California Independent
System Operator Corporation

Draft Final Proposal

Post-Release 1 MRTU Functionality for Demand Response

Executive Summary

The California Independent System Operator (CAISO) has a goal of helping to develop demand response resources that add capacity to California's energy supply portfolio and can participate in the CAISO's markets. The purpose of this document is to convey how the CAISO intends to enhance the functionality for demand resources that is in the initial release (Release 1) of its Market Redesign and Technology Upgrade (MRTU) program so that demand resources can more fully integrate and participate in the CAISO's markets and grid operations. This document is the result of a stakeholder process that is specifying the core set of software requirements that will be implemented in the CAISO's next phase of demand response. Once these are set, the Working Group will proceed to develop the procedures and User Guide for implementation of this Post-Release 1 approach.

This Draft Final Proposal provides details about the enhanced functionality to be implemented Post Release 1 of MRTU, as part of the Markets and Performance (MAP) program. The functionality described herein consists of two market design enhancements that will both be added to the functionality provided by MRTU:

1. Dispatchable Demand Resource (DDR) functionality will effectively provide demand resources with full comparable functionality to that of a generator in the CAISO's market software and systems. This proposed design provides considerable flexibility for demand resources, allowing Participating Loads to (1) simply bid into the CAISO Markets with a forward Energy Bid, or (2) provide additional details about the operating characteristics of the demand resource like Minimum Load Reduction (minimum MW of demand response), Minimum and Maximum Load Reduction Time, and Minimum Load Reduction Cost in addition to the Energy Bid, or (3) provide capacity for Residual Unit Commitment (RUC) and/or as Non-Spinning Reserve or other Ancillary Services (AS). The DDR functionality will be implemented within 12 months after the start of operations under MRTU, and will replace the MRTU Participating Load functionality.[1]
2. Proxy Demand Resource (PDR) functionality will provide many of the key elements of the DDR design, with simplified implementation requirements for both the CAISO and Market Participants. The PDR will allow Participating Loads to continue to schedule their Demand as part of their Non-Participating Load at their Default Load Aggregation Point (LAP), instead of requiring a Custom LAP, and uses Proxy Generators to indicate

[1] The MRTU functionality that is replaced by DDR is the Extended Non-Participating Load Model, which is described in the Business Practice Manual for Market Operations. In MRTU Release 1, Participating Loads are also eligible to use the Pumped-Storage Hydro Unit Model, which remains available after DDR implementation.

the availability of demand response within local areas as required for effective Real-Time CAISO operations. The CAISO will treat Day-Ahead Schedules for Proxy Generators as adjustments to Default LAP Schedules, instead of being settled at their locations within local areas, which allows significant simplifications in their implementation. Because of the simplified implementation, the CAISO expects the PDR functionality to be available within a few months of MRTU operations, e.g., by mid to late 2009.

In addition to providing additional options to market participants, having additional resources participating in the CAISO Markets makes adds depth and liquidity and helps address market power concerns, and having resources bid at their locations instead of at the Default Load Aggregation Point enhances congestion management.

The guiding principle for this Draft Final Proposal, which is that the Participating Load model should provide flexibility, means that at the most basic level, the minimum participation for Participating Load requires submitting only a simple Energy Bid. This provides a way of "participating" in the CAISO's market without requiring more complex resource parameters. Yet the model does appropriately provide additional options within the same program design when Participating Loads want additional functionality and resource modeling capability. A Participating Load that simply submits an Energy Bid is not very different from Price-Responsive Demand that bids as non-Participating Load, and both are valuable resources in the CAISO Markets. A Participating Load can bid into the Real-Time Market as well as the Day-Ahead Market, receive local LMP prices as compensation for Demand reductions when local areas are more congested than larger areas of the transmission system, and can set the Real-Time market price. Using additional, optional Bid components, a Participating Load can choose to provide capacity for RUC or AS, or to inform the CAISO that it has operational limits including but not limited to Minimum Load Reduction and associated costs, Minimum and Maximum Load Reduction Times, minimum time between load reductions, Minimum and Maximum Daily Energy Limits, and maximum number of daily load curtailments. The CAISO's design accommodates end-use loads that have hourly or sub-hourly metering intervals. Telemetry is required only if a Participating Load provides Ancillary Services, such as Non-spinning Reserve.

This document updates a Draft Straw Proposal that the CAISO published (http://www.caiso.com/1c64/1c64d4d07e40.pdf) on September 25, 2007, a Revised Draft Straw Proposal that the CAISO distributed to demand response working group participants on October 25, 2007, and a Straw Proposal that the CAISO published (http://www.caiso.com/1c91/1c919e0e11c30.pdf) on November 9, 2007, based on written comments on those documents from working group participants and discussion at working group meetings on October 16 and November 5, 2007. The Straw Proposal has been discussed at a stakeholder meeting on December 4, 2007, and a Market Surveillance Committee meeting on February 8, 2008.[2] Discussion continued at a working group meeting on June 12, 2008, and technical design sessions on July 30, August 8, and August 14, 2008, that guided funding applications to the California Public Utilities Commission. To the extent that working group participants' and stakeholders' suggested enhancements to the CAISO's initial Draft Straw Proposal and subsequent documents can be accommodated within the overall MRTU design and within the CAISO's obligations as a Balancing Authority, the CAISO has incorporated them in this Draft Final Proposal. The CAISO has used the discussion in the demand response working group to add to the stakeholder process that began with discussion of an Issue Paper at a stakeholder meeting on June 26, 2007. In the CAISO's typical

[2] The next steps following the discussions listed here include presentation of the CAISO's proposal to the CAISO's Board of Governors. The timing of these steps has been affected by delays in the completion of MRTU implementation. However, in the meantime, the CAISO has been able to proceed with some of its work on detailed design for implementing the proposal presented in this document.

stakeholder process, the next step after the Issue Paper would have been publication of a Straw Proposal, but the CAISO used additional stakeholder input through the working group to produce a more complete Straw Proposal. The CAISO believes that the added discussion in the demand response working group has resulted in a more thorough consideration of stakeholder concerns than would have occurred if the Straw Proposal had been produced directly after the Issue Paper. After discussion of the Straw Proposal and the current Draft Final Proposal with stakeholders as a whole, the CAISO will continue to use its stakeholder and working group processes in parallel to actively involve stakeholders in the informal working group setting to develop tariff provisions, updates to Business Practice Manuals, and develop a User Guide, and then bring the results to stakeholders as a whole at the same intervals that would normally occur.

Introduction

The CAISO's market design prior to MRTU includes opportunities for Loads to participate in the CAISO's Real-Time (RT) Energy market, and to provide Non-Spinning Reserve – known as Participating Loads. Through MRTU and subsequent market enhancements, the CAISO seeks not only to preserve these existing options, but also to add to their functionality. The September 21, 2006, FERC Order on MRTU, as well as FERC Orders since then, directed the CAISO to work with market participants to present additional opportunities for Demand Response resources to participate in the CAISO Markets.

The CAISO MRTU Release 1 software will include limited functionality but will allow demand resources to participate directly in the CAISO wholesale markets. The CAISO markets for MRTU Release 1 will accommodate aggregated loads in the CAISO markets as Participating Loads, allowing demand resources to provide Energy as well as Non-Spinning Reserve. This Draft Final Proposal proposes market design enhancements that significantly expand the options available to Participating Loads under MRTU Release 1. These enhancements comprise two sets of functionality:

- Dispatchable Demand Resource (DDR) is a flexible model that allows a single resource, using a Custom LAP, to schedule Demand and bid demand response Supply as an integrated bid, which can use co-optimization of Energy and Ancillary Services in both the Day-Ahead and Real-Time Markets to determine the best utilization of the available demand response. The DDR model allows Participating Loads to supplying all forms of Ancillary Services in the market (Non-Spinning Reserve, Spinning Reserve, and Regulation), and honors resource constraints such as equivalents of the start-up time, minimum run-time and off-time, start-up cost and minimum load, and other features characteristics that are recognized for generators, in order to provide full comparability to generators. The DDR model includes bidding into the Residual Unit Commitment (RUC) process, and ensures resources that their market revenues will at least recover their Bid costs. The DDR model will be implemented within 12 months of MRTU Go-Live, i.e., by the time when other features of MAP such as Scarcity Pricing are implemented.
- Proxy Demand Resource (PDR) is a more limited model that has simplified implementation requirements for both the CAISO and market participants. The PDR model keeps the scheduling and settlement of Demand at the Default LAP, while bidding demand response Supply at local levels, using Proxy Generators that represent the available response within Sub-LAPs. The demand response using PDR is metered and settled as part of the Demand at the Default LAP, rather than at the local level, to simplify a number of aspects of implementation. The PDR model does not support RUC participation, but Day-Ahead schedules of Proxy Generators are recognized as

contributing to meeting RUC requirements. The PDR model does not support bid cost recovery, and initially does not support Ancillary Services, although the CAISO is exploring the addition of Non-Spinning Reserve a few months after the initial PDR implementation. Due to these simplifications, PDR can be implemented faster than DDR.

Additional details of the DDR and PDR models are discussed throughout this Draft Final Proposal.

In response to the FERC Orders and keen interest expressed by the California Public Utilities Commission (CPUC) and California Energy Commission (CEC) in developing and integrating demand resources into the wholesale markets, five key demand resource working groups have been formed to help meet this important objective. The five working groups are:

1. Demand Response Participation in MRTU Release 1 (Lead agency - CAISO)
2. Demand Response Participation in MRTU Post Release 1 (Lead agency - CAISO)[3]
3. Demand Resource Product Specification (Lead agency - CEC)
4. Infrastructure for Demand Resources (Lead agency - CEC)
5. Vision for Demand Resources (Lead agency - CPUC)

Each working group has specific objectives and resulting deliverables to produce, with the over-arching objective being to enable greater participation from demand resources in the wholesale electricity markets.

This Draft Final Proposal is the result of a collaborative effort by the Demand Response Participation in MRTU Post Release 1 Working Group (group 2). As a product of the Post Release 1 working group, the scope of this document is to develop details for the implementation of enhanced Participating Load functionality in MAP, and is not intended to be a comprehensive vision statement for demand response in broader California contexts. This Draft Final Proposal adds functionality to what is available in MRTU Release 1, and does not replace MRTU Release 1's functionality for non-Participating Load. (The relationship to MRTU Release 1's functionality is described later in this Draft Final Proposal.)

Through the working group's activity, this Draft Final Proposal has been developed in consultation with the broader community of stakeholders, which will continue to be a key input into the CAISO's software development process. The working group will also continue its activity by providing input into the CAISO's Business Practice Manuals and a User Guide for Participating Loads.

The CAISO initiated this working group by publishing an Issue Paper on "Post-Release 1 MRTU Functionality for Demand Response" on June 26, 2007 (see http://www.caiso.com/1c08/1c0810a2e527b0.pdf), and presenting it for discussion at a MRTU Release 1 demand response working group meeting on that date. The CAISO's Issue Paper described the vision for Participating Load functionality as originally stated in the CAISO's Market Design 2002 ("MD02") filings, but that original vision could not be realized until after the initial implementation of Market Redesign and Technology Upgrade ("MRTU"). The reader is encouraged to review the Issue Paper for the background that it provides. Feedback from stakeholders at that meeting indicated that there is interest in proceeding to develop the Participating Load functionality following the concepts that were described. Consequently, the CAISO has documented its proposed functionality through the series of documents that have culminated in this Draft Final Proposal, including an appendix titled "Development of Software

[3] The scope that has been outlined for Working Group 2 is: "Determine how demand resources will be modeled and fully integrated into the wholesale electricity markets and CAISO grid operations. This could involve changes to the MRTU software and tariff."

Requirements for Participating Load (Post-Release 1)". The CAISO's intent is that the content of this appendix will become part of the Software Requirements Specification that guides the implementation of the Participating Load functionality.

Background

The original MD02 conceptual design included a comprehensive Participating Load model, which included voluntary three-part bids similar to generators' start-up/ minimum-load cost/ multi-segment Energy Bid, RUC participation, Load aggregation, participation in multiple markets (Day-Ahead (DA) and RT), eligibility to provide Non-Spinning Reserve, run-time constraints, etc. The original Participating Load design contemplated scheduling at local or aggregated levels, however, the overall MRTU design changed to scheduling Load at highly aggregated levels, which created a challenge since the Dispatch of Participating Load is needed at specific physical locations in the CAISO's transmission network. A market power concern was raised regarding the originally proposed Participating Load design: if the two principles of (1) overall scheduling of Load at highly aggregated levels and (2) dispatching at specific physical locations were simply combined in a way that would first schedule Load at a highly aggregated level and then re-dispatch it at its specific physical location, an opportunity for abusing the market design would be created through scheduling of fictitious Load that is then "curtailed" at a higher price, back to its actual level.[4] This difference meant that the full Participating Load model could not be adapted in time for implementation in MRTU Release 1, and interim solutions needed to be implemented in MRTU Release 1, as described in the June 26 Issue Paper. However, the original Participating Load model was partially developed during MRTU Release 1's implementation, and will be restored as a market enhancement after Release 1 with enhancements as described in this document.

The scope of this document does not include the functionality for pumped storage hydro generation, which is already addressed in MRTU Release 1. Future market enhancements will not decrease, and may improve, the Release 1 functionality for pumped storage hydro generation, but such changes are beyond the scope of this document.

Principles for Participating Load Functionality

A guiding principle for this Draft Final Proposal is that as a full dispatchable demand resource model, the Participating Load model should provide flexibility. This it does since, given at the most basic level, minimum participation for Participating Load means only a simple Energy Bid must be submitted. The ability to provide only a simple Energy Bid can be considered as "Participating Load Lite" if you will, i.e., a way of "participating" in the CAISO's market without requiring more complex resource parameters to be submitted along with the energy bid. Yet the model does appropriately provide additional options within the same program design when Participating Loads have need for additional functionality and resource modeling capability. A Participating Load that simply submits an Energy Bid is not very different from non-Participating Load, and both are valuable resources in the CAISO Markets. Using additional, optional Bid components, a Participating Load can choose to participate more flexibly in the CAISO Markets, to the benefit of both the CAISO, the market, and the Participating Load. The following discussion outlines several levels of participation that are available to Participating Load in the CAISO Markets.

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[4] The potential for abusing the market design, and the resulting requirements for its mitigation, were discussed in a working group meeting on October 16, 2007. See http://www.caiso.com/1c79/1c799d9a40d50.pdf.

Price-Responsive Demand

Despite its name, a non-Participating Load can participate in the CAISO markets by submitting an hourly Energy Bid in the CAISO's Day-Ahead Market (DAM) and, most likely, purchasing or selling Energy in the Real-Time Market (RTM) by having actual Demand that differs from its DA Schedule.[5] The use of an hourly DA Energy Bid, and the opportunity to adjust Demand in RT based on the market price of Energy, constitute Price-Responsive Demand.[6] The DA Energy Bid for Price-Responsive Demand may have up to 10 segments, but a Bid may include fewer segments. The Price-Responsive Demand can indicate in its Energy Bid the price that it is willing to pay for the specified quantities of Energy in the DAM. The geographic areas that are covered by DA Energy Bids by non-Participating Load (including Price-Responsive Demand that is not Participating Load) are three large Load Aggregation Points (Default LAPs), where the same price applies to all locations within the Default LAPs.[7]

Figure A presents an example of an Energy Bid in the DAM for Price-Responsive Demand. In this example, there is a minimum amount of Demand that is labeled "Minimum Load", which is a "price taker", i.e., the bidder is willing to pay any market clearing price for this amount of Energy, regardless of how high the price is.[8] There are then multiple Bid segments that indicate amounts of Energy that would be purchased at various prices, which extend out to a "Maximum Load", which represents the most Energy that this bidder would purchase at any price, regardless of how low the price is. There is no requirement that the prices of the Energy Bid segments must be greater or less than an expected market clearing price: that is, an Energy Bid segment could either indicate a limited willingness to buy Energy if it costs more than a certain amount, or an interest in buying inexpensive Energy if it is available.

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5 As an alternative to submitting an Energy Bid that indicates a price that the Load is willing to pay in the Day-Ahead Market, the Load can be "self-scheduled" by submitting only a MW quantity. However, a Self-Schedule is a "price taker" and is not price-responsive from the CAISO market perspective.

6 Other terms that use capitalization (e.g., Participating Load), the term is capitalized because it has the meaning stated in Appendix A of the MRTU tariff. For purposes of this document, "Price-Responsive Demand" is capitalized to emphasize that it has an equally important role in the CAISO Markets. Generally, "Price-Responsive Demand" is used to describe Demand that responds to varying prices in DA or RT, which is not necessarily a Participating Load.

7 The three Default LAPs are the Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric transmission areas.

8 Any Demand that is scheduled using Transmission Ownership Right (TOR) or Existing Transmission Contract (ETC) capacity must be scheduled as a price taker at a MW level no higher than the Minimum Load. Price-Responsive Demand cannot be self-scheduled using a TOR or ETC scheduling priority, because the use of these scheduling priorities inherently excludes the capacity covered by an economic Energy Bid. This applies to Participating Load as well as to non-Participating Load.

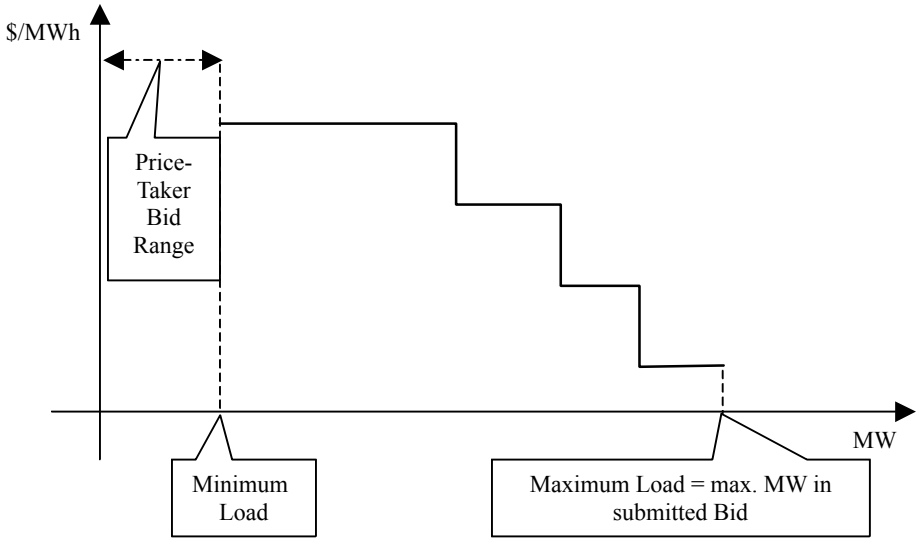

Figure A: Day-Ahead Energy Bid for Price-Responsive Demand

In RTM, the CAISO must dispatch enough "Supply" to match the actual Demand, and therefore non-Participating Load, by its very definition, is not dispatchable by the CAISO.[9] Thus, non-Participating Load is ineligible to submit RT Energy Bids and participate in the RTM. However, under MRTU, the CAISO will publish the current RT cost of Energy (which is the market clearing price for market dispatches issued at the start of a Dispatch Interval, for Energy needed during the Dispatch Interval), in addition to advisory prices 45 minutes before the beginning of each hour, for each 15-minute interval within the hour.[10] This will allow Price-Responsive Demand to adjust its level of consumption to either avoid paying for avoidable usage during high-cost intervals, or purchase additional Energy during low-cost intervals. The CAISO discussed the availability and use of the RTM's advisory prices in the demand response working group meeting of July 17, 2007. The CAISO's presentation is available at http://www.caiso.com/1c27/1c27755a43710.pdf.

There are no penalties in the CAISO Markets under MAP that limit the ability of Price-Responsive Demand to select its level of consumption in the DAM or to adjust its consumption in the RTM: (1) whereas section 11.23 of the MRTU tariff provides Uninstructed Deviation Penalties that may be imposed, subject to additional FERC Order, on generators and Interchange transactions with other Balancing Authority Areas, these provisions do not apply to Load or Curtailable Demand, and (2) provisions that are currently being developed for MRTU Release 1 to ensure sufficient DA scheduling of Load terminate with the implementation of Convergence Bidding in MAP, which is when the Participating Load functionality described in this document is also implemented.

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9 This document's discussion retains the term "non-Participating Load", for consistency with established terminology. However, the CAISO expects to replace this with the term "Non-dispatchable Demand Resource" (NDR) when DDR and PDR functionality is implemented, to indicate that the NDR does participate in CAISO Markets but simply is not dispatchable in RTM.

10 The RTM's Hour-Ahead Scheduling Process (HASP) determines binding hourly Schedules and prices for Intertie resources that cannot participate in RT interval dispatch, and also publishes the dispatch and prices within the CAISO Control Area that result from HASP, which are non-binding for Non-Participating Loads or for resources that dispatchable in RT interval dispatch.

Because location-specific information is not provided in Bids for non-Participating Load, Price-Responsive Demand that is non-Participating Load cannot bid to provide AS or capacity for RUC. Instead, the CAISO has been working through the MRTU Release 1 working group to establish a mechanism for Load Serving Entities to inform the CAISO about their operation of demand response programs that use non-Participating Load (whether price-responsive or not), and for the CAISO to use this information to adjust its capacity procurement in the RUC process. The mechanisms developed for MRTU Release 1 can remain available for as long as Load Serving Entities operate demand response programs that use non-Participating Load.

Participating Load: Basic Functionality

Like other Price-Responsive Demand, the Energy Bid for a Participating Load may have up to 10 segments, but a Bid may include fewer segments. The Energy Bid is the only required Bid component for a Participating Load. Figure B presents an example of an Energy Bid for Participating Load. As the reader will note, Figure B is nearly indistinguishable from Figure A – that is, there are few differences between the minimum participation of a Participating Load and the activity of Price-Responsive Demand that is in the CAISO Markets as a non-Participating Load.[11]

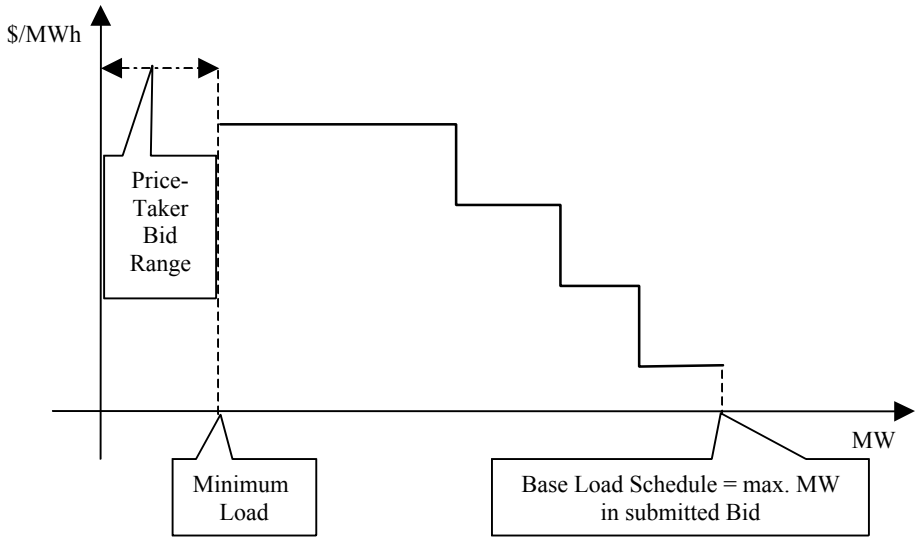

Figure B: Day-Ahead or Real-Time (DDR) Energy Bid for Participating Load

[11] The CAISO's Participating Load software functionality for Release 1A will need to assume that in the market optimization, there is a single Energy Bid that includes both the initial scheduling of Energy and the demand response that may modify that Energy Schedule. However, the policy that affects how Bids are submitted to the CAISO may change to allow a demand response aggregator that is a separate Market Participant from the Load Serving Entity (LSE), if CPUC regulations allow this to occur. The CAISO will specify that its vendor's software design should not assume that the demand response aggregator is the same entity as the LSE, but more details will be needed before these market roles can be separated. First, retail market rules would need to be established such as whether the demand response aggregator and the LSE need to be aware of the other's Bids and Schedules, how Imbalance Energy would be allocated between them, etc. Then the CAISO would need to define rules to maintain reliability and accurate settlements, such as the LSE needing to schedule the same Custom LAP as the demand response aggregator, avoiding double-counting that could occur if the LSE's Scheduling Coordinator schedules its demand based on the same reduction that the demand response aggregator is bidding, defining responsibility for Uninstructed Deviations in the wholesale market, etc.

The differences between the Energy Bids presented in Figures A and B depend on whether the Participating Load uses the DDR or PDR model, as follows:

1. The DDR model is an integrated resource that uses the same Bid for the original scheduling of Demand and the demand response that is offered for dispatch by the CAISO. Thus, for DDR, Bids that have been submitted in the DAM may be revised in the RTM, for scheduling in either the Hour-Ahead Scheduling Process[12] or RT interval dispatch (depending primarily on the interval-recording capability of the end-use customer's meter).

   In contrast, the PDR uses a Bid at the Default LAP for scheduling Demand as non-Participating Load, and a separate Bid at a Sub-LAP to represent demand response. MRTU functionality only allows a Bid for non-Participating Load to be submitted in DAM, so no updates to these Bids are supported after DAM. Instead, the CAISO intends to allow the Proxy Generators that represent demand response in the PDR model to be submitted in RTM within a few months of the initial PDR implementation.

2. As indicated in the June 26, 2007, Issue Paper, Participating Loads using the DDR model will schedule at a nodal level or using custom load aggregation points (Custom LAPs), generally within boundaries such as the Local Capacity Areas used in Resource Adequacy requirements. Proxy Generators in the PDR model will submit demand response Bids at locations within "sub-LAPs" used in parts of the current Congestion Revenue Right allocation process.[13] These levels of aggregation ensure that the CAISO can rely on scheduling and dispatching Participating Load demand resources to appropriately manage congestion. Along with ensuring Real-Time reliability of the network, this can also help to ensure the feasibility of scheduling Load using the Default Load Aggregation Points (LAPs). If there are insufficient Bids available for Congestion Management of local network constraints, reductions of Load throughout a Default LAP may be necessary, and the result would be high LMPs in constrained locations since a large amount of Load must be rescheduled to relieve a constraint by a small amount. Having Energy Bids from Participating Load available to the CAISO at the local level reduces the risk of this outcome. The MRTU Release 1 tariff provides that a Participating Load resource is settled entirely at its location's LMP, including Minimum

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[12] The October 25, 2007, Revised Draft Straw Proposal added an option to the design in the September 25 Draft Straw Proposal to recognize that some retail meters only support hourly metering intervals, by dispatching these Participating Loads in the Hour-Ahead Scheduling Process (HASP), similar to Intertie resources. Dispatch in HASP has some limitations because HASP has a limited look-ahead period for its market optimization, and because Real-Time Bids are only available hour-by-hour. Multi-hour dispatch commitments are not possible in HASP, other than unit commitment of medium-startup-time generation (which generally has a minimum load that is a small fraction of its maximum capacity). For Participating Loads that cannot participate in Real-Time interval dispatch and have minimum curtailment periods, minimum operating time limits will be available in the Day-Ahead Market. This option does include limitations on availability for dispatch, as opposed to minimum duration of dispatch.

[13] The Sub-LAPs that are used in the CRR allocation process are sub-areas of the Default LAPs, which have been based on the CAISO's previous analyses of congestion patterns. Defining the boundaries of Custom LAPs in this way is consistent with the CAISO's existing Participating Load Technical Standard, section 8.2, which states: "… The location of the Load must be included in the bids submitted to the CAISO. Loads posing potential Intra-Zonal Congestion problems will be identified and will not be allowed to participate. Preference will be given to Loads within areas where potential Congestion problems could be mitigated by Demand curtailment … The ISO reserves the right to determine whether a group of Loads … spans or interferes with an intra-zonal path." In MAP, the CAISO does not propose to exclude loads that have different intra-zonal congestion impacts from participation, but instead has used congestion to define the boundaries of Sub-LAPs. The CAISO will review the Sub-LAP boundaries with the working group before MAP implementation.

Load that is not included as a price-sensitive portion of the Energy Bid. Because consistent pricing is needed for scheduling and settlement, and because the DDR model identifies the Participating Load's specific location when its Demand is scheduled, the Participating Load will continue to be settled at its location's LMP using the DDR model. For Participating Loads that use the PDR model, only the approximate location of the demand response portion is identified, so Settlement must continue to be at the Default LAP.

The example in Figure C illustrates how Participating Load that uses the DDR model would function with only an Energy Bid curve. In this example, the Participating Load has submitted an Energy Bid with four segments. Following the definition of Base Load in the MRTU Release 1 tariff ("the maximum consumption of a Participating Load as bid in the CAISO Markets by Scheduling Coordinators"), the highest MW level of the Energy Bid is labeled as the "Base Load". The lowest MW level of the Energy Bid is labeled as the "Minimum Load", and in this case (since there is only an Energy Bid, and no optional Bid components have been used), the Minimum Load is a Self-Schedule like a Price-Responsive Demand Bid could include. The Participating Load's Schedule would be determined economically within its Bid range, i.e., between its Minimum Load and Base Load. In this example, the fourth Bid segment's price is less than the market clearing price at its location, so its Schedule is at the break between its third and fourth Bid segment. This is shown as a reduction ("Load Curtailment") from its Base Load.[14]

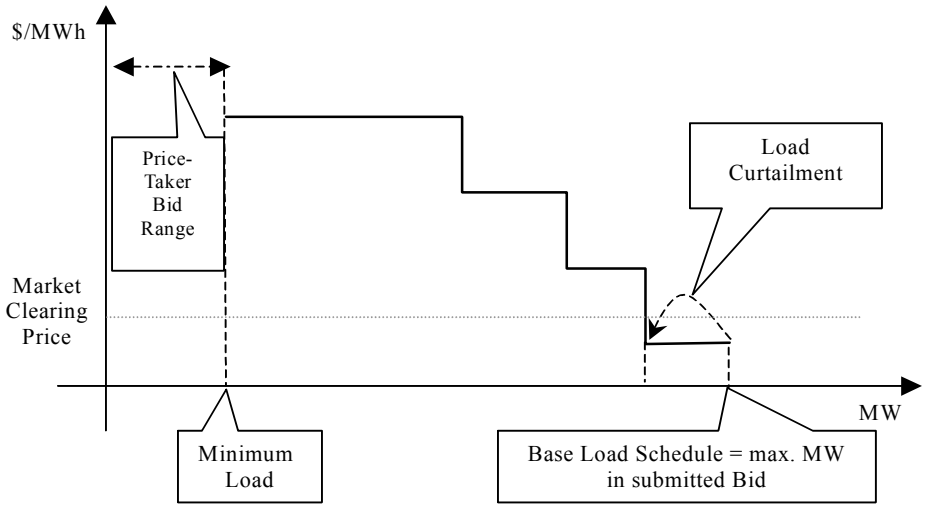

Figure C: Participating Load Energy Bid

The DAM uses hourly scheduling intervals for all loads, including Participating and non-Participating load. In the RTM, the dispatch interval for each Participating Load resource

[14] Optional Bid components are discussed in subsections below, but one merits discussion at this point. For a Participating Load that participates in Real-Time interval dispatch, a single bid segment could cover a larger MW range than the Participating Load is actually able to change within a 5-minute interval, and price changes between intervals could cause multiple Bid segments to be dispatched. The Participating Load can specify a Load Drop Rate and/or Load Pickup Rate that limits how fast the CAISO changes the Participating Load's dispatch.
The significance of the CAISO's "dispatch" of a Participating Load also needs to be understood. As noted previously, Loads and Curtailable Demand are not subject to the Uninstructed Deviation Penalty, if this provision of the CAISO Tariff is activated. The "Dispatch" simply informs the Participating Load of where its optimal operating point is, based on its submitted Bid.

depends on the metering intervals that apply to the relevant end-use customers. Participating Load using the DDR model that is supported only by hourly metering can participate in RT dispatch using hourly intervals, which are provided in the Hour-Ahead Scheduling Process (HASP) but not in subsequent RT interval dispatch. For these Participating Loads, the process for submitting Settlement Quality Meter Data (SQMD) is the same as for non-Participating Load. For Participating Loads that participate in RT interval dispatch (which uses 5-minute dispatch intervals in MRTU), the SQMD needs to be submitted for 5-minute intervals, but the intervals within the meters may actually be 15-minute intervals. The CAISO allows the 15-minute underlying data to be reported by dividing it into the 5-minute reporting intervals required by SQMD. Except as needed to use 5-minute reporting intervals rather than 60-minute reporting intervals, the process for reporting these end-use customers' SQMD would also be the same as for non-Participating Loads.

Technical requirements for participation in Energy markets using the DDR model are limited to providing SQMD that meters Energy usage for the time intervals that match the market prices for the Participating Load's location, and establishment of Custom LAPs that identify the Participating Load's location. The additional metering requirements for Participating Loads using the DDR model, compared to non-Participating Loads, exist because settlement for hourly or sub-hourly prices requires accurate hourly or sub-hourly meter data (not data determined from load profiles). For Participating Loads that use the PDR model, the metering requirements are the same as for non-Participating Loads, because the Proxy Generators affect Settlements only as adjustments to non-Participating Load Schedules at the Default LAP.[15] No telemetry is required for Participating Loads to participate in Energy markets (although the availability of telemetry will assist the CAISO in maintaining system reliability).[16]

Participating Load: Optional Capacity Products

The PDR model is designed primarily as an Energy resource, while the DDR model is a flexible design intended to have comparable functionality to generators. The CAISO anticipates that the PDR model may be extended to support Non-Spinning Reserve within a few months after the PDR model's initial implementation, but details remain to be resolved during the detailed design phase, and full comparability to generators is not a design goal. Thus, unless otherwise noted, the following discussion applies only to the DDR model.

In addition to the basic functionality of participating in Energy markets, a Participating Load using the DDR model may optionally participate in the Residual Unit Commitment (RUC) process if it submits a RUC Availability Bid.[17] The Participating Load model enables demand resources to offer all available Ancillary Service products including Non-Spinning Reserve,

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15 Provision of Non-Spinning Reserve by PDRs will involve additional metering requirements that are not required for non-Participating Loads. These requirements will be defined during the detailed design phase.

16 Because no telemetry will be available for some Participating Loads, and because a uniform method of dispatch is desired regardless of whether telemetry is available, the CAISO will use the most recent Dispatch as the starting point for future intervals.

17 Participation in RUC may be required for Resource Adequacy (RA) Resources. Participating Loads are anticipated to be use-limited resources in RA portfolios. A RUC Availability Bid of $0/MWh is used for RA Resources that are required to bid into the CAISO Markets. However, bidding requirements for such resources are being developed through other regulatory and stakeholder processes, and are beyond the scope of this document. The CAISO intends to insert adjustments to the CAISO Forecast of CAISO Demand (CFCD) when Load Serving Entities (LSEs) inform the CAISO that they are implementing Day-Ahead demand response programs that are not bid into the CAISO Markets as Participating Load. The CFCD is the basis for the CAISO's capacity reservation in RUC. The CAISO anticipates that this will continue in MAP.

Spinning Reserve, and Regulation.[18] The eligible amount of AS capacity is the Load reduction that can be delivered within 10 minutes (which requires RT interval dispatch),[19] and requires certification by the CAISO to ensure compliance with technical standards established by the Western Electricity Coordinating Council (WECC) and North American Electric Coordinating Council (NERC).[20] Ancillary Services can be simultaneously self-provided for part of the resource's capacity, and bid for any remaining capacity using a single segment for the quantity and price of offered capacity. The RUC Availability Bid indicates the quantity and price of capacity that is offered to meet the CAISO's RUC Requirement. A RUC Award does not alter the Participating Load's DA Schedule, but obligates the bidder to offer the RUC capacity for Dispatch in RTM.

A summary of requirements for providing AS is as follows. Details of the current technical specifications for Non-Spinning Reserve are documented in the CAISO's Participating Load Technical Standard, which is available at http://www.caiso.com/docs/2001/01/22/200101221153242073.pdf. The technical specifications for provision of Non-Spinning Reserve are currently under review as new participants are planning to use the MRTU Release 1 Participating Load functionality. Detailed technical specifications for provision of Spinning Reserve and Regulation will be developed through the working group process. In the meantime, the foundation of requirements for Spinning Reserve and Regulation are under review in external standard-setting processes at WECC, NERC, and FERC, such as the consideration of a Frequency Response Reserve that would change the current requirements for Spinning Reserve and Regulation. Nevertheless, it is important to recognize the essential differences between the various Ancillary Services, as a general guide to market design.

- **Non-Spinning Reserve:** In addition to the interval metering requirements for energy, Non-Spinning Reserve requires telemetry. Telemetry is required to abide by WECC and NERC standards. The WSCC Operating Reserve White Paper (http://www.wecc.biz/documents/library/PWG/wsc6oprs.pdf) states: "The WSCC [Minimum Operating Reliability Criteria] requires that system operators must know, at all times, the amount of Operating Reserve available which can be fully activated within the next 10-minutes. That means this information must be periodically calculated and displayed." CAISO Energy Management System (EMS) requires 4-second reporting intervals in a Scheduling Coordinator's Data Processing Gateway (DPG), but allows 1-minute updates from end-use meters to the Scheduling Coordinator's system. In other words, a DPG is not required at every load point, but a DPG must exist between the SC and the CAISO and be able to communicate with the CAISO on a 4-second basis. The limiting requirement is the one-minute updates that must occur between the SC's load

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[18] The CAISO will be updating its Participating Load Technical Standard as part of its implementation of MRTU and MAP Participating Load functionality, to reflect the applicable requirements. As specific demand response resources demonstrate to the CAISO that they satisfy the performance requirements for Ancillary Service products, the CAISO will also ensure that applicable WECC and NERC requirements are satisfied.

[19] If the capacity that can be delivered within 10 minutes becomes less than the awarded AS capacity, the SC must notify the CAISO using the CAISO's outage tracking system. Other limitations on the availability of Participating Loads that occur after the submission of bids to the applicable market are not required to be reported.

[20] The CAISO's current Participating Load Technical Standard documents the requirements for providing Energy and Non-Spinning Reserve, and is available at http://www.caiso.com/docs/2001/01/22/200101221153242073.pdf. Telemetry for Non-Spinning Reserve is required by WECC and NERC standards, but Participating Loads do not need to provide Non-Spinning Reserve. The CAISO's Participating Load Technical Standard also limits the amount of Non-Spinning Reserve from loads that are reported through a single Data Processing Gateway to 400 MW, but this is not a limit on the total amount of Non-Spinning Reserve that can be provided by Participating Loads as a whole.

points and the SC's DPG. Otherwise, except as necessary, metering and telemetry requirements for Participating Loads are the same as for non-Participating Loads.

- **Spinning Reserve:** In addition to the requirements for Non-Spinning Reserve, CAISO Tariff Appendix K (Ancillary Service Requirements Protocol) requirements for Spinning Reserve include: (1) the resource must provide an automatic frequency response governor with minimum performance (5% droop,[21] governor deadband must be ± 0.036 Hertz, and power output must change within one second for any frequency deviation outside the governor deadband), and (2) ability to "increase real power output" within one minute after instructions to dispatch Spinning Reserve.[22] Qualification for Spinning Reserve will require certification by the CAISO and compliance with applicable technical standards.

- **Regulation:** The CAISO Tariff definition of Regulation is "The service … capable of responding to the CAISO's direct digital control signals … in an upward and downward direction to match, on a real-time basis, Demand and resources, consistent with established NERC and WECC Reliability Standards and operating criteria. …". In addition to the requirements for Spinning Reserve, WECC Minimum Operating Reliability Criteria (MORC) requirements for Regulating reserve include: "Sufficient spinning reserve, immediately responsive to automatic generation control (AGC) to provide sufficient regulating margin to allow the control area to meet NERC's Control Performance Criteria." Qualification for Regulation will require certification by the CAISO and compliance with applicable technical standards.

Participating Load: Other Optional Bid Components

In addition to the options stated above, the DDR model offers several optional Bid components that may be used by Participating Loads to guide how their capacity is dispatched in the CAISO Markets, but that are not required components. Through the Proxy Generator in the PDR model, a Participating Load using the PDR model may use the same attributes as generators, but these are static values in the CAISO's Master File instead of being Bid components as DDR allows. The components applicable to each model are listed in the following table:

[21] Droop measures the change in output as a percentage of capacity, in response to frequency deviations.

[22] The requirements for frequency response may change when WECC adopts a separate Frequency Response Reserve. The requirement for one-minute initial response by Spinning Reserve to dispatch instructions, as stated in Appendix K of the CAISO Tariff, may change due to recently adopted and/or pending changes in WECC and NERC standards. Currently, Appendix K states a similar requirement for Non-spinning Reserve.

Comparison of Dispatchable Demand Resource Bid Components with Generation Resource		
Dispatchable Demand Resource		Generator Resource or Proxy Demand Resource
Bid Component	Explanation	
Base Load Schedule	Expected Demand if not curtailed	Base Load
Minimum Load Reduction	Minimum amount of curtailment	Minimum generator output
Minimum Load	Minimum usage	Maximum generator output
Load Reduction Initiation Time	Time required to initiate load reduction	Start-up time
Minimum Load Reduction Time	Minimum time required to operate at reduced load after start of load reduction	Minimum up time
Maximum Load Reduction Time	Maximum time required to operate at reduced load after load reduction initiation	Maximum daily energy limit
Minimum Base Load Time	Minimum time after load restoration, before the next load reduction	Minimum down time
Maximum number of daily load curtailments	Maximum number of curtailments per day	Maximum number of daily starts
Minimum & Maximum Daily Energy Limit	Limits on daily energy from load reduction, if a Curtailable Demand Bid is dispatched	Maximum daily energy limit
Load Drop Rate	Ramp rate for load drop	Ramp up rate
Load Pickup Rate	Ramp rate for load pickup	Ramp down rate
Load Reduction Initiation Cost	Minimum curtailment cost, per curtailment	Start-up cost
Minimum Load Reduction Cost	Minimum curtailment cost, per hour	Minimum load cost

For end-use customers with hourly metering intervals, which would be eligible for dispatch in HASP using the DDR model, all optional Bid components apply in DAM, but the options in RTM are limited to:

- Base Load Schedule
- Minimum Load Reduction
- Minimum Load
- Maximum Load Reduction Time
- Minimum Base Load Time
- Maximum Number of Daily Load Curtailments,
- Maximum Daily Energy Limit
- Load Reduction Initiation Cost
- Minimum Load Reduction Cost

The availability of these Bid components provides Participating Loads with essentially the same flexibility that generators have in the CAISO Markets to ensure that the CAISO's Dispatch

recognizes limitations in their availability.[23] The Load Drop Rate and Load Pickup Rate Bid components, which indicate how fast the Participating Load can respond to the CAISO's Dispatch instructions, can be pertinent to all Participating Loads. In addition, the Minimum Load and Minimum Load Reduction can be relevant even if only the Energy Bid is submitted (without AS or RUC Bids). The remaining optional Bid components are meaningful if a Participating Load has a minimum amount of load, which is the "Minimum Load Reduction", that must be dispatched if any Load Curtailment is used; these are: Base Load Schedule, Minimum Load Reduction, Load Reduction Initiation Time, Minimum & Maximum Load Reduction Time, Minimum & Maximum Daily Energy Limit, Load Reduction Initiation Cost, and Minimum Load Reduction Cost.

The role of these optional Bid components can be seen by comparing Figure D, "Generator Bid", with Figure E, "Participating Load Bid with Minimum Load Reduction". The generator's output is variable within the range of its Energy Bid, but cannot operate below its "Gen Minimum Output". To reach its minimum output, the generator may incur start-up costs. To operate at its minimum output level, it may incur average costs that are higher than the incremental cost at points within its first Bid segment. The generator may have operating limits including how fast it can start, how long it must run once it starts, and how much Energy it can produce in a given day. The CAISO's market optimization software will take these costs and operating limits into account in determining the optimum Schedules for this and other supply resources. Similarly, the operation of the Participating Load shown in Figure E is variable within the range of its Energy Bid, but if it reduces its Demand below its Base Load, it must reduce by at least its Minimum Load Reduction. It may incur a minimum cost for starting each Load Curtailment, or an hourly cost for its minimum Load Curtailment that exceeds the price at which it can offer additional reductions in Demand. The Participating Load may have operating limits including how fast it can initiate its Load Curtailment, a minimum amount of time that it must remain off-line once it starts a Load Curtailment, a maximum duration of a Load Curtailment, or minimum or maximum amounts of Energy reduction during Load Curtailments. The attributes that the CAISO proposes to include as Bid components are listed in the table above, which the CAISO believes enables a very flexible array of options for tailoring and managing demand resources.

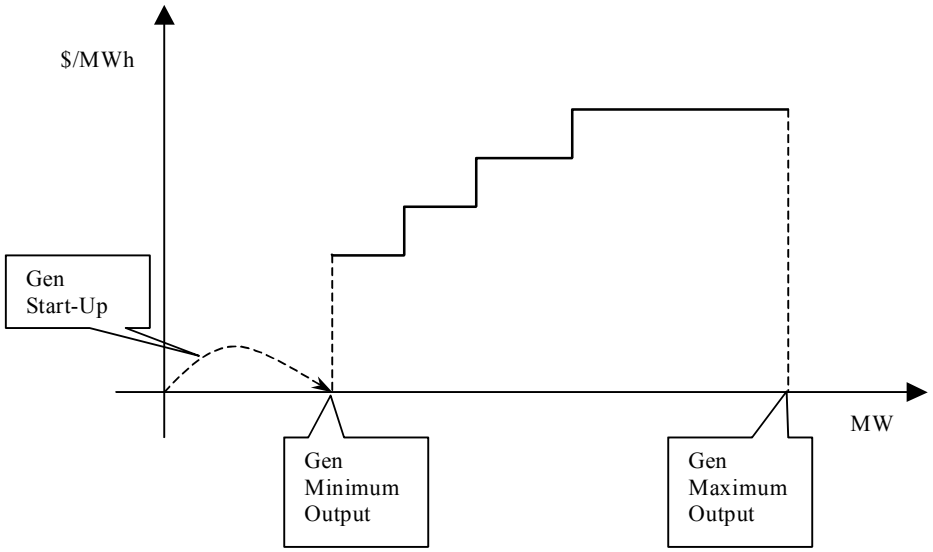

Figure D: Generator Bid

[23] The CAISO compares the options available to Participating Loads and generators to demonstrate that its proposal provides comparable flexibility for scheduling in CAISO Markets, not to suggest that Participating Load is the same as generation.

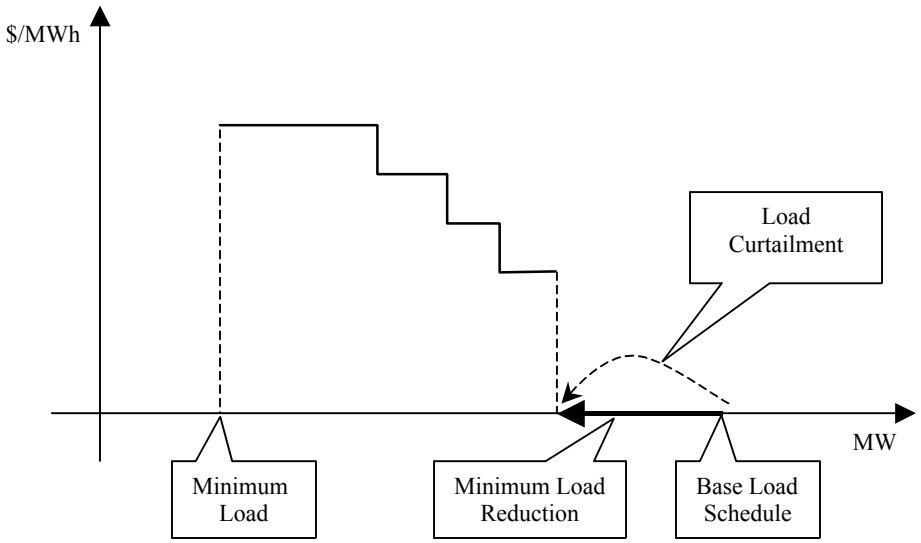

Figure E: Participating Load Bid with Minimum Load Reduction

Needs for Market Power Mitigation and bidding activity rules are more limited for demand response than for other Supply resources. Two existing bidding activity rules in MRTU Release 1 are that the Load Reduction Initiation Cost and Minimum Load Reduction Cost cannot be negative, and these rules are retained for DDR and PDR. The CAISO will include the Market Power Mitigation mechanisms in the DDR and PDR models that apply to generation resources, but their activation for DDR and PDR is subject to conclusions by the CAISO's Department of Market Monitoring that this step is appropriate.

Settlements for DA and RT Energy is straight-forward: the DA Schedule is settled at the DA Energy price for its applicable location, and the difference between actual metered Demand and the DA Schedule is settled at the RT Energy price. (For DDR, the RT Dispatch distinguishes instructed versus uninstructed Energy, but for Participating Loads, these are settled at the same price.) When there are payments in Settlements for actual performance in response to the CAISO's Dispatch, the CAISO will develop compliance mechanisms to verify that performance. Verification of performance applies to bid cost recovery for Load Reduction Initiation Cost and Minimum Load Reduction Cost, Ancillary Services, and RUC, which apply to DDR but not PDR.

Future Enhancement Possibilities

The CAISO has endeavored to recognize all currently-identified needs for demand response in the development of this Draft Final Proposal, while maintaining consistency of the Participating Load designs with the reliable operation of the CAISO Balancing Authority Area. Looking beyond the current proposal, the CAISO sees the ongoing stakeholder process as an opportunity to identify potential future enhancements to its Participating Load functionality.

The CAISO invites input, on an ongoing basis, as to whether additional, future enhancements should become part of the Participating Load model. Because these topics would affect multiple types of resources, the CAISO would need to understand how any suggested enhancements would fit into its overall market development strategy, which is managed through a process known as the "Market Initiatives Roadmap". Once potential future enhancements are identified, they can be placed in the Roadmap process for prioritization among the CAISO's other initiatives.

Next Steps

The CAISO's publication of its June 26, 2007, Issue Paper, September 25, 2007 Draft Straw Proposal, October 25, 2007, Revised Draft Straw Proposal, November 9, 2007, Straw Proposal, and this Draft Final Proposal are part of the process that will result in implementing improvements to the Participating Load functionality of MRTU Release 1. In parallel, the CAISO has initiated work on the detailed design phase of implementing the PDR and DDR models, and released draft Scheduling Infrastructure and Business Rules (SIBR) rules for DDR.[24] The CAISO's proposed schedule for moving toward implementation steps is as follows:

- CAISO issues Draft Final Proposal to stakeholders: October 30, 2008
- Stakeholder meeting: November 5, 2008
- Post-meeting stakeholder comments requested: November 12, 2007
- Presentation to Board of Governors: December 16 – 17, 2008

Working Group input on Business Practice Manual and User Guide will be ongoing, in continuation of the working group process that began in summer 2007. Tasks include:

  - Identify data needs, data flow and associated timelines
  - Develop business rules and outline business process
  - Also develop necessary tariff modifications

The working group activity will parallel internal CAISO work of software development, consisting of (1) CAISO software requirements going to the CAISO's vendor, and the vendor preparing its detailed design, (2) vendor implementation, followed by several testing phases, and (3) CAISO integration testing and market simulation testing, leading to PDR implementation in 2009 and DDR implementation by February 2010.

Throughout the course of this project, the CAISO will coordinate its development of all MAP features, and identify both (a) any interactions between Convergence Bidding and Participating Load, and (b) the role of demand response in Scarcity Pricing.

[24] The draft SIBR rules are available at http://www.caiso.com/205c/205c7df5b590.xls. Since the PDR model uses existing MRTU functionality for non-Participating Load and generation, so any change to SIBR rules should be minimal.

Appendix

Development of Software Requirements for Dispatchable Demand Resources (Post-MRTU Release 1)

1 Introduction

This document describes enhancements to functionality in Release 1 of the CAISO's Market Redesign and Technology Upgrade (MRTU) for Load resources that wish to actively participate in the CAISO Markets. These resources are known as "Participating Loads",[25] and participate in the CAISO Markets through tariff provisions including the following definitions:[26]

> **Participating Load**: An entity, including an entity with Pumping Load, providing Curtailable Demand, which has undertaken in writing by execution of a Participating Load Agreement to comply with all applicable provisions of the CAISO Tariff, as they may be amended from time to time.
>
> **Curtailable Demand**: Demand from a Participating Load or Aggregated Participating Load that can be curtailed at the direction of the CAISO in the Real-Time Dispatch of the CAISO Controlled Grid. Scheduling Coordinators with Curtailable Demand may offer it to the CAISO to meet Non-Spinning Reserve or Imbalance Energy.
>
> **Custom Load Aggregation Point (Custom LAP):** An aggregation of Load PNodes created by the CAISO based on a set of custom LDFs submitted by a Scheduling Coordinator, at which such Scheduling Coordinator may submit a single Bid and settle Demand consistent with the CAISO Tariff rules, and for which the Scheduling Coordinator is required to submit to the CAISO Meter Data for the nodal Load represented in such aggregation.

MRTU Release 1 includes limited functionality for Participating Loads, and the CAISO intends to expand this functionality in MAP. In addition to participation in the Day-Ahead Market (DAM) providing opportunities for response by Participating Loads to the CAISO's needs for capacity that might not be available in the Real-Time Market (RTM) since the DAM allows end-use customers more time to plan their Energy consumption, and because the CAISO intends to procure 100% of its Ancillary Service (AS) capacity (e.g., Non-Spinning Reserve) in the DAM, the functionality described herein will be

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[25] After implementation of the MRTU Release 1, the CAISO will implement two models for enhanced demand response functionality: Dispatchable Demand Resource (DDR), and Proxy Demand Resource (PDR). This appendix describes functional requirements for the software vendor's implementation only of the DDR model, because the PDR model is a fairly simple adaptation of existing MRTU Release 1 functionality. For consistency with existing vendor documentation, this appendix retains the term "Participating Load" when referring to the DDR model.

[26] These provisions are from the CAISO Tariff for MRTU as of October 12, 2007.

available in both the DAM and the RTM. For other types of resources, participation in the DAM and the RTM involve separate bidding and scheduling processes in most ways – differences involve aspects such as bidding activity rules, and scheduling priority in the RTM for schedules that have been established in the DAM. Similarly, the functionality described in this document is intended to apply to both the DAM and the RTM, as separate bidding and scheduling processes, except where specific differences are noted.

The scope of this document does not include the functionality for pumped storage hydro generation, for which MRTU Release 1 provides at least some functionality.

2 Load Aggregation

2.1 General Requirements

The MRTU market design aggregates Loads using Standard/Default Load Aggregation Points (Default LAPs) and Custom Load Aggregation Points (Custom LAPs). The CAISO will determine criteria for the designation of Custom LAPs. For scheduling and settlement, SCs may schedule Participating Load using a Custom LAP or at a nodal level if they are registered to schedule at the nodal level.[27] The load that is scheduled at an aggregated level will be distributed to nodes according to relevant Load Distribution Factors (LDFs). The LDFs for the Custom LAPs for aggregated Participating Load are fixed (i.e., not variable) during the optimization. The Integrated Forward Market (IFM) / Residual Unit Commitment (RUC) application shall provide final DA and RT schedules at each bus and at the same aggregation level that SCs specified when they submitted their schedules.

For Custom LAPs, the minimum for the total size of an aggregation will be reduced to 0.1 MW.

2.2 LMPs for Aggregated Participating Load

A Participating Load aggregation is treated as an aggregate control in the optimization, with a fixed distribution to the underlying nodes using the relevant Custom LDFs. For Participating Load, the Locational Marginal Prices (LMPs) calculated at Aggregated Pricing Nodes (APNodes) are aggregated, weighted-averages of the LMPs at the Pricing Nodes (PNodes) that make up the APNodes, weighted by the same LDFs that are used to distribute the aggregated Participating Load Bid to nodes during the optimization.

Custom Load Aggregations that represent Participating Loads are excluded from the calculation of the aggregated LMPs for Default LAPs. While LDFs for Default LAPs' Load are determined based on historical State Estimator data, LDFs for Custom LAPs

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[27] Currently, a single SC submits Bids for both Energy and demand response. The CAISO is not changing this arrangement at this time. However, the underlying policy may change in the future, as a result of policies that may be established by the CPUC about the structure of retail markets. Among the many potential alternatives are:

- One SC could self-schedule Energy while a different SC submits a bid curve for demand response, or an Ancillary Service Bid, in the same market, or
- One SC could schedule a Participating Load in DAM while a different SC schedules the Participating Load in RTM.

Until the underlying policies about future retail market structure are determined, the CAISO cannot develop details of software requirements. However, the software design described herein should not assume that the same SC submits Bids for Energy and demand response.

are established by the CAISO using data provided by the Scheduling Coordinator. A question to be resolved is whether Scheduling Coordinators should be able to update the LDFs for Custom LAPs through their Bid submissions, or remain as Master File data as in MRTU Release 1. Similarly, the frequency of updates of the static LDFs in the Master File based on nodal Meter Data, and requirements for hourly submission of nodal Meter Data for Settlement, need to be established.

3 Bids Usage and Treatment in IFM/RUC Application

3.1 Bids for Participating Loads

Bids for Participating Loads provide for participation in CAISO Markets beyond that of non-Participating Loads. Non-Participating Loads can submit a monotonically decreasing staircase curve having up to 10 segments defined by MW load levels and prices. This Bid curve applies to scheduling at a Default LAP. There are no inter-temporal constraints in the Bid for a non-Participating Load (i.e., it is not a three-part bid).

Participating Load shall be modeled at a specified node or Custom Load Aggregation. The Participating Load functionality supports a variety of Bid components in order to provide Scheduling Coordinators with flexible options for structuring Demand Response programs, including a three-part bid and certified operating limits, ramp up/down rates, and inter-temporal constraints, as detailed further below. A Participating Load may also provide AS[28] with a capacity and energy bid up to a certified capacity, and may offer capacity for RUC.

Figure 1 shows an example of a Participating Load Energy Bid.

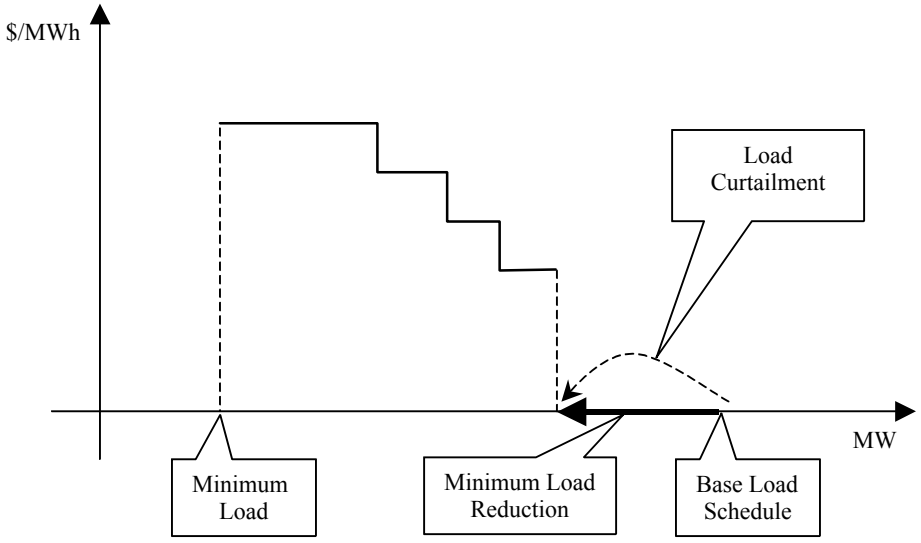

Figure 1. *Participating Load Energy Bid*

[28] Ancillary Service bidding by Participating Loads will be provided in the market software systems for Non-Spinning Reserve, Spinning Reserve, Regulation Up, and Regulation Down.

The Energy Bid Curve is required, but use of the other Bid components is optional. The three-part bid includes the following:

- Load Energy Bid curve (required, allows multiple segments) [29]
- Load Reduction Initiation Cost (optional)[30]
- Minimum Load Reduction Cost (optional)

A RUC Availability Bid is optional, but may be required if a Demand Resource is a Resource Adequacy Resource:[31]

- RUC Availability Bid

The Participating Load model data provides the following additional Bid components, [32] which are included in submitted Bids only at the option of the Participating Load. Default values will be used if specific values are not submitted in the Bid for a Participating Load. [33]

- Base Load Schedule (see discussion below)
- Load Reduction Initiation Time (the time required to initiate Load reduction – single segment)
- Minimum Load Reduction Time (the minimum time required to operate at reduced load after load reduction initiation)

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29 The energy bid that is submitted by the Scheduling Coordinator has up to ten segments. But the Scheduling Infrastructure and Business Rules (SIBR) system may add up to ten additional segments from the proxy bid curve. Therefore the energy bid that is passed to the IFM from SIBR may have up to 20 segments. In addition, the IFM application may add additional segments to represent various self-scheduling priorities.
Any Demand that is scheduled using Transmission Ownership Right (TOR) or Existing Transmission Contract (ETC) capacity must be scheduled as a price taker at a MW level no higher than the Minimum Load. This applies to Participating Load as well as to Non-Participating Load.

30 The use of the Load Reduction Initiation Cost and Minimum Load Reduction Cost require that a Bid also includes a Minimum Load Reduction.

31 The CAISO's development of Participating Load functionality in its market systems does not determine either the requirements for Resource Adequacy Resources to bid into CAISO markets or the eligibility of Load to qualify as a Resource Adequacy Resource.

32 This list of Bid components is based on the CAISO's previous Software Requirements Specification Addendum for the Real Time Market, version 1.2, from which the CAISO's vendor prepared a detailed design. Bid components that are now being added to this list, because of requests by CAISO Market Participants, are separately stated.

33 The default values are:
- Base Load Schedule: maximum MW in Energy Bid
- Load Reduction Initiation Time: zero
- Minimum Load Reduction Time: zero
- Maximum Load Reduction Time: unlimited (i.e., a large number)
- Load Drop Rate: unlimited (i.e., a large number)
- Load Pickup Rate: unlimited (i.e., a large number)
- Minimum and Maximum Daily Energy Limits: minimum = zero, maximum = unlimited (i.e., a large number)
- Minimum Base Load Time: zero
- Maximum Number of Daily Curtailments: unlimited (i.e., a large number)
- Maximum Non-Spinning Reserve Capacity: zero
- Maximum Spinning Reserve Capacity: zero
- Maximum Regulation-Up Capacity: zero
- Maximum Regulation-Down Capacity: zero

- Maximum Load Reduction Time (the maximum time required to operate at reduced load after load reduction initiation)
- Load Drop Rate (the ramp rate for load drop)
- Load Pickup Rate (the ramp rate for load pickup)
- Minimum and Maximum Daily Energy Limits (limits on daily energy from load reduction, if a Curtailable Demand Bid is dispatched)
- Maximum Non-Spinning Reserve Capacity (MW and price for load reduction within 10 minutes, for qualified resources) [34]

Additional optional Bid components are also required in the design, which have been requested by the CAISO's Market Participants as being necessary for specific business requirements:

- Minimum Base Load Time (minimum time after load restoration, before another Load reduction is dispatched),
- Maximum Number of Daily Load Curtailments,
- Maximum Spinning Reserve Capacity (MW and price for load reduction within 10 minutes, for qualified resources)
- Maximum Regulation-Up Capacity (MW and price for load reduction within 10 minutes, for qualified resources)
- Maximum Regulation-Down Capacity (MW and price for load increase within 10 minutes, for qualified resources)[35]

The three-part Energy Bid Curve in RTM may be submitted for either the Hour-Ahead Scheduling Process (HASP) or Real-Time Interval Dispatch process (RTID), depending on the type of meter installed for the end-use customers, and the available Bid components between these options. The Real-Time (RT) dispatch for end-use customers with metering intervals of less than one hour (e.g., 15-minute intervals) will occur in RTID, and all of the optional Bid components listed above are applicable for Bids in RTM. The RT dispatch for end-use customers with hourly metering intervals will occur in HASP and settled at HASP prices, and while all optional Bid components (except AS eligibility) are applicable to these end-use customers in DAM, the optional Bid components in HASP (in addition to a multi-segment Energy Bid that can include a Minimum Load greater than zero) are limited to:

- Base Load Schedule
- Minimum Load Reduction
- Load Reduction Initiation Cost
- Minimum Load Reduction Cost
- Maximum Load Reduction Time

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[34] All Ancillary Services provided by Participating Loads may be simultaneously self-provided for part of the resource's capacity, and bid for remaining capacity. If a Participating Load's Ancillary Service capacity Bid is accepted in DAM, then its Energy Bid range in RTM must be at least as much as the awarded Ancillary Service capacity.

[35] An end-use customer may provide Regulation by using an energy storage system to manage its regular load. As a result, it may have a negative load (net positive injection) from time to time. The market software must accommodate variable, negative loads.

- Maximum Daily Energy Limit
- Minimum Base Load Time
- Maximum Number of Daily Load Curtailments,

A Participating Load may specify a "Base Load" as part of its Bid. [36] The specification of a Base Load causes the Bid to be treated differently in the optimization if the Base Load exceeds the maximum MW of Load that is stated in its Energy Bid. The two options are:

1. If the Participating Load designates a Base Load that is higher than the maximum MW of Load that is stated in its Energy Bid, then the difference between (a) its designated Base Load, and (b) the maximum MW of Load that is stated in its Energy Bid, defines the "Minimum Load Reduction". That is, the CAISO's optimization may set the Schedule for the Participating Load either (a) at the designated Base Load or (b) within the range of the Energy Bid, but the CAISO's optimization shall not schedule the Participating Load within the range defined as the Minimum Load Reduction. So that the CAISO's optimization considers a meaningful decision between these two points, the Base Load may be considered to be an initial Schedule for the Participating Load if the Minimum Load Reduction is greater than zero (i.e., if the Base Load is higher than the maximum MW of Load that is stated in its Energy Bid). The CAISO's optimization then determines whether to accept the Participating Load's Bid to reduce its Demand below its Base Load.
   If a Participating Load's Bid includes a Minimum Load Reduction, then its Bid may also include (a) a Load Reduction Initiation Cost (which is a fixed cost for reducing Load below the Base Load, regardless of the duration of reduction below the Base Load), and/or (b) a Minimum Load Reduction Cost (which is an hourly cost of reducing Load below the Base Load). The Load Reduction Initiation Cost and Minimum Load Reduction Cost will affect the CAISO optimization's determination of whether (a) the Participating Load's optimal schedule remains at its Base Load (i.e., the combination of Energy Bid, Load Reduction Initiation Cost, and Minimum Load Reduction Cost does not make it economic to reduce the Participating Load's Schedule below the Base Load, which is its Schedule if its Curtailable Demand Bid is not accepted), or (b) its Curtailable Demand Bid is accepted and it is scheduled at a lower MW level within the range of the Energy Bid.
2. If the Participating Load's Bid does not designate a Base Load, or the designated Base Load does not exceed the maximum MW of Load that is stated in its Energy Bid, it is considered to be able to provide Demand Response over the entire range of its Energy Bid, and its Base Load is treated as the maximum MW of Load that is stated in its Energy Bid. [37] The minimum MW of Load in its Energy Bid (i.e., the start of its first submitted Bid segment) constitutes the Participating Load's Self-Schedule. This Self-Schedule up to the start of the first energy bid point is a "price taker", i.e., it is charged the relevant aggregate LMP

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[36] The MRTU Release 1 tariff defines "Base Load" as "the maximum consumption of a Participating Load as bid in the CAISO Markets by Scheduling Coordinators."

[37] If the Base Load does not exceed the maximum MW of Load that is stated in its Energy Bid, its Minimum Load Reduction equals zero. If a Participating Load's Bid states a Load Reduction Initiation Cost and/or Minimum Load Reduction Cost but does not have a Minimum Load Reduction greater than zero, then the Load Reduction Initiation Cost and/or Minimum Load Reduction Cost will be ignored.

regardless of its dispatched level up to the self-scheduled MW, as is any non-Participating Load. In the CAISO's optimization, scheduling of the self-scheduled MW is implemented for Congestion Management by inserting "uneconomic" Bid segments between zero MW and the self-scheduled MW, based on artificial prices ("penalty prices", in optimization terms) that reflect various scheduling priorities, such as TOR and ETC schedules, etc. – the same as is the case for non-Participating Load. [38]

For Generating Units, a resource's minimum load ("Pmin") is registered in the CAISO's Master File, and changes to the resource's minimum load due to derates are reported in SLIC or the Siemens Outage Scheduler. For a Participating Load using the DDR model, the Minimum Load Reduction is submitted implicitly with the energy bid, as the difference between Base Load and the last (highest) MW Energy Bid quantity. Thus, there is no need for updates to be received from SLIC or the Siemens Outage Scheduler for Participating Loads that provide only Energy. For Participating Loads that provide AS, the CAISO will define a mechanism (e.g., SLIC) for reporting that the awarded AS in unavailable.

3.2 RUC Participation

By submitting a RUC Availability Bid, a Participating Load indicates the quantity (MW) and price ($/MWh) at which it offers to sell capacity for the specified interval of time to meet the CAISO's Residual Unit Commitment requirement. The CAISO's acceptance of a RUC Availability Bid does not alter the Participating Load's DA Schedule, but obligates the bidder to offer the RUC capacity for dispatch in RTM. A RUC participation flag that is contained in its Bid submitted to the IFM controls participation of each Participating Load in RUC. For Load resources, only Participating Loads using the DDR model can participate in RUC. [39] The RUC participation flag has the same values that are defined for generators.

Participating Loads may be required to submit RUC Availability Bids of $0/MWh for their RUC capacity, and to be excluded from receiving RUC payments. The CAISO will determine the requirements for validating and/or adjusting RUC Availability Bids and for RUC settlements. Bidding requirements for RA Resources are being developed through other regulatory and stakeholder processes, and are beyond the scope of this document.

3.3 Market Power Mitigation

The CAISO will determine Market Power Mitigation requirements once the general design of the Participating Load functionality is established, through consultation with its Department of Market Monitoring. This may include bidding activity rules or other requirements.

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[38] If the Base Load exceeds the maximum MW of Load that is stated in its Energy Bid, the CAISO's optimization shall also insert "uneconomic" Bid segments for Congestion Management between zero MW and the lowest MW level in the Energy Bid curve.

[39] In cases where Load-Serving Entities have Demand Response programs that utilize the CAISO's Non-Participating Load functionality or the PDR model, the CAISO may adjust the RUC procurement target using the same mechanisms that are being defined and used prior to implementation of the expanded functionality described herein.

4 Modeling of Participating Load Resources in Optimization

This section builds on the previous sections by describing the Participating Load model's formulation in optimization terms, as part of implementing the business requirements stated above.[40] The functionality described herein anticipates the use of an explicit Participating Load Resource model with an example of a three-part bid as follows:

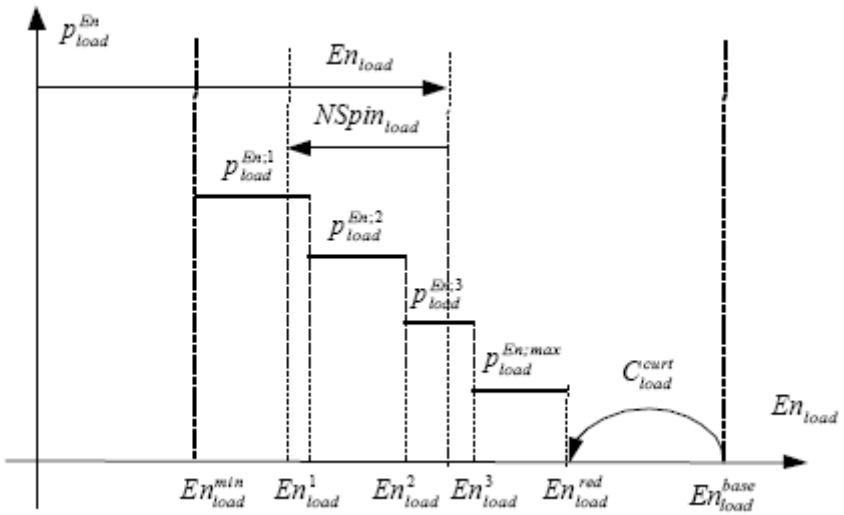

Figure 2. *Participating Load Resource model*

The contribution of a dispatched Participating Load Resource at time period *t* in the objective function of the DAM and RTM is as follows:[41]

$$C_{load}^{curt} + C_{load}^{\min} + C_{load}^{En}\left(En^{t}{}_{load}\right) + C_{load}^{NSpin}\left(NSpin^{t}{}_{load}\right) + C_{load}^{Spin}\left(Spin^{t}{}_{load}\right) + C_{load}^{\mathrm{Re}gUp}\left(\mathrm{Re}gUp^{t}{}_{load}\right) + C_{load}^{\mathrm{Re}gDown}\left(\mathrm{Re}gDown^{t}{}_{load}\right)$$

Where:

En_{load}	is the dispatch (DOT);
En_{load}^{base}	is the Base Load;
En_{load}^{red}	is the dispatch at Minimum Load Reduction;
$En_{load}^{\min}$	is the minimum dispatch;
En_{load}^{i}	for *i*=1,2,…,*n*; define the segments of the energy bid;

40 The latest description of the Participating Load functionality for MRTU Release 1 was stated in the CAISO's Software Requirements Specification Addendum for the Real Time Market, version 1.2, and has been adapted for the current document.

41 The objective function in MRTU includes additional terms such as adjustments to self-schedules, which need to be added to this specification.

$p_{load}^{En;i}$	for *i*=1,2,…,*n*; are the prices of the energy bid segments;
$C_{load}^{En}\left(En_{load}\right)$	is the energy bid (the incremental cost as a function of dispatch);
C_{load}^{curt}	is the Load Reduction Initiation Cost (the cost to initiate load reduction);
$C_{load}^{\min}$	is the Minimum Load Reduction Cost (the cost/hr to operate at reduced load); and
$NSpin_{load}$	is the Non-Spinning Reserve Award;
C_{load}^{NSpin}	is the Non-Spinning Reserve Bid Price.
$Spin_{load}$	is the Spinning Reserve Award;
C_{load}^{Spin}	is the Spinning Reserve Bid Price.
$\mathrm{Re}\,gUp_{load}$	is the Regulation-Up Award;
$C_{load}^{\mathrm{Re}\,gUp}$	is the Regulation-Up Bid Price.
$\mathrm{Re}\,gDown_{load}$	is the Regulation-Down Award;
$C_{load}^{\mathrm{Re}\,gDown}$	is the Regulation-Down Bid Price.

The following inter-temporal constraints apply to Participating Load Resources:

a) Load Reduction Initiation Time (the time required to initiate load reduction);

b) Minimum Load Reduction Time (the minimum time required to operate at reduced load after load reduction initiation);

c) Maximum Load Reduction Time (the maximum time required to operate at reduced load after load reduction initiation);

d) Load Drop Rate (the ramp rate for load drop);

e) Load Pickup Rate (the ramp rate for load pickup);

f) Minimum and Maximum Daily Energy Limits (limits on daily energy from load reduction);

g) Minimum Base Load Time (minimum time after load restoration, before another Load reduction is dispatched);

h) Maximum Number of Daily Load Curtailments.

Participating Loads will not contribute reactive power capacity for voltage regulation.

5 Settlement Principles

The basic principle for financial Settlements for this Participating Load model is that DAM and RTM establish scheduled levels of operation, which creates a financially binding DA Schedule for purchases at the CAISO's DA LMPs, and that the final

Settlement in RTM will be based on the difference between Settlement Quality Meter Data and the DA Schedule, priced at RT LMPs. The benefit of being a Participating Load rather than a non-Participating Load is the ability to offer Bids in RTM that will receive Dispatches from the CAISO that indicate opportunities to be paid at least the Bid price for Load reductions as well as to buy additional Energy at no more than the Bid price, to respond to locational prices for Energy purchases in DAM as well as RTM, and (if qualified) to earn capacity payments for RUC and Ancillary Services.

In addition, to the extent that a Participating Load includes a Load Reduction Initiation Cost and/or hourly Minimum Load Reduction Cost in its Bid, it will be assured that its market revenues for Load reductions in DAM or RTM will be at least as much as these Bid components. The principles for Bid cost recovery will be the same as for other resources, as described in the CAISO Tariff.

6 Changes from Software Requirements Specification for MRTU Release 1

An implementation of the Participating Load model was included in MRTU Release 1 and was partially implemented, but as other aspects of the MRTU Release 1 design evolved, not all market design features of the Participating Load model could be conformed to the overall design within the required timeframe. The latest description of the Participating Load functionality for MRTU Release 1 was stated in the Software Requirements Specification Addendum for the Real Time Market, version 1.2, and has been adapted for the current document.

In the original design, a Participating Load was required to self-schedule a “Base Load” in the IFM in order to provide Demand Response and/or Non-Spinning Reserve. The “Base Load” Self Schedule would be a price taker, i.e., it would be charged the relevant aggregate LMP, like any non-Participating Load. Using the “Base Load” as its initial schedule, Demand Response would be provided using a three-part Bid and certified operating limits, ramp up/down rates, and inter-temporal constraints. When the Participating Load would be dispatched (curtailed) from its Base Load, it would be paid the LMP for the Load reduction at its specific location, in addition to being charged for its Base Load at the Default LAP price. The Participating Load would be eligible for recovering its Load Reduction Initiation Cost and its hourly Minimum Load Reduction Cost through Bid cost recovery. The original design’s difference in Settlement between the Base Load and reductions from the Base Load led to requirements (1) for the Participating Load to qualify for locational pricing of its demand response by registering a minimum value for its Minimum Load Reduction in the CAISO’s Master File, (2) for the Scheduling Infrastructure and Business Rules (SIBR) system to validate that the Participating Load’s Base Load exceeds the highest Energy Bid quantity by no less than the registered Minimum Load Reduction, and (3) for the optimization process to check whether a derate had increased the Minimum Load Reduction below the last energy bid quantity, and potentially delete the overlapping portion of the energy bid for the duration of the derate. Non-Spinning Reserve would optionally be provided with a capacity and Energy Bid up to a certified capacity, subject to Demand Response plus Non-Spinning Reserve not exceeding the Base Load schedule.

The revised design requirements described in this document are very similar to the original design requirements. One difference is that the Base Load will now be settled at the same locational price as reductions from the Base Load. As a result, there is no need to limit to a Master File value, or validate the Minimum Load Reduction against a

Master File value, and the implementation is simplified. This also results in a more flexible design from the perspective of the Participating Load, which can determine whether its own business needs justify defining a Minimum Load Reduction.

The original design would have also required validation that the Base Load could be scheduled as a Self-Schedule as part of the Default LAP, separately from the determination of whether Load reductions should be dispatched at the locational price, whereas the current design allows the use of a single Energy Bid. The current design sets the "self-scheduled" quantity at the Participating Load's lowest Energy Bid quantity. By avoiding the requirement for each Participating Load to have a Minimum Load Reduction greater than zero, the current design may improve the performance of the optimization process.

The original design also contains references to (a) a separate hour-ahead market and (b) binding scheduling and dispatch in the Hour-Ahead Scheduling Process for resources that also participate in RTID, which are no longer part of the MRTU design. This updated statement of software requirements provides an option for some Participating Loads to be dispatched in HASP instead of RTID, which is similar to HASP's operation for intertie resources. For Participating Loads, this updated document allows optional Bid components in HASP that are not available to intertie resources in HASP, but these are a subset of the options that are available to generators in RTID. This document adds Bid components that were not available to Participating Loads in the previous Software Requirements Specification, although these are among the Bid components available to generators.

Although it appears that the current design simplifies the implementation, whether these changes do facilitate the implementation of the Participating Load model will need to be determined through consultation with the vendor while the design is being completed.