating bid segments supported	Up to 10 segments	Single Segment (Pump is on or off)	Up to 10 segments
Aggregate physical resources?	Yes	No	Yes
Bid Components	Three-part bid: • Load Curtailment Cost • Minimum Load Reduction Cost • Load Energy Bid	Two-part bid: • Shut-Down Curtailment Cost • Pump Energy Costs	One-part bid: • Load Energy Bid
Base Load Supported	Yes	No	No
Settlement	• Base Load at nodal LMP as price-taker. (DAM or RTM) Note: Prior to LECG review Base Load settled at LAP. • Curtailment from Base Load is settled at Minimum Load Reduction Cost for energy plus Load Curtailment Cost • Dispatch below minimum load reduction is settled nodal LMP in DAM/RTM	• In DAM pump can only bid to buy energy. If scheduled pump load is charged DAM LMP. If not scheduled in DAM no charge. • In real-time any curtailment from DAM schedule will be paid nodal LMP plus shutdown curtailment cost. If pump not schedule in DAM, pump resource may offer to buy to pump in RTM.	• CDWR pumps will have separate Load Aggregation Points (LAPs) for DAM and RTM LMP calculation. For other potential Participating Loads, CAISO will determine feasible level of LMP disaggregation on a case-by-case basis. • Schedule in DAM is settled at locational DAM price. • Difference between DAM and actual RT Demand is settled at locational RTM price. Participating Load is not subject to Uninstructed Deviation Penalty.
Day-ahead Market Treatment	Base Load must be price-taker. Therefore, Dispatchable Demand Response can be dispatched from Base Load in DAM and be compensated for curtailment/dispatch accordingly in DAM	Model as a negative generator and can only submit offer to buy in DAM	• Energy is scheduled in DAM as non-participating Load. • Participating Load is eligible to bid Non-Spinning Reserve, using pseudo-generators placed at the locations of Loads.

Real-time Market Treatment	May bid to curtail/dispatch load from either DAM level or RTM Base Load level.	In real-time, pump may offer to curtail from DAM schedule (if scheduled in DAM) or offer to buy to pump in RTM if not scheduled to pump in DAM. However, same energy bid used in the Day-Ahead market must be used in all hours. As a result, there is no opportunity for a pump to shape its offer price for different hours.	• Loads determine RT operating point by monitoring RT price. • CAISO dispatches Non-Spinning Reserve as contingency-only reserve, using pseudo-generators placed at the locations of Loads. Actual response will be expected as a reduction in Demand.
Inter-temporal Constraints	Yes • Load Curtailment Time (time to curtail load) • Minimum Load Reduction Time (minimum time after load curtailment) • Minimum Base Load Time (minimum time after load restoration) • Maximum Number of Daily Load Curtailments	Yes • Minimum Up Time (minimum time to stay in pumping mode after switching to that mode) • Maximum status changes (maximum switches into pumping mode) • Daily Energy Limit	No
Load Ramping	Yes • Load Drop Rate • Load Pickup Rate	No	No
Ancillary Service Eligibility	Eligible to provide Non-Spinning Reserve	Eligible to provide Non-Spinning Reserve	Eligible to provide Non-Spinning Reserve

In summary, a full Dispatchable Demand Response model would likely consist of the following:

- A three-part bid consisting of:
  - Load curtailment cost
  - Minimum load reduction cost
  - Load energy bid
- Load curtailment time (time to curtail load)
- Minimum load reduction time (min time after load curtailment)
- Minimum base load time (min time after load restoration)
- Maximum number of daily load curtailments
- Load drop rate
- Load pickup rate
- Maximum Non-spinning reserve capacity (load reduction within 10 minutes)

In addition, the DDR model is contemplated to have the following attributes:

- The base load component is a price taker, i.e., it is charged the relevant aggregate LMP as any non-participating load irrespective of dispatch
- When the DDR is dispatched from the base load, it is eligible for recovering its load curtailment cost and its hourly minimum load reduction cost
- When the DDR is dispatched, it is paid its LMP for the load reduction

Thus, a DDR resource could be compared and contrasted to a generator as follows:

DDR Resource	Generator Resource
Load Schedule	Base Load
Minimum load reduction	Minimum generator output
Minimum load	Maximum generator output
Load curtailment time	Start-up time
Minimum load reduction time	Minimum up time
Minimum base load time	Minimum down time
Maximum number of daily curtailments	Maximum daily start-ups
Load drop rate	Ramp up rate
Load pickup rate	Ramp down rate
Load curtailment cost	Start-up cost
Minimum load reduction cost	Minimum load cost