Regulation Energy Management Draft Final Proposal

January 13, 2011

Renewable Integration:

Market and Product Review

Phase 1

Regulation Energy Management (REM) Revised Draft Final Proposal

Table of Contents

1 Introduction

Regulation energy management (REM) is an enhancement of the ISO's current rules for the regulation and real-time energy markets that is designed to remove barriers that limit the full participation of limited energy resources in the ISO's regulation markets. Without REM, limited energy resources can participate in the regulation market but only for a portion of their capacity. This enhancement will allow the ISO to utilize these resources for their full range of capacity to provide regulation.

In the day-ahead market, the ISO procures regulation in one hour intervals. In order to receive the capacity payment for regulation ($/MW), a resource must certify that it can produce energy to satisfy a regulation up award and reduce energy production or consume energy to satisfy a regulation down award over the entire hour.[1] Since the ISO procures 100% of the forecasted regulation needs in the day-ahead market, the 60 minute requirement for regulation sold in that market creates a barrier for resources that can provide regulation, but only produce or consume energy for a limited duration. Similarly, the real-time market has a 30-minute requirement for any additional regulation procured. Such limited energy resources could utilize the real time market to manage their ability to provide continuous energy but for the fact that market timelines require the submission of supply bids 75 minutes prior to the operating hour and the real time market does not allow demand bids. REM functionality allows a resource to purchase or sell energy in real-time to meet the continuous energy requirement for regulation in the day-ahead market.

By selecting REM, a resource's scheduling coordinator will allow the ISO to maintain the resource's preferred operating point by balancing the energy dispatched from the resource through the ISO Energy Management System to meet ISO regulation requirements. The ISO will adjust its forecast of demand for the next Real Time Dispatch interval to offset the energy produced/consumed during the previous interval's regulation energy dispatch. By ensuring that the energy offset is met by the real time energy market, a resource which has selected REM can satisfy the 60 minute continuous energy requirement for regulation in the day-ahead market. However, this approach also requires that the resource only provides regulation in intervals when it can be accommodated by the ISO dispatch.

[1] Figure 1 below provides an illustration of how the ISO estimates its regulation requirement in the day-ahead market, but then may or may not exceed that requirement in real-time. The figure also helps to illustrate why the ISO established a one hour continuous energy requirement for day-ahead regulation for resources not utilizing REM. Because regulation capacity is procured in hourly intervals in the day-ahead market, the actual energy which will need to be delivered is unknown. Assuming a resource only had a regulation up award, in the Figure, the energy delivered over the hour is the area between zero and the regulation up dispatch. However, in the day-ahead timeframe the ISO does not know the area representing energy delivered resulting from the regulation dispatch, so the ISO must require that the resource is capable of providing energy for the entire interval. When a resource selects REM it allows the ISO to maintain its state of charge which ensures that the resource will be able to deliver its full capacity over the one hour interval.

2 Plan for Stakeholder Engagement

Item	Date
Post Revised Draft Final Proposal	January 13, 2011
Stakeholder Conference Call	January 20, 2011
Board Meeting	February 3-4, 2011

3 Modifications from December 17, 2010 Draft Final Proposal

This *Revised Draft Final Proposal* includes the following refinements from the *Draft Final Proposal* that was posted on December 17th, 2010:

- Section 7.16 - Removed the 40 percent threshold for stakeholder review. The ISO will monitor the operational performance of REM as the penetration of limited energy resources increases.
- The remaining details of this proposal are unchanged from the *Draft Final Proposal*.

4 Background

The ISO proposes to complete the design of REM in Phase 1 of its stakeholder initiative on Renewable Integration: Market and Product Review (RI-MPR).[2] The ISO and stakeholders previously considered REM as part of the initiative to address the participation of non-generator resources in the ISO's ancillary services market.[3] Stakeholders raised the following concerns regarding REM during the stakeholder process:

- REM constitutes a new product and is out of scope for the non-generator resource stakeholder process
- new ancillary service products should be vetted and considered in the broader context of a comprehensive redesign of the ancillary services markets
- some key design issues are unresolved

Based on stakeholder feedback, the ISO removed REM from the scope of the non-generator resource ancillary services initiative and committed to the board and stakeholders to address it in Phase 1 of the Renewable Integration –Market & Product Review (RI-MPR).

Stakeholders had divergent views on the original proposal published in March 2010. PG&E and SCE argued that REM and traditional regulation are different products and should be priced and procured separately. Beacon Power and the California Energy Storage Alliance (CESA) supported the basic elements of REM because it was consistent with designs of other RTOs/ISOs to enable limited energy storage resources to meet the one hour duration of regulation purchased in the day-ahead market. However, they also expressed concern with the initial limit (a 10 percent cap) proposed by the ISO for the amount of regulation which the ISO market would procure under REM as well as the proposed rules for the disqualification of REM resources if the Real Time Dispatch (RTD) process could not meet forecasted demand. In addition, the ISO's Department of Market Monitoring (DMM) raised several concerns regarding the original proposal including: 1) allowing traditional generators to use REM could potentially be used by generators to withhold capacity from ancillary service markets; 2) the pricing impacts

[2] http://www.caiso.com/27be/27beb7931d800.html; all stakeholder comments below dated October 22, 2010 can be found at this location.
[3] http://www.caiso.com/2415/24157662689a0.html

of the proposed10 percent limit on REM participation in the regulation market; 3) disqualifying all REM capacity if RTD could not meet demand; and 4) potential uplift costs resulting from not settling real time energy for REM resources. In light of these concerns, DMM recommended that the ISO delay implementation and revisit the proposed rules in the RI-MPR.

Additional documentation and stakeholder comments regarding the initiative to address the participation of non-generator resources in the ISO's ancillary services market can be found at http://www.caiso.com/2415/24157662689a0.html.

During the July 16, 2010 stakeholder forum and through written comments on the September 20, 2010 issue paper[4] under this initiative, Beacon Power and CESA requested that the ISO include REM within the scope of RI-MPR Phase 1 issues. This view was supported by CPUC as an effort to both facilitate and better understand potential roles for non-conventional sources of system flexibility such as demand response and storage, while other stakeholders contended that REM was a type of new market product that needed further justification before implementation.[5] Beacon and other stakeholders argued that enhancements such as REM to existing market products should be seen as reasonable accommodations for the physical characteristics of different technologies that can provide Regulation, similarly to the ISO's efforts to improve modeling of multi stage generation in the energy markets. The ISO agrees with these views and provides further justification for proceeding with REM at this time below.

The ISO reviewed the *Straw Proposal* with stakeholders during the Market Surveillance Committee (MSC) meeting held on November 18, 2010. In addition to the ISO presentation, MSC member Ben Hobbs presented on REM and discussed when products should be separate. The separate product discussion led by Dr. Hobbs was targeted at resolving stakeholder concerns raised throughout the stakeholder process that REM creates a new regulation product that is distinct from traditional regulation. Dr. Hobbs presentation is available at http://www.caiso.com/284b/284b8a6515ad0.html. During the discussion, it became apparent that a more granular model based upon realistic system conditions would assist stakeholders in understanding how the REM would manage the energy offset and what would be the resulting energy settlement. The ISO has developed a REM model which uses actual 4 second regulation dispatch to illustrate how REM manages the resources state of charge under realistic system conditions. The model has been posted with the draft final proposal.

The ISO has also created a stakeholder comment matrix to respond to specific stakeholder issues raised regarding the *Straw Proposal*. The document is posted at http://www.caiso.com/27e3/27e3c4fbfbd0.html#28607cd936950.

5 Renewable Integration Study Findings on Regulation Requirements

Several stakeholders have asked for additional justification for REM in the context of assessments of future regulation requirements.[6] The ISO believes that facilitating the provision of regulation by limited energy resources will help address future system requirements. The ISO has not demonstrated the future market value of, or operational need for, any particular type of regulating resource but believes it is appropriate to create a platform that allows more

---

[4] ISO, Issue Paper: Renewable Integration, Market and Product Review Phase 1 (September 30, 2010), available at http://www.caiso.com/2821/2821c31a21680.pdf

[5] See, e.g., SCE (October 22, 2010) at 4.

[6] See, e.g., comments by SCE (October 22, 2010) at 4.

resources to provide regulation. The ISO's renewable integration studies highlight the potential need for additional procurement of both regulation up and regulation down. As shown in Table 1 below, in its study of integration requirements under 20% RPS,[7] expected to be achieved by California in 2012 (using a mix of internal and external renewable resources), the ISO estimated that regulation requirements could increase by almost 40 percent in aggregate during some seasons.[8] This projected requirement is not equally distributed over the operating day: in some hours there may be little additional regulation required, but in others the requirement could be up to three times greater than currently procured to address significant wind and solar ramps.[9]

Table 1: Percentage Increase in Total Seasonal Simulated Operational Capacity Requirements under 20% RPS, 2012 vs. 2006*

	Spring	Summer	Fall	Winter
Total maximum regulation up	35.3 %	37.3 %	29.6 %	27.5 %
Total maximum regulation down	12.9 %	11.0 %	14.2 %	16.2 %

* Note that 2006 is being used as a benchmark year to calculate the incremental operational requirements

The ISO's 20% RPS Study also identified that there is substantial regulation-certified capacity available in the generation fleet to meet the additional requirements: almost 20,000 MW.[10] And the ISO's initial production simulations suggested that the current generation fleet can meet the additional regulation needs in 2012. Hence, the ISO's 20% RPS Study does not establish the market or operational value of additional regulating resources under these changing conditions in the near term (2-3 years).

Beyond the 20% RPS, the ISO's 33% RPS operational simulations suggest continued increases in regulation requirements, with higher regulation ramp rates, depending on where the variable energy resources are located in the West and to some degree by technology type. The ISO has presented initial results of the simulation modeling at workshops on the CPUC's long-term procurement planning proceeding (CPUC Rulemaking 10-05-006 *et al.)*, but discussions among interested parties continue about the appropriate assumptions and methods.[11] At the same time, other environmental regulations, including the carbon emissions reductions mandated under California Assembly Bill 32 and rules to eliminate the environmental consequences of once-through cooling, could further change the thermal resource mix and add further constraints on the availability of particular generation resources to provide integration services. While these trends point to the potential value of additional non-generation resources to provide regulation, including significant utility-scale capability,[12] the ISO has not definitively

---

[7] California ISO, *Integration of Renewable Resources – Operational Requirements and Generation Fleet Capability at 20% RPS* (August 31, 2010), available at http://www.caiso.com/2804/2804d036401f0.pdf.
[8] Subject to the modeling assumptions explained in the 20% RPS Study.
[9] See, e.g., figures in Section 3.4 and Appendix A in the 20% RPS Study.
[10] See Table 4.2, pg. 70, in the 20% RPS Study.

[11] See updates at http://www.cpuc.ca.gov/PUC/energy/Renewables/100824_workshop.htm.
[12] For example, the ISO has supported the objective stated by the California Clean Energy Future initiative of at least 1000 MW of utility-scale storage by 2020. See http://www.cacleanenergyfuture.org/ .

established the market or operational value of different regulating resources under 33% RPS. Nevertheless, the ISO believes that reducing barriers now to participation of non-generation resources in regulation markets will help prepare the power system for future operational requirements.

6 REM is Consistent with Future Market Software Needs

In addition to forecasts of increased regulation requirements, the ISO believes that the REM functionality, while initially applied to small limited energy technologies, is sufficiently general to support other expected software modifications. The objective of REM is to provide the ISO with a method for monitoring and managing the state of charge for resources with limited energy delivery duration. The software logic used in REM to accommodate a resource with 15 minutes duration is the same as the logic needed to handle any length of duration less than 24 hours, such as 2 hour or 8 hour resources. Hence, REM is providing a base functionality to support dual-mode resources. Dual-mode resources are resources that have the capability to inject and withdraw energy to provide the services the ISO needs to meet the operational needs necessary to reliably manage and operate the grid. The design elements of REM are thus consistent with the ISO's long term market software expectations to support expanded, flexible use of dual-mode resources.

7 Proposed Design Elements of Regulation Energy Management

7.1 REM and Market Product Definition

Stakeholder discussion has centered on whether or not REM is sufficiently different from traditional regulation to warrant creation of a new product. One position is that REM is similar to other software enhancements, such as multi-stage generation, which enable a resource to make its full capabilities available to the ISO market. The opposing view is that REM is a new and unique product from traditional regulation and should be procured and priced separately. The core argument revolves around whether the real-time energy market can appropriately serve as the fuel source for limited energy resources and provide similar regulation service as conventional generation.

The ISO believes the design below addresses issues raised in the prior stakeholder process, including whether and how to settle regulation energy, the maximum procurement target of resources using REM functionality, whether to disqualify resources that use REM when RTD cannot meet forecasted demand, and whether to allow all resources to use REM.

The ISO's proposed approach to implement software enhancements to maintain the resource's regulating range through the real-time market and measurement of energy provided when responding to regulation signals is similar to the approaches developed by the Midwest ISO, PJM Interconnection and the New York ISO. These ISOs/RTOs do not separate regulation into regulation up and regulation down, but procure a single regulation product which limited energy resources can provide, if these resources agree to allow the market operator to manage their state of charge .

The ISO believes the proposed design for REM reflects software enhancements that will allow limited energy resources to provide regulation on a basis comparable with a generator and does not reflect a new product. The bid timeline of the real time energy market does not enable limited energy resources to manage their state of charge, thus REM removes this barrier while ensuring the ISO receives the quality of regulation the ISO procured in the day-ahead market.

Resources under REM provide the same regulation service to the ISO as traditional generation. All regulation resources must respond to each 4 second energy management system signal and produce/consume the energy necessary to balance the grid as directed by the ISO. Also, REM permits limited energy resource to exceed the current spinning and non-spinning continuous energy requirement which allows higher quality reserves to cascade to lower quality reserves when economic to do so. Finally, resources using REM are subject to the same settlement rules and provisions relating to rescission of ancillary service payments as traditional generation.

7.2 Overview of Regulation Energy Management

By selecting REM, a resource's scheduling coordinator will allow the ISO to maintain the resource's preferred operating point or state of charge by balancing the energy dispatched from the resource through the ISO Energy Management System to meet ISO regulation requirements. By ensuring that the energy offset is met by the real time energy market, a resource which has selected REM can satisfy the 60 minute continuous energy requirement for regulation in the day-ahead market.

7.3 Regulation Energy Management Spreadsheet Model

In response to stakeholder requests, the ISO has created a detailed spreadsheet model of REM operations under realistic system conditions, posted at http://www.caiso.com/27be/27beb7931d800.html. The model uses actual data on day-ahead regulation procurement and 4-second regulation dispatch from July 15, 2010, hour ending 9:00. Figure 1 plots the actual day-ahead hourly regulation procurement and the 1-minute interval regulation dispatch for that day. This section provides a description of the REM resource being modeled and how its regulation dispatch and real-time energy offset are calculated in the spreadsheet.

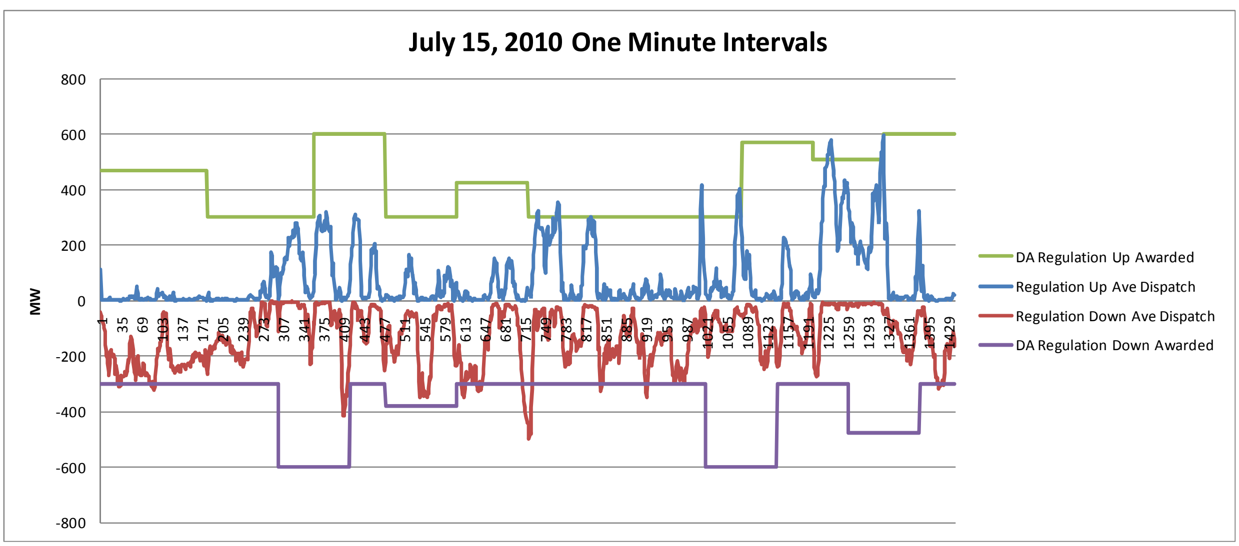

Figure 1 – One Minute Average Regulation Up and Regulation Down Dispatch

The model assumes a single 20 MW / 5MWh limited energy resource, which has been awarded 20 MW of regulation up capacity and 20 MW of regulation down capacity. The resource has a preferred operating point or initial state of charge of 2.5 MWh. Given the actual 4-second data for the market, the model calculates the resource's share of total regulation dispatch for each 4-second interval and returns this value as the regulation dispatch for the resource. Figure 2 plots, for each 4-second interval, the energy delivered by the resource while providing regulation up (the red line) and the energy consumed by the resource while providing regulation down (the blue line). In addition, the real time energy offset is shown for each four second interval (the green line). The calculation of the energy offset is explained in more detail in section 7.3.1.

Note that the model assumes that the REM resource is operating at maximum capability given the assumed regulation up and regulation down requirement in each interval modeled. Also, the modeled resource can only provide its share of the upwards or downwards regulation; in actual practice, the ISO may adjust the regulation dispatch of any particular resource providing regulation to reflect the net regulating requirement; also, all other regulating resources are providing the remainder of the regulation requirement, but are not modeled explicitly (there is further discussion of how regulation dispatches are optimized among the full set of regulating resources in Section 7.3.2).

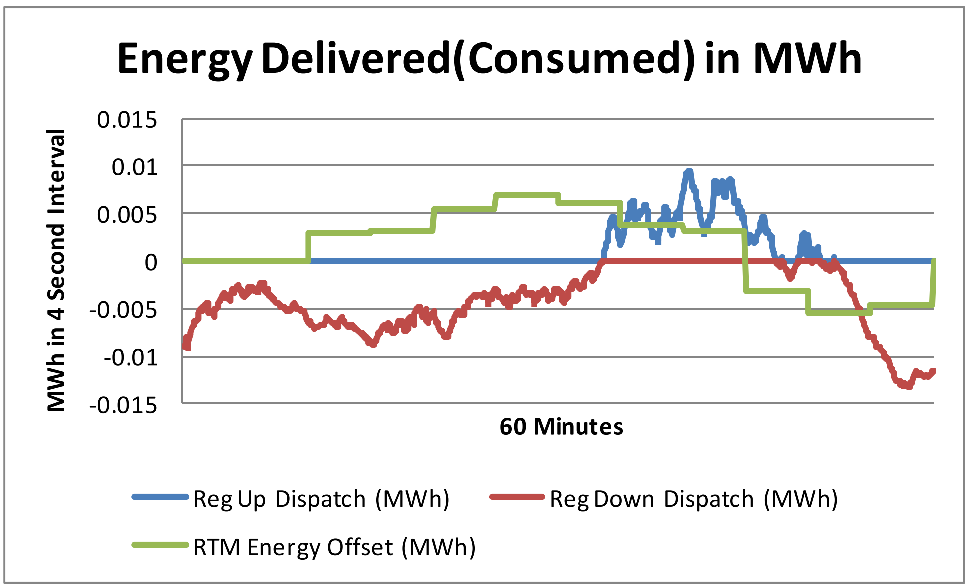

Figure 2 – REM Resource Energy Dispatched through Regulation and RTM Energy Offset Schedule

Figure 3 reflects the actual state of charge over the hour as the resource responds to regulation dispatch and follows its RTD energy offset. This diagram shows that through the combination of both regulation dispatch and the energy offset the resource moves above and below its preferred operating point of 2.5 MWh, but never fully discharges or fully charges. Since the state of charge does not violate the storage capacity, the resource is able to respond to ISO AGC signals at its full awarded capacity MW value on a continuous basis.

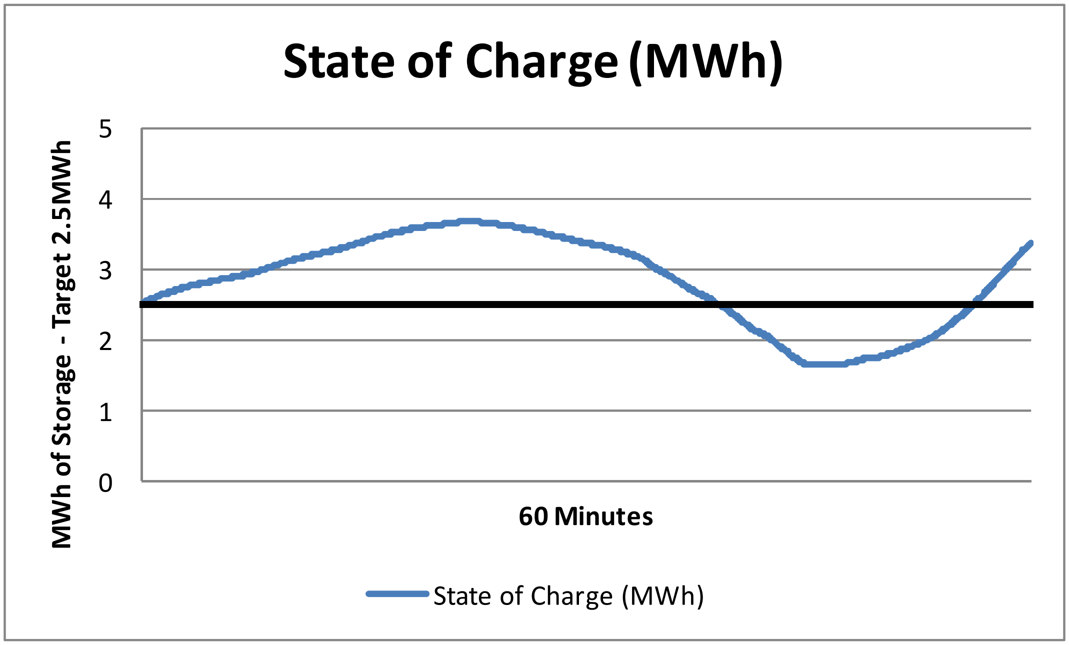

Figure 3 – REM Resource State of Charge while providing Regulation

7.3.1 Calculation of the Energy Offset in the Model

The energy offset is forecasted using two data points available at T-7.5 minutes of RTD. The first is the REM resources current state of charge. The second is the energy offset planned from T-7.5 minutes to the start of RTD. The sum of these two data points is compared to the preferred operating point of the resource using REM and the difference is the energy offset for the five minute RTD interval. Thus, if no regulation energy dispatch occurred from T-7.5 minutes to the end of the RTD interval, the resource's state of charge would be at the preferred operating point.

For the examples below, we are assuming a resource with a 20 MW Regulation Up capacity award and a 20 MW Regulation Down capacity award with a preferred operating point at a state of charge of 2.5 MWh.

Example 1 – The state of charge is above 2.5 MWh

a. At T-7.5 minutes, the state of charge is 3.0 MWh
b. From T-7.5 minutes to T-0 minutes, the resource is scheduled to consume 0.5 MWh

Therefore, the energy offset needed for the 5 minutes interval is,

3.0 MWh + 0.5 MWh - 2.5 MWh = 1.0 MWh

So, in each 4 sec interval the resource is scheduled to discharge 0.01333 MWh or 1.0 MWh divided by 75 four second intervals

Example 2 – The state of charge is below 2.5 MWh

a. At T-7.5 minutes, the state of charge is 1.5 MWh
b. From T-7.5 minutes to T-0 minutes, the resource is scheduled to consume 0.5 MWh

Therefore, the energy offset needed for the 5 minute interval is,

1.5 MWh + 0.5 MWh - 2.5 MWh = -0.5 MWh

So, in each 4 sec interval the resources is scheduled to charge 0.00667 MWh

The energy offset from Example 2 assumes the resource is 100% efficient in charging; however, the ISO must consider the charging efficiency of a resource and increase the energy offset. Also, the ISO must insure that the offset does not exceed the resource's charge rate. If a resource consumed 1 MW, but could only return 0.9 MW at a later period, the resource would have a charging efficiency of 90%. The resource in Example 2 has a charging efficiency of 90%. For this reason, the scheduled charge would increase to 0.00741 MWh (0.00667 MWh / 0.90). If the prior calculation resulted in an offset greater than the maximum charge rate of the resource of 0.02222 MWh, the offset would be set at the maximum charge rate.

Since the model only represents one hour, the ISO calculated the final energy offset that returns the resource to its starting point as a single value. If a resource is not awarded regulation in consecutive hours, the energy offset necessary to return the resource to its preferred operating point will occur of over the first 10 minutes of the following hour and will be settled at that interval's price. In the first ten minutes of the model, the resource does not have an energy offset since we assumed the resource started to provide regulation in the current hour. Most resources which have expressed interest in REM are interested in providing regulation only on a 24x7 basis, so in actual practice an energy offset will always be in place further ensuring the resource is able to provide its full regulation capacity.

7.3.2 Optimization of Regulation Fleet Ramp Capability

In addition to the energy offset, the ISO continuously optimizes the resources on AGC providing both regulation up and regulation down to maximize the fleet's ramp capability in the direction needed for second-by-second system balancing. For example, if the direction of the regulation requirement is up, both regulation up dispatches and regulation down dispatches to return (upwards) to the preferred operating point can be sent simultaneously to different resources. In actual operations, the different ramp rates may also require that particular units are providing regulation at cross-purposes, although the aggregate regulation response is in the right direction. The spreadsheet model does not attempt to reflect this optimization, but rather assumes that the resource being modeled receives its exact share of total net regulation dispatch.[13] Through the regulation optimization, there may be instances when our regulation dispatch to REM resources is different than the percentage share and will move the REM resource closer to its preferred operating point. Thus, the ISO can manage the resource's state of charge each 4 second interval in addition to energy offset.

The optimization can be seen in Figure 1 as there are instances where over a one minute interval the average regulation up dispatch and regulation down dispatch are both non

[13] That is, the REM resource is providing a residual regulation up or regulation down requirement assuming the net production by all other regulating resources.

zero. The increase in the fleet's ramp capability in the upward direction is accomplished by moving regulation up resources to a higher MW value and simultaneously moving regulation down resources back to their preferred operating point of zero. For example, assume at interval one the dispatch was regulation up at 100 MW and regulation down for -40 MW resulting in total net regulation dispatch of 60MW. Then in interval two, system conditions require an additional 15 MW to balance supply and demand. To meet this requirement, regulation up resources could be dispatched to 110MW and regulation down could be dispatched to -35 MW which results in a total change of 15 MW and a total net regulation dispatch of 75 MW.

7.4 Qualification as a REM resource

The ISO proposes that a resource can select REM if for reasons related to its technical characteristics the resource requires a real-time energy offset to provide regulation. Resources such as flywheels, batteries, and some demand response resources may require a real-time energy offset; whereas, a traditional hydro or thermal unit does not. The qualification requirement is similar to the approach for Multi-Stage Generation Resources. This proposal addresses DMM's previous concern that REM would be made available for all resources.

Stakeholders requested additional clarification as to why conventional generation would not be allowed to select REM. Conventional generation is required to have a day ahead energy schedule in order to establish the downward dispatch capability necessary to provide regulation down capacity. Therefore, the conventional resource does not require a real time energy offset and has already been compensated for the day ahead energy schedule necessary to respond to regulation down energy dispatches. REM resources do not require a day ahead energy schedule. The REM resource consumes energy while providing regulation down and is settled at the real time LMP. Since the REM resource, is consuming in real time, an energy offset is needed to maintain the resource preferred operating point. A conventional generator, does not need the energy offset to return to its preferred operating point which is its day ahead energy schedule.

7.5 Determination of Capacity

The ISO proposes to allow a resource using REM to bid capacity based upon the maximum amount of energy which can be delivered and consumed over a fifteen minute interval. The ISO will calculate the amount of hourly day-ahead regulation up capacity using the following formula: MWh delivered over 15 minutes multiplied by 4 with the resource starting at full charged state. The regulation down capacity will be calculated using the following formula: MWh consumed over 15 minutes multiplied by 4 with the resource starting at full discharged state. For example, a fully charged storage device with a discharge rate of 20 MW and 5 MWh of stored energy would be certified to provide 20 MW regulation up. If a resource which is completely discharged has a charge rate of 10 MW and 2.5 MWh of available storage capacity, the resource would be certified to provide 10 MW of regulation down.

7.6 Regulation Energy Management Bidding Process

REM resources must submit separate bids for regulation up and regulation down capacity. The submission of two separate bids does not guarantee that the resource will receive symmetrical regulation up and regulation down awards. Conventional generators are required to have a day-ahead schedule in order to provide regulation. This requires those generators to submit a bid or self-schedule for energy into the day-ahead market. The ISO can then move these resources up and down to provide regulation based on the set point established in the day-ahead schedule and the regulating range of the resource. Limited energy resources have a set point of zero and will only be providing regulation energy through REM; therefore, these resources will not submit day-ahead energy bids and are not required to have a day-ahead schedule to provide regulation through REM.

Previously, the ISO proposed that a symmetrical bid and award of regulation up and regulation down would be required. However, the ISO procures different quantities of regulation up and regulation down hourly based upon forecasted regulation needs. The ISO needs to co-optimize regulation, operating reserves, and energy bids and there may be instances where a symmetrical award is not the optimal solution. Such as when an hour has significant regulation down requirements and minimal regulation up is required.

7.7 Real-time Communication of Regulation Range to the ISO

In addition to existing regulation telemetry requirements, resources selecting REM must communicate the real-time available capacity to provide regulation up and regulation down. For example, a battery or flywheel must communicate the real-time state of charge and a demand response aggregator must communicate available real-time range of load.

7.8 Settlement of Regulation Capacity and Energy

Previously the ISO proposed not settle real-time imbalance energy for resources participating in REM. Given concerns raised by certain stakeholders that this may not accurately account for the efficiency losses of an REM resource and different energy prices during times of charge and discharge, the ISO is now proposing to settle these resources the same as resources providing traditional regulation. Resources that select REM will receive regulation capacity payments from the day-ahead market. When the ISO dispatches a resource using REM with a regulation up award, the resource will receive the real time LMP. When the ISO dispatches a resource using REM with a regulation down award, the resource will be charged the real time LMP. The real time energy produced/consumed by a resource using REM to maintain the resource's state of charge, including losses, will be settled at the real time LMP. Resources using REM will be subject to the applicable Grid Management Charges for their forward regulation schedules and real time energy.

The settlement of energy addresses stakeholder concerns that REM creates a separate regulation product for two reasons. 1) the settlement of energy between REM resources and traditional regulation resources will now be exactly the same and 2) the concern of potentially higher uplift costs if the energy necessary to maintain the state of charge is no longer applicable. In addition, a REM resource now has an incentive to improve charging efficiency to reduce the cost of recharging the resource after a regulation up dispatch.

The posted model illustrates the full settlement of a REM resource. A REM resource in most hours will receive total revenue which is equivalent to the capacity payment only. As is seen in the model, the energy settlements resulting from providing regulation up, regulation down, and the energy offset result in a net energy settlement near zero. Therefore, if a limited energy resource can meet the one hour continuous energy requirement required to provide regulation without REM, the resource will receive higher revenue by managing its state of charge and receiving the full energy settlement. The ISO does not anticipate that a limited energy resource with sufficient duration exceeding one hour would forego its day ahead energy schedule required to provide regulation down capacity as the total revenue would exceed the revenue from capacity only. Thus it is economic only for resources which require an energy offset to maintain its state of charge within an hour to select REM when providing regulation.

7.9 Maximum Regulation Procured from Resources Using REM

Previously, the ISO proposed a maximum procurement limit for REM equal to 10% of the total Regulation requirement to allow for operational experience with limited energy resources, while expecting to increase the cap over time.[14] A number of stakeholders argued against the cap, noting that it could limit the development of commercial-scale limited energy storage in California.[15] On further examination, the ISO believes that due to the small number of limited energy resources anticipated to participate in the market over the next several years that an initial cap on procurement is not needed.[16] The ISO will closely monitor the development of REM resources and work with stakeholders to modify the market design in the event that more REM resources enter the market than anticipated (see section 7.16). The ISO will gain experience through the interconnection of limited energy resources over time and can determine in the future what design modifications may be needed. In addition, the cap could have resulted in different prices for the same regulation service because if the cap was binding REM resources would clear at a lower price.

7.10 Substitution for Spinning Reserves

Resources under REM will be allowed to cascade and substitute for spinning or non-spinning reserves when it is economic to do so. REM functionality enables limited energy resources to meet the continuous energy requirement for day-ahead regulation of 60 minutes. This exceeds the continuous energy requirement for spinning and non-spinning reserves of 30 minutes. The current market design cascades regulation up at a system level to meet spinning reserve requirements, if economic to do so. Only the awarded regulation up capacity award applies to cascading. There are no lower quality products that regulation down can substitute.

Stakeholder comments to the *Straw Proposal* expressed concern that given a resource using REM may have a maximum possible duration at full discharge of 15 minutes that this may pose reliability issues if REM resources are used to meet spinning requirements. The ISO analyzed the percentage of regulation up capacity which has substituted for spinning reserves in each 15 minute interval from November 2009 to November 2010. Table 1 summarizes the percentage of regulation up which was used to meet spinning reserve requirements. For example, if the regulation up requirement was 300 MW and the ISO procured 400 MW of regulation up, 100 MW of additional regulation up was procured or 25% of regulation up was used to meet spinning requirements. Table 2 summarizes the percentage of regulation up of the total spinning reserve requirement. Based upon the prior example, if the ISO spinning reserve requirement was 1000 MW and 100 MW of regulation up was used to meet this requirement, 10% of spinning reserves were provided by regulation up. As the tables illustrate, a very small percentage of regulation up is cascaded to spin for the vast majority of fifteen minute intervals. When regulation up does cascade, it substitutes for a very small percentage of the spin requirement for the vast majority of fifteen minute intervals.

---

[14] E.g., ISO, Issues Paper (September 30, 2010), op cit., pg. 36.

[15] See, e.g., Beacon (Oct. 19, 2010), at 3-5; CESA, pg 2

[16] REM resources are not expected to make up a large percentage of the regulation market over the next several years.

% of Reg Up that Cascaded to Spin	
Bin	*Frequency*
0%	9529
0% to 5%	16683
5% to 10%	1286
10% to 15%	1334
15% to 20%	1005
20% to 25%	830
25% to 30%	768
30% to 35%	774
35% to 40%	656
40% to 45%	589
45% to 50%	706
> 50%	524
Total	34684

Table 1 - Reg Up Cascading to Spin

% of Reg Up meeting Spin Requirement	
Bin	*Frequency*
0%	9529
0% to 5%	18475
5% to 10%	2098
10% to 15%	1485
15% to 20%	901
20% to 25%	607
25% to 30%	605
30% to 35%	487
35% to 40%	327
40% to 45%	135
45% to 50%	32
> 50%	3
Total	34684

Table 2 – Reg Up meeting Spin Requirement

The 30 minute continuous energy requirement for spinning reserves is an ISO requirement to ensure that the ISO receives the service it procured since the ISO is not directly managing the resource as it is with resources under regulation which are following the AGC signal. It should be noted that regulation up capacity that has substituted for spinning reserves is still operated as regulation up and is under AGC control. NERC and WECC do not have duration requirements for how long a resource must be able to provide energy in order to qualify to provide regulation, spinning or non-spinning. The 30 minute ISO requirement was determined by evaluating the length of major disturbance control standard (DCS) during September 2009, which showed no events exceeded 15 minutes. The ISO then requested an additional 15 minutes to allow the market software to return from contingency dispatch mode to economic dispatch mode.

The ISO currently cascades regulation to spinning reserves on a system level and does not identify which regulation resources are substituting for spinning reserves. All regulation resources are managed as regulation resources, even the capacity which has been counted towards the spinning reserve requirement. Therefore, the concerns of REM cascading to spinning reserve are only realized once the amount of REM resources committed for ancillary services exceeds 100% of regulation up system requirements.

Given the anticipated quantity of REM resources over the next few years and the current duration of contingency events, the ISO believes that a separate constraint to not allow regulation up capacity provided from REM resources to substitute for spin is unwarranted at this time. However, if a high penetration of REM resources does result in operational concerns and/or changes in the duration of major DCS events occur, the ISO will revisit this issue. The ISO has committed to review potential rule changes regarding the cascading to spinning reserves once REM resources provide 40 percent or more of the ISO's regulation capacity requirements.

7.11 Cost Allocations to Measured Demand

Resources under REM will be not be allocated uplifts that apply to measured demand since the resource only consumes energy to return the energy at a later time.

7.12 Disqualification of REM Resources

In the event that RTD cannot meet the CAISO forecast of CAISO demand plus the REM energy offset, the ISO will disqualify resources under REM from providing regulation. This rule recognizes that the combination of the resource's discharge/charge rate and the real-time market are needed to meet ISO regulation requirements. The shortfall will be allocated on a pro-rata basis to all resources current utilizing REM. For example, if the energy offset for all REM resources is 20 MW, however, RTD can only clear 15 MW, the 5 MW shortfall will be distributed to all REM resources based upon their awarded capacity. The shortfall that results from insufficient stored energy will be subject to no-pay as outlined in section 7.13.

Previously the ISO proposed to disqualify all REM resources. The modified rule above addresses DMM's concerns that by disqualifying the full regulation capacity instances of scarcity pricing may occur where REM resources had sufficient capacity available not to trigger scarcity pricing.

7.13 Criteria for Rescission of Payments for Regulation Capacity

Under the ISO's proposal, resources selecting REM are subject to rescission of payments for regulation capacity as outlined in the ISO tariff section 8.10.8.6. This tariff section provides:

> Payment for Regulation Up and Regulation Down Capacity will be rescinded, in accordance with the provisions of Section 11.10.9, if the resource providing Regulation Up and Regulation Down capacity: (i) is off Regulation or off Automatic Generation Control, (ii) is not running, (iii) is not providing sufficient Regulating Range, (iv) is generating outside the Regulating Range, (v) has a Regulating Range that overlaps with its Forbidden Operating Regions, or (vi) has telemetry equipment that is not available.

Additional information regarding rescission of payments for regulation capacity is available in section 5 of the ISO's Compliance Monitoring BPM.

In comments to the straw proposal, stakeholders requested additional clarification on when resources using REM may face rescission of payments for regulation capacity and how, if at all, this differs from other resources providing regulation. A resource using REM would be subject to rescission of regulation capacity payments, if the resource is unable to respond to Automatic Generation Control (AGC). Through AGC, the ISO will provide the net energy dispatch necessary to provide the resources share of regulation and the energy schedule to maintain the state of charge. Conventional resources are not required to follow their schedule, but are subject to energy imbalances if the resource deviates below their schedule. Resources using REM must follow their real time energy schedule which will initially be communicated through the AGC signal. If in the future, the ISO considers separating the regulation dispatch and energy offset schedule versus providing as a single AGC signal, a resource using REM must follow its energy offset schedule. If the resource does not follow its energy schedule it would be subject to rescission of payments.

7.14 Interconnection Procedures or Aggregation Arrangements

Resources selecting REM will be subject to applicable generator interconnection procedures or an ISO approved aggregation arrangement.

7.15 Implementation of Mileage Payment

Some stakeholders[17] have advocated that the ISO should provide an additional payment to regulation resources based upon their movement from the preferred operating point. A "mileage payment" would be an administrative payment based upon the sum of the absolute value of all deviations from the resources preferred operating point in response to ISO regulation signals. While there may be merit in implementing such a payment, as has been done in ISO New England, this would be a fundamental change in how the ISO procures and pays for regulation services and as such is within scope of the larger market product discussion in RI-MPR Phase 2. REM implements functionality that manages the real-time energy offset necessary to allow limited energy resources to meet the existing definition of regulation. If in the future, a new payment approach was implemented, the REM functionality will still be required.

7.16 Monitoring of Operational Performance of REM

The ISO does not anticipate a large percentage of regulation to be provided by REM within the next few years. Many of the potential operational concerns raised by stakeholders arise when all or a substantial portion of regulation is provided by resources using REM. In addition, the ISO will benefit from operational experience with REM as the penetration of limited energy resources increases. Therefore, the ISO believes it is reasonable to allow this initially small amount of capacity to participate in the regulation market in order to gain operational experience and avoid discouraging development of such resources. The rules adopted based upon the current near term amount of REM capacity to enter the ISO market are subject to review.

The ISO will monitor the operational performance of resources using REM as the penetration rate increases and will determine if modifications are needed based upon actual operating experience with resources using REM. The ISO will review resources state of charge while providing regulation, the regulation dispatch these resources receive, the frequency and duration resources using REM are awarded regulation, and the resources performance in various grid system conditions. Resources using REM and entering the market under these initial rules will not be grandfathered if and when the ISO modifies these rules.

8 Next Steps

The ISO will present the REM Revised Draft Final Proposal during a stakeholder call on January 20, 2011.

[17] See, e.g., Beacon (Oct. 19, 2010), pg 7.