

**UNITED STATES OF AMERICA  
BEFORE THE  
FEDERAL ENERGY REGULATORY COMMISSION**

California Independent System Operator  
Corporation )

Docket No. ER10-1755-000  
ER11-1875-000

**REPORT OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR  
CORPORATION CONCERNING REGULATION ENERGY MANAGEMENT**

**I. Introduction**

Consistent with the Commission's September 10, 2010 order in the above-captioned docket, the California Independent System Operator Corporation submits this report to discuss design elements associated with regulation energy management and technical issues surrounding real-time availability of limited energy storage resources to provide regulation.<sup>1</sup> The ISO is moving forward to implement enhancements to allow limited energy storage resources to provide regulation.

Regulation energy management will allow limited energy storage resources to more effectively bid their capacity into the ISO's regulation markets consistent with the continuous energy requirements for regulation service set forth in the ISO's tariff. Under the proposal, the ISO will manage the resources' state of charge. The ISO will discharge the resource for regulation energy associated with regulation up and will charge the resource for regulation energy associated with regulation down. The ISO will use offsetting dispatches of energy from the real time energy market, if necessary, so that the resource can satisfy its regulation capacity award. The ISO has completed a stakeholder process to finalize the design of its regulation energy

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<sup>1</sup> *California Indep. Sys. Operator Corp.* 132 FERC ¶ 61,211 (2010) at PP 26-34. (*September 2010 Order*)

management proposal and is commencing efforts to file any necessary tariff revisions to implement this functionality next year.

**II. The ISO has completed a stakeholder process to finalize its regulation energy management proposal**

The ISO discussed the design of regulation energy management functionality with its stakeholders as part of the ISO's initiative to facilitate participation by non-generator resources in the ISO's ancillary service market. As reflected in the Commission's *September 2010 Order*, the ISO deferred consideration of regulation energy management in connection with that initiative.<sup>2</sup> During phase 1 of the ISO's renewable integration market and product review initiative, the ISO again examined the potential design of regulation energy management to facilitate participation by limited energy resources in the ISO's ancillary services market. As discussed with stakeholders, the continuous energy requirements for regulation service limit the ability of these resources to their bid capacity into the ISO's regulation market. Based on available information related to the recovery from disturbances and the fact that the ISO's market rules allow regulation up to substitute for spinning reserve and non-spinning reserve, the ISO continues to believe that it should maintain the existing continuous energy requirements for regulation. As an alternative to reducing the continuous energy requirements to accommodate limited energy resources, the ISO worked with stakeholders to refine the proposed design for regulation energy management.<sup>3</sup>

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<sup>2</sup> *September 2010 Order* P 25.

<sup>3</sup> The ISO's draft final proposal for regulation energy management is available at the following website: <http://www.caiso.com/2b05/2b05e7075f6d0.pdf>.

On February 3, 2011, the ISO Board of Governors voted to authorize the ISO to make tariff changes necessary to implement regulation energy management.<sup>4</sup> Among other design elements, the ISO's proposal establishes that resources that will use regulation energy management must agree to allow the ISO to maintain the resource's state of charge. The proposal also resolves a number of issues, including eligibility requirements, initial bidding rules, settlement of regulation energy, and rules for rescission of ancillary services capacity award payments as well as disqualification of resources using regulation energy management from providing regulation. The proposal also eliminates a proposed procurement limit on regulation service from resources using regulation energy management.

The ISO believes the design of regulation energy management strikes the appropriate balance between facilitating participation by limited energy resources in the ISO's regulation market while not creating potential risks to system reliability. The ISO intends to monitor the operational performance of resources using regulation energy management on an ongoing basis and will determine if modifications are needed based on actual operating experience.

### **III. The ISO is targeting an effective date of April 2012 to implement regulation energy management**

The ISO is currently planning the implementation of regulation energy management. This effort will require modifications to the ISO tariff as well as changes to ISO systems. The ISO intends to model resources using regulation energy management as a resource with both a positive and a negative range.

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<sup>4</sup> The ISO's proposal as presented to its Board of Governors is available at the following website: <http://www.caiso.com/2b14/2b14899b24c90.pdf>. The ISO has attached hereto as Exhibit A the documents presented to the ISO Board of Governors as part of the regulation energy management proposal as well as a record of the ISO Board of Governors' vote. The ISO has also attached the Market Surveillance Committee's final opinion on regulation energy management as Exhibit B and the report of the ISO's Department of Market Monitoring pertaining to regulation energy management as Exhibit C.

Downstream applications in the ISO's systems must recognize these resources. The ISO will need, for example, to make sure its scheduling infrastructure and business rules acknowledge and accommodate resources using regulation energy management and that market systems appropriately optimize regulation awards in the integrated forward market, hour ahead scheduling process and real time unit commitment process. Importantly, the ISO will need to ensure its energy management system can effectively manage the state of charge of a resource using regulation energy management. This effort will require market simulation efforts as resources seeking to use regulation energy management interconnect to the ISO grid. Finally, the ISO will need to make changes to its settlements and market clearing system. All of these changes will require some level of modification to business practice manuals and ISO business processes. The ISO is targeting an effective date of April 2012 to bring resources using regulation energy management into production but may request an earlier effective date for certain tariff provisions to allow resources that intend to use regulation energy management to undergo market simulations.

#### **IV. Conclusion**

The ISO has completed a stakeholder process to finalize the design of regulation energy management and the ISO's Board of Governors has authorized the ISO to make any necessary filings with the Commission to make appropriate tariff changes. The ISO will soon commence discussions with stakeholders on proposed tariff changes and intends to submit a tariff amendment during the third quarter of 2011.

Respectfully submitted,

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Attorneys for the California Independent  
System Operator Corporation

Dated: March 4, 2011

## **CERTIFICATE OF SERVICE**

I hereby certify that I have served the foregoing document upon the parties listed on the official service list in the captioned proceedings, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated at Folsom, California this 4<sup>th</sup> day of March, 2011.

*/s/ Susan L. Montana*

Susan L. Montana

## **EXHIBIT A**



# Memorandum

**To:** ISO Board of Governors  
**From:** Keith Casey, Vice President, Market and Infrastructure Development  
**Date:** January 27, 2011  
**Re:** Decision on Regulation Energy Management

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*This memorandum requires Board action.*

## EXECUTIVE SUMMARY

Regulation energy management is a proposed market enhancement to the rules the California Independent System Operator Corporation uses for procuring regulation services. This enhancement will allow new types of storage resources, such as batteries and flywheels, to provide regulation service. The extremely fast ramping ability of these resources can provide significant operational benefits to the ISO. However, these resources also have limitations in the amount of energy they can produce for a sustained period of time. Without regulation energy management, these resources are limited to providing only a portion of their available capacity to the regulation market. Management believes that implementing regulation energy management will lead to increased participation in the ancillary service market by energy storage and demand response resources and will support the integration of additional renewable resources.

Regulation energy management also allows new storage technologies to provide regulation energy over a continued sustained period. The ISO maintains the resource's state of charge by balancing the energy dispatched from the resource providing regulation service with offsetting dispatches through the real-time energy market in subsequent periods. By ensuring that the energy offset is met by the real-time energy market, the ISO is assured that the resource will provide the regulation capacity the ISO procured.

The integration of renewable resources introduces new requirements to reliably manage the grid, and new market solutions and technologies will be needed to meet the emerging challenges. This enhancement will allow the ISO to gain valuable operational experience with new technologies that provide more varied capabilities for ISO grid operations. Management proposes the following motion:

***Moved, that the ISO Board of Governors approves the proposed regulation energy management software enhancement, as described in the memorandum dated January 27, 2011; and***

***Moved, that the ISO Board of Governors authorizes Management to make all necessary and appropriate filings with the Federal Energy Regulatory Commission to implement the proposed tariff change.***

## **BACKGROUND**

The ISO originally commenced this initiative in connection with FERC Order Nos. 719 and 890. Order 719 directs regional transmission organizations and independent system operators to allow demand response resources to participate in ancillary services markets, assuming the demand response resources are technically capable. Order 890 requires RTOs and ISOs to evaluate non-generation resources, such as demand response and storage, on a comparable basis to services provided by generation resources in meeting mandatory reliability standards, providing ancillary services and planning the expansion of the transmission grid.

In March 2010, the Board approved modifications to existing operating characteristics and technical requirements for ancillary services to remove barriers for non-generation resource participation in the ISO's regulation markets. Specifically, the Board approved a proposal that reduced the minimum rated capacity and continuous energy requirements for providing ancillary services. With these modifications, limited energy resources such as flywheels and batteries are now able to participate in the day-ahead and real-time regulation market. However, the amount of day-ahead capacity for providing regulation service from these resources is significantly limited by a one hour continuous energy requirement. The ISO tariff requires that regulation capacity offered must be dispatchable on a continuous basis for at least sixty minutes in the day-ahead market and at least thirty minutes in the real-time market after issuance of a dispatch instruction.

Management planned to include a regulation energy management feature as part of the March 2010 proposal but removed it prior to the Board meeting based on stakeholder concerns that outstanding issues with the design were not adequately resolved. Management committed to the Board and to stakeholders to revisit regulation energy management in Phase 1 of the Renewable Integration –Market & Product Review stakeholder process. As described further in this memo, we believe the proposed design addresses issues raised in both the prior and current stakeholder processes.

### ***Barriers for limited energy resources providing regulation***

There are existing barriers in the current regulation market design to limited energy resources for providing regulation services. 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. 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 (i.e., "limited energy resources").

By implementing measures that utilize the real-time market more dynamically to manage the resources state of charge, limited energy resources are able to meet the continuous energy requirement for providing regulation services.

### ***Comparison with other ISOs***

The ISO's proposed approach to implement software functionality to maintain a limited energy resource's regulating range through the real-time market is similar to the approaches developed by the Midwest ISO, PJM Interconnection, ISO New England and the New York ISO. As in this

proposal, these ISOs/RTOs enable limited energy resources like small batteries and flywheels to provide regulation service by managing their state of charge on behalf of the resource.

### ***Regulation energy management is consistent with future market software needs***

The proposed functionality, while initially applied to limited energy resources providing regulation, will also be used in the future to support other expected software enhancements to integrate storage and to allow demand response resources to provide regulation service. The software logic used 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 a 2 hour or 8 hour storage resource. The cost of this software functionality is estimated to be around one million dollars.

## **PROPOSAL**

### ***Operation of resources using regulation energy management***

Under regulation energy management, a resource's scheduling coordinator agrees to allow the ISO to maintain the resource's state of charge by balancing the energy dispatched from the resource in providing regulation service with offsetting dispatches from the real-time energy imbalance market in subsequent intervals. By ensuring that the energy offset is met by the real-time energy market, a resource which has selected regulation energy management can satisfy the 60 minute continuous energy requirement for regulation in the day-ahead market.

### ***Bidding***

Regulation energy management resources will submit separate bids for regulation up and regulation down capacity the same as conventional generation. Bids to provide regulation may be submitted into the day-ahead and/or real-time market. In contrast to conventional generation resources that must have a day-ahead energy schedule to provide regulation, limited energy resources have a set point of zero and will only provide regulation energy through the use of regulation energy management. Therefore, these resources will not submit day-ahead energy bids and are not required to have a day-ahead schedule.

### ***Settlement of regulation energy and energy offset***

Management proposes to settle resources using regulation energy management the same as conventional generation providing regulation. Resources that utilize regulation energy management will receive regulation capacity payments from the market and will be paid the locational marginal price for providing regulation up and charged the locational marginal price for providing regulation down. The real-time energy produced and/consumed by a resource to maintain the resource's state of charge, including losses, will be settled at the real-time locational marginal price.

### ***Monitoring of regulation energy management design***

Management intends to monitor the operational performance of resources using regulation energy management on an ongoing basis and will determine if modifications are needed based on actual operating experience. We plan to monitor the resources state of charge while providing regulation, the regulation dispatch received, frequency and duration of regulation awarded, and performance

under various grid system conditions. The ISO likely will develop additional monitoring metrics in the future as more experience is gained with these storage resources.

### ***Disqualification and rescission of payment***

Management proposes to disqualify, on a pro-rata basis, resources using regulation energy management from providing regulation in the event that the real-time energy market cannot meet the ISO forecast of ISO demand plus the regulation energy management energy offset. 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. This pro-rata allocation will result in a rescission of the regulation capacity payment for the allocated shortfall.

In addition, whenever a resource using regulation energy management fails to respond to automatic generation control, the ISO will rescind the regulation capacity payments. This rescission of payment is similar to the provisions in place for conventional generators.

### ***Eligibility to participate in regulation energy management***

Management proposes that a resource can select regulation energy management only if its technical characteristics require a real-time energy offset to provide regulation (i.e., it cannot meet the 60-minute continuous energy requirement for its full capacity). 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.

## **POSITIONS OF THE PARTIES**

### ***Stakeholder Process***

The ISO examined a proposal to implement regulation energy management as part of the modifications to ancillary services to support non-generation resources initiative that was approved by the Board in March 2010. Management deferred bringing regulation energy management to the Board so that we could address several outstanding issues related to the functionality, including whether regulation energy management created a separate ancillary service product, whether or not to implement a procurement limit, and whether or not to settle regulation energy dispatched from these resources.

In the current stakeholder process, Management has worked to resolve each of these issues so that the regulation service provided by resources using regulation energy management is comparable to that of a conventional generator. Specifically, the proposal differs from the previous proposal in that it removes the limit on the amount of regulation energy management capacity that could be procured by the ISO and settles the energy provided and consumed by these resources at the real-time locational marginal price.

Most stakeholders have expressed support or at least acceptance of the proposal, subject to a review of regulation energy management based on actual operating experience. The proposal has received strong support from limited energy storage interests. Some stakeholders remain neutral, but continue to express concerns about potential operational issues given the energy limitations of these resources. The ISO Department of Market Monitoring (DMM) expressed concerns and proposed potential modifications to the design. These concerns were resolved through

modification to the design and a commitment to monitor the effectiveness of the regulation energy management design after implementation. For additional information on DMM's concerns, please refer to their separate Board memo, provided in the Board materials for this meeting and posted on the ISO website. PG&E continues to oppose the design and requests additional analysis and modeling prior to implementation. The Market Surveillance Committee (MSC) has also raised concerns and recommends the ISO place three different caps on participation by limited energy storage resources. Their concerns are described in the MSC Opinion on regulation energy management. The Opinion is attached to the MSC Board memo which was also provided in the Board materials for this meeting.

In response to the MSC opinion, Management believes that the volume of energy limited storage resources participating in the ISO's regulation markets over the next several years will be very small. If this is indeed the case, the caps suggested by the MSC are unwarranted and create unnecessary complexity for implementation. As described above, the ISO will be closely monitoring the participation of these resources in the regulation markets and will propose modifications to the design if warranted. Caps on participation can be added later if necessary, after the ISO gains experience with these new resources and has better justification for future design modifications.

The concerns described above expose the ongoing paradox with accommodating new technologies in the ISO markets. If the ISO does not remove existing barriers to allow participation of new technologies, the new resources will not enter the ISO market and we will not gain the operational experience necessary to address stakeholder concerns. Stakeholders expressed similar concerns regarding performance in the market to the proxy demand resource product, as the ISO had no experience with demand response resources and performance of these new resources was not proven.

Below is a discussion of the key issues that staff addressed and the design modifications that were made based on stakeholder feedback. Comments are summarized in more detail in the Stakeholder Matrix, which is *Attachment A* to this memo.

### ***Regulation energy management as a new product***

Stakeholders were divided on the issue of whether or not regulation energy management is sufficiently different from traditional regulation to warrant creation of a new product. Some stakeholders advocated that regulation energy management 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 regulation energy management is a new and unique product from traditional regulation and should be procured and priced separately. Management views regulation energy management as an enhancement that will allow the ISO to utilize the full range of regulation capability available from limited energy resources and does not at this time require the development of a new product. However, we recognize that a new regulation market product may be warranted in the future.

## ***Settling imbalance energy***

Previously, Management proposed not to settle real-time imbalance energy for resources participating in regulation energy management to simplify implementation. However, we modified the proposal in response to stakeholder concerns that this approach may not accurately account for the efficiency losses of a resource using regulation energy management and different energy prices during times of charge and discharge.

## ***Eligibility Limits***

This design feature was added to resolve stakeholder concerns that regulation energy management could be used by conventional generators to withhold regulation capacity from the market. Only resources that require an energy offset due to their operational characteristics may participate in regulation energy management.

## ***Review threshold for regulation energy management design***

During the stakeholder process, there was discussion of establishing a review threshold based upon the penetration of resources using regulation energy management. Once the threshold is reached, stakeholder review of the design would be initiated. The purpose of the review threshold was to address stakeholder concerns that operational issues could emerge at higher penetration of resources using regulation energy management. Management previously proposed a 40 percent threshold and DMM suggested that if a threshold were to be used, a much lower 5 percent threshold would be more appropriate. Others suggested that ongoing monitoring should allow review if operational issues occur at any penetration level. Management agrees a review threshold is not warranted as we plan to monitor on an ongoing basis. If operational issues arise, the ISO will engage with stakeholders to make appropriate changes to the design.

## ***Procurement limits***

Previously, Management proposed an initial procurement limit for regulation energy management equal to 10 percent of the total regulation requirement to allow for operational experience with limited energy resources. A number of stakeholders argued against this limit on the grounds that it would hinder the development of commercial-scale limited energy storage in California. DMM also raised concerns that if the procurement limit was exceeded it would result in differential pricing for resources providing regulation through regulation energy management and resources providing regulation conventionally. On further examination, we removed this design element and believe the ongoing monitoring of the design is preferable to a market constraint.

## ***Ancillary services substitution***

Under the ISO's current market rules, regulation up may substitute for spinning and non-spinning reserves, when it is economic to do so. Regulation energy management functionality enables limited energy resources to meet the continuous energy requirement for day-ahead regulation of 60 minutes. This timeframe exceeds the continuous energy requirement for spinning and non-spinning reserves of 30 minutes.

Stakeholders expressed concern with allowing resources using regulation energy management to substitute for spinning reserve requirements given their inherent energy limitations. Given the

anticipated quantity of resources using regulation energy management over the next several years and the current duration of contingency events, the ISO believes that a separate constraint to prevent regulation up capacity provided from resources using regulation energy management from substituting for spinning reserve is unwarranted. The ISO will monitor the design during contingency events and if unforeseen operational issues arise, the ISO will revisit this issue and determine, based upon actual operational data, if design changes are required.

### ***Implementation of a mileage payment***

Some stakeholders 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 by ISO New England, this would be a fundamental change in how the ISO procures and pays for regulation. This proposal is more appropriately within the scope of the larger market product discussion in Phase 2 of the Renewable Integration –Market & Product Review. In the future, if a new payment approach were implemented, these limited energy resources will still require the regulation energy management functionality.

## **MANAGEMENT RECOMMENDATION**

Management requests Board approval of regulation energy management as detailed in this memorandum. Regulation energy management will remove barriers to participation in the ISO regulation market by storage and demand response resources that are energy limited and allow the ISO to gain operational experience with new technologies that provide more varied capabilities to ISO markets. If approved, the ISO intends to implement this functionality as part of the ancillary services for non-generation resources project in Spring 2012.

## **Stakeholder Process: Regulation Energy Management**

### **Summary of Submitted Comments**

**Stakeholders submitted four rounds of written comments to the ISO on the following dates:**

- Round One: Renewable Integration: Market and Product Review Discussion Paper, 07/30/10
- Round Two: Renewable Integration: Market and Product Review Issue Paper, 10/18/10
- Round Three: Regulation Energy Management Straw Proposal, 12/01/10
- Round Four: Regulation Energy Management Draft Final Proposal, 01/07/11
- Round Five: Response to DMM Comments on Draft Final Proposal, 01/12/11

**Parties that submitted written comments:** A123 Systems, Beacon Power Corporation, California Energy Storage Alliance, Dynergy, ENBALA Power Networks, Pacific Gas & Electric, Powerex, Southern California Edison, and Western Power Trading Forum

**Parties that participated in meetings or conference calls:** (All the parties above), California Department of Water Resources, California Public Utility Commission, City of Anaheim, City of Riverside, Customized Energy, Edison Mission, KEMA, Megawatt Storage Farms, Modesto Irrigation District, San Diego Gas & Electric, Turlock Irrigation District, WAPA

**Stakeholder comments are posted at:** <http://www.caiso.com/27e3/27e3c4fbfb0.html#28607cd936950>

**Other stakeholder efforts included:**

- In-person stakeholder meeting to review discussion paper, 07/16/10
- In-person stakeholder meeting to review issue paper, 10/05/10
- In-person Market Surveillance Committee meeting to review straw proposal, 11/19/10
- Stakeholder conference call to review draft final proposal, 12/21/10
- Stakeholder conference call to review revised draft final proposal, 01/20/11

<b>Management Proposal</b>	<b>A123 (LESR)</b>	<b>Beacon (LESR)</b>	<b>CESA (LESR)</b>	<b>Dynegy (Generator)</b>	<b>Powerex (Importer)</b>	<b>PG&amp;E (IOU)</b>	<b>SCE (IOU)</b>	<b>Management Response</b>
Settlement of regulation energy and energy offset	Supports	Strongly Supports	Strongly Supports	Supports	No Comment	Supports	Supports	The settlement of regulation energy is the same for all resources. The energy offset including losses will receive the locational marginal price.
Capacity determined based upon 15 minute duration	Strongly Supports	Strongly Supports	Strongly Supports	No Comment	Does not support Recommends 30 minutes	Does not support Recommends further analysis	Neutral ISO should monitor for sustained events and have explicit tariff authority to simply not purchase REM in hours where it cannot perform the service being sold.	15 minutes is the minimum time necessary for the ISO to manage the resource's state of charge. The capacity determination is similar to market designs approved in other ISOs.
Ongoing monitoring of REM. If operational issues arise the ISO will propose changes to the design.	Supports	Strongly Supports	Strongly Supports	No Comment	Does not support ISO may not be able to acquire a high volume of regulation capacity in the real-time market.	Does not support REM should be a pilot	Supports	The ISO intends to monitor the operational performance of resources using REM and will determine if modifications are needed based on actual operating experience even at low penetration levels.
Eligibility to participate in REM based upon technical characteristics	Supports	Strongly Supports	Strongly Supports	No Comment	No Comment	No Comment	Supports But urges ISO to remain open to expanding to all resources in the future.	The qualification requirement is similar to the rule for multi-stage generation. The rule ensures that REM cannot be used for unintended purposes.
Rescission of regulation capacity payment when resource unable to respond to automatic generation control	Supports	Strongly Supports	Strongly Supports	No Comment	Supports	Neutral Seeks additional analysis	Supports	Comparable treatment between conventional generation and limited energy resources.

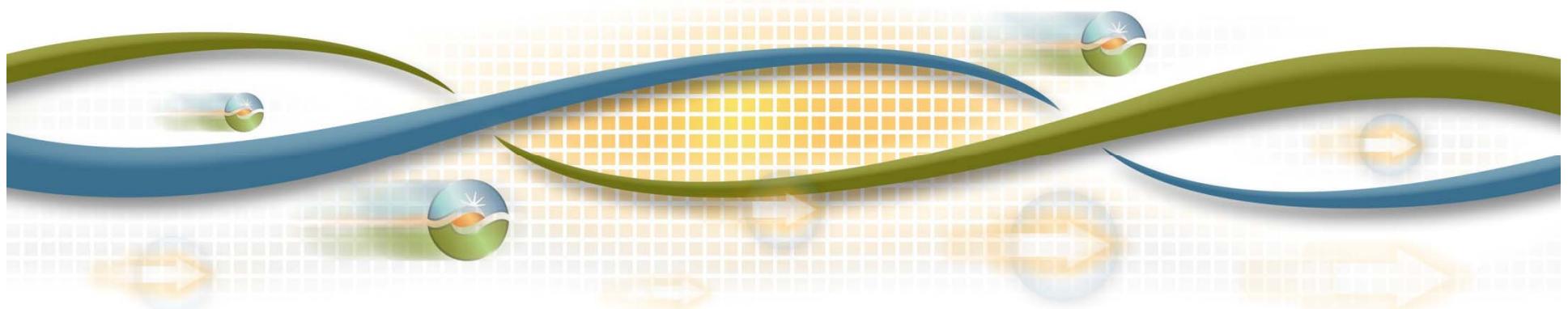
Management Proposal	A123 (LESR)	Beacon (LESR)	CESA (LESR)	Dynegy (Generator)	Powerex (Importer)	PG&E (IOU)	SCE (IOU)	Management Response
Pro-rata disqualification when RTD cannot meet energy offset	Supports	Strongly Supports	Strongly Supports	<p>Neutral</p> <p>Concerned resources that could have provided day-ahead regulation were displaced from doing so by resources providing REM</p>	No Comment	<p>Neutral</p> <p>Seeks additional analysis</p>	Supports	Recognizes that the real-time energy market is necessary to maintain the full regulation capacity. The pro-rata approach addresses concerns that scarcity pricing could be triggered if the total capacity from resources using REM had been disqualified.
Allow resources using REM to count towards spinning/non-spinning requirements	Supports	Strongly Supports	Strongly Supports	No Comment	<p>Neutral</p> <p>Seeks confirmation that rule will not impact reliability</p>	Does not support	No Comment	The ISO manages regulation capacity that has counted towards spinning/non-spinning requirements under AGC. The ISO will monitor resources using REM operational performance during contingency events.
Resources using REM are not required to submit symmetrical bids	Supports	Strongly Supports	No Comment	No Comment	No Comment	No Comment	No Comment	The ISO procures different quantities of regulation up and regulation down. The ISO co-optimizes regulation, operating reserves and energy bids and there may be instance where a symmetrical award is not optimal.
Mileage payment is within scope of RI-MPR Phase 2	No Comment	Supports	Supports	No Comment	No Comment	No Comment	No Comment	Changes to overall regulation payment structure is within scope of Phase 2



# Decision on Regulation Energy Management

Greg Cook  
Director, Market & Infrastructure Policy

Board of Governors Meeting  
General Session  
February 3, 2011



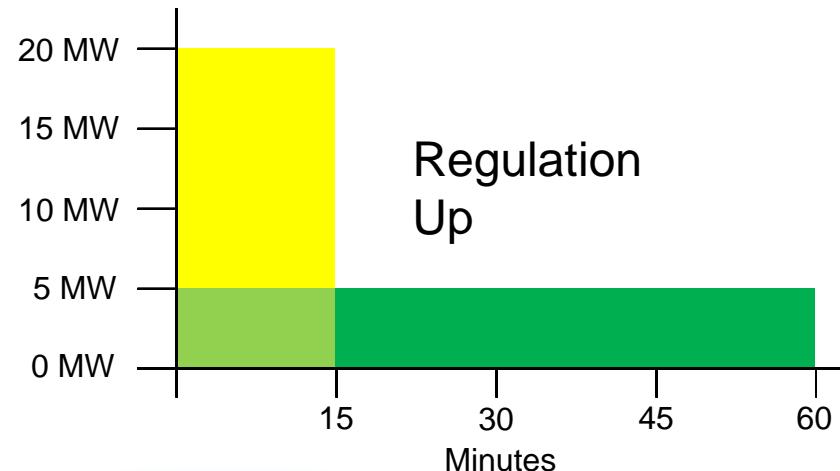
## Regulation energy management enables new storage technologies to provide regulation service.

- Due to the limited energy characteristics of storage resources, they are unable to participate in the day-ahead regulation market at full capacity.

*Example: 20 MW limited energy resource*

*Green – current requirement*

*Yellow – regulation energy management*



Proposal addresses stakeholder concerns from prior and current stakeholder process.

- Settles limited energy resources the same as conventional resources providing regulation.
- Eligibility restricted to limited energy resources.
- Pro-rata disqualification in event that real-time energy market cannot meet energy offset.
- No pay applied when resource does not respond to regulation signal.
- Ongoing monitoring of operational performance.

# Most stakeholders support or conditionally support the proposal.

- Strong support from storage companies.
- Others conditionally support the proposal subject to review based on actual operating experience.
- PG&E argued for deferring the proposal to allow for more analysis.

## Management requests Board approval for regulation energy management.

- Proposal provides reasonable starting point to allow the ISO to gain experience with limited energy resources.
- Safeguards are adequate considering low projected volumes of limited energy resources.
- Consistent with future software needs.
- Meets goals of comparable treatment of non-generation resources.



Board of Governors

February 3, 2011

Decision on Regulation Energy Management

**Motion**

***Moved, that the ISO Board of Governors approves the proposed regulation energy management software enhancement, as described in the memorandum dated January 27, 2011; and***

***Moved, that the ISO Board of Governors authorizes Management to make all necessary and appropriate filings with the Federal Energy Regulatory Commission to implement the proposed tariff change.***

**Moved: Habashi      Second: Foster**

Board Action: <b>Passed</b>	Vote Count: <b>3-0-1</b>
Doll	Not present
Foster	Y
Habashi	Y
Willrich	Y

**Motion Number: 2011-02-G1**

## **EXHIBIT B**

## Opinion on Regulation Energy Management

by

**Frank A. Wolak, Chairman**

**James Bushnell, Member**

**Benjamin F. Hobbs, Member**

**Market Surveillance Committee of the California ISO**

January 21, 2011

### Summary

This opinion comments on the ISO's Regulation Energy Management (REM) proposal which allows energy-limited resources, such as batteries or flywheels, to participate in the ISO's regulation markets. We strongly support the motivation for the REM proposal to expand the set of resources able to participate in the ISO's regulation market. However, a number of grid reliability challenges associated with how energy-limited resources can provide Regulation Up (RegUp) and Regulation Down (RegDown) continuously for 60 minutes argues for a measured approach to introducing this new market feature.

This opinion characterizes the two major reliability challenges associated with allowing energy-limited resources to provide RegUp and RegDown. The first is the need for ISO's real-time market software to issue the appropriate dispatch instructions throughout the operating hour to allow the energy-limited resource to maintain the charge necessary to continue to provide the amount of Regulation Reserve sold for the entire hour. The second issue is whether ancillary service capacity from an energy-limited resource sold as RegUp provides a comparable service to Spinning Reserve from a conventional resource. Traditionally, the market clears ancillary services demand in a fashion that cascades from faster responding products, such as RegUp, to slower responding products such as Spinning Reserve and Non-Spinning Reserve. This allows the CAISO to purchase a larger amount of "superior" reserves when they are offered at lower prices. We discuss challenges associated with continuing this practice for these energy-limited resources.

Because of these reliability challenges, we favor a cautious approach to implementing the REM proposal to limit the risk of unintended negative consequences. The significantly lower prices for RegUp and RegDown after the implementation of the new nodal market design makes it likely that there will be a small amount REM capacity during the initial implementation phase, which should temper the need for explicit market interventions to address these reliability challenges. Nevertheless, we recommend that the ISO carefully monitor the impact of using REM capacity to provide Regulation Reserve on the performance of its energy and ancillary services markets and overall grid reliability.

There are three specific areas that the ISO should monitor. The first is the extent to which the maximum amount of RegUp and RegDown capacity that the ISO allows each energy-limited resource to offer is set to ensure that the resource has sufficient energy to provide the Regulation Reserves sold for the entire operating hour. The second is the relationship between overall system reliability and the share of total RegUp and RegDown being provided by energy limited resources. The third is the relationship between the amount of energy-limited resources providing RegUp that could be used to displace the ISO's spinning reserve requirements and overall system reliability. With these monitoring mechanisms in place and the other minor modifications of the REM proposal suggested in this opinion, we are confident that the ISO operators can limit any adverse reliability consequences associated with using energy-limited resources to provide RegUp and RegDown.

## **1. Introduction**

Energy-limited resources are a necessary source of additional supply of both energy and ancillary services in a wholesale electricity market with an increasing share of intermittent resources. Even without California's ambitious renewable energy goals, there are significant potential reliability and market efficiency benefits from allowing these resources to participate in the ISO's ancillary services and energy markets. The ISO's REM proposal makes creative use of the ISO's 5-minute real-time market to allow an energy-limited resource to sell a frequency response service in the ISO's hourly Regulation Reserve market that it is physically capable of providing for only a short period of time without re-charging.. Real-time dispatch instructions are issued by the ISO operators in order to maintain enough potential energy in the REM resource for it to provide this service for an entire operating hour and beyond.

There are two prerequisites for maintaining the same level of system reliability using energy-limited resources as could be provided by a market utilizing only conventional generation resources to provide Regulation Reserve. One is a deep market for real-time energy so that the recharge energy required by REM resources can be supplied without significantly disrupting the real-time market. The second is a sophisticated 5-minute real-time dispatch algorithm that maintains the level of storage in the energy-limited resource and allows it to provide the Regulation Reserve capacity sold throughout the entire hour. The magnitude and frequency of real-time price spikes in the real-time market documented in the most recent Department of Market Monitoring (DMM) Quarterly Report suggests that using significant amounts REM resources to provide Regulation Reserve may not be advisable during all 5-minute intervals of the year.<sup>1</sup> Substitution of significant amounts of Regulation Reserve from REM resources for Spinning Reserve during the hours containing real-time price spikes could also create reliability challenges.

Nevertheless, we also believe that REM resources can provide significant amounts of quick-response capacity for Regulation Reserve during most hours of the year and that during these hours some of the REM resources providing RegUp can substitute

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<sup>1</sup> Quarterly Report on Market Issues and Performance, November 8, 2010, prepared by Department of Market Monitoring (available at <http://www.caiso.com/2848/2848983817680.pdf>)

for the ISO's Spinning Reserve requirement. For these reasons, we support the goal of the REM proposal, but favor a measured approach to its introduction. We also support symmetric treatment of these resources with other energy limited resources in the ISO control area and suggest a possible modification of the REM proposal that we believe achieves this goal.

In preparing this opinion, the MSC has discussed this topic at several Market Surveillance Committee meetings, most recently on November 19, 2010. In addition, individual MSC members have participated in conference calls and meetings with ISO staff, market participants, and state regulatory staff to discuss the REM proposal. Moreover, we reviewed the written comments provided by stakeholders on the REM proposal. We would like to acknowledge these entities for their very helpful input.

## **2. Reliability Implications of Providing Regulation from Energy Limited Resources**

A conventional generation resource providing RegUp is capable of providing more energy within a pre-specified range above its final energy schedule for that hour. A unit providing RegDown is capable of providing less energy than its final energy schedule for that hour. In either case, a conventional generator is generally capable of being dispatched at the full amount of RegUp or RegDown capacity for the entire hour when this is needed. Thus, there is no need for the ISO operators to make additional energy purchases in the real-time market in order for that generation unit to provide these services for the entire hour or for a longer period of time.

In contrast, for an energy-limited resource to provide Regulation Reserve, the real-time market must dispatch sufficient additional energy to maintain the operating point for the energy limited resource so that it can continue to be responsive to automatic generation control (AGC) signals for the entire operating hour. Moreover, this additional energy dispatched to maintain the operating point of the REM resource must be delivered from a unit able to inject energy into the transmission network, rather than simply from the lowest-priced offer during that dispatch interval. To the extent there is a deep real-time market for additional energy at locations in the grid where these energy-limited resources are located, there are unlikely to be reliability concerns associated with using REM resources to provide Regulation Reserve.

The following example illustrates how a conventional generation resource provides RegUp versus an energy-limited resource. A 100 MW generation unit that sells 10 MW of RegUp for the hour can be dispatched to provide RegUp (additional energy in response to AGC signals) in each of the twelve 5-minute intervals of the operating hour. With a final energy schedule of 80 MW, this 10 MW RegUp sale means that the unit could be operating between 80 MW and 90 MW anytime within the hour, depending on the AGC signals it receives. In contrast, an energy-limited resource needs not just the upward capacity to provide RegUp but also needs available potential energy to respond to AGC instructions within the hour. For conventional units, the potential energy to respond is always on hand in the form of fuel. An energy-limited storage unit needs to recharge in order to have the energy capability to deliver its full RegUp capacity on a sustained basis throughout the hour.

However, during the hours when a number of transmission paths are congested, there is a reduced likelihood that the necessary incremental energy from available generation units with unloaded capacity can be feasibly injected into the transmission network to maintain the operating points of all REM resources. The ISO operators may be unable to find enough feasibly located unloaded generation capacity that can be dispatched to provide the necessary energy to the REM units. For example, if a REM unit is located in a generation poor region, it may be the case that the additional energy necessary to maintain the operating point of the REM resource cannot be delivered to the node where the REM unit is interconnected.

Under these circumstances, a REM resource may be unable to provide energy for more than two or three 5-minute intervals without recharge. As a consequence, if there is a sustained need for RegUp resources, REM resources may not provide the same reliability benefit to the system as conventional resources. Such a sustained need would occur, if ever, only when the system is in a very highly stressed state, which is precisely, when RegUp resources are the most valuable. Although the ISO is confident that such episodes will rarely, if ever occur, there is an absence of analysis of high stress periods to confirm this. The analysis on the REM proposal submitted by the DMM on January 6, 2011 suggests that such high stress periods could occur.<sup>2</sup> A close examination of experience of the eastern ISOs with REM-type resources would also have been informative for determining when these high stress periods are likely to create reliability problems.

During stressed system conditions, it may also be unwise to rely on a significant amount of REM resources providing RegUp to reduce the ISO's Spinning Reserve purchases. If a large generation unit fails, then the ISO may need additional energy from the REM resources for a sustained period of time. However, unless there is a sufficient unloaded generation capacity able to inject additional energy in real-time to maintain the operating points of the REM resources, these resources cannot provide the necessary RegUp energy for a very long period time. When there is a limited amount of unloaded available generation capacity in the real-time market, there is a higher risk that an energy-limited resource may be unable to provide energy equal to the amount RegUp capacity sold for the remainder of the operating hour.

It is important to note that there is a tradeoff between using REM resources and just relying on generation resources to provide Regulation Reserve. The technologies that are most likely to provide REM resources, especially storage, will be able to ramp much more quickly than the thermal power plants that provide most Regulation Reserve. This rapid ramp capability is valuable to the system, and will become increasingly so as the penetration of intermittent renewable increases. Whether this makes REM resources on net more or less valuable to the system than more traditional sources of regulation is unclear.

Therefore we believe that it is worthwhile for the ISO to gain experience with significant quantities of REM resources in order to evaluate this question, and to

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<sup>2</sup> "Comments on Draft Final Proposal for Regulation Energy Management (REM)," Department of Market Monitoring, January 6, 2011 (available at <http://wepex.net/2afe/2afee17a2b670.pdf>)

determine whether additional safeguards are needed in case the limited energy storage available in REM resources proves to be a problem when the system is highly stressed. If it turns out that the fast-ramping REM capacity is more valuable for the system than Regulation Reserve from conventional generation resources as the amount of wind and solar penetration increases, while imposing insignificant risks to the system in terms of running out of energy for sustained RegUp generation, then consideration might eventually be given to creating a separate fast ramp regulation product that could also be substituted for regular ramp.

Because of these reliability challenges associated with using energy-limited resources to provide Regulation Reserve, a cautious approach to implementing the REM proposal would limit the risk of unintended negative consequences and maximize the opportunities to learn the costs and benefits of using energy-limited resources in this manner. This could be accomplished by stringent monitoring of the impact of using energy-limited resources to provide Regulation Reserve during the initial implementation stage of the REM proposal. There are three dimensions to this monitoring process.

The ISO should first compare the limits it places on the maximum amount of RegUp and RegDown an energy-limited resource owner can offer into the ISO's Regulation Reserve markets against the unit's actual performance providing Regulation Reserve at that level for the entire hour. The ISO should correlate this comparison with actual real-time system conditions to understand how the risk of Regulation Reserve shortfall from these units varies with real-time system conditions.

Second, the ISO should also monitor the how the aggregate amount of RegUp and RegDown capacity provided by all energy-limited resources for the entire hour compares to total amount sold from these units during that hour. Understanding how the inability to provide the total amount of Regulation Reserve sold from energy-limited resources during the hour varies both spatially and temporally should provide valuable feedback for the design of the mechanism for dispatching real-time energy to maintain sufficient energy in the these resources to provide the Regulation Reserve sold for the entire hour under all possible system conditions.

Finally, the ISO should also monitor the reliability implications of using energy-limited resources providing RegUp to displace the ISO's spinning reserve requirements. As noted earlier, under stressed system conditions with high levels of congestion it may not be possible for the ISO operators to obtain sufficient energy from the real-time market at the locations necessary to allow these resources to provide a product with the same reliability benefits as Spinning Reserve from a generation resource.

ISO should be ready to take action to modify the algorithm for dispatching additional energy from the real-time market to provide additional energy to the REM resources should any of these adverse reliability consequences occur. In the event, that this monitoring and dispatch algorithm modification is ineffective at address these reliability consequences, the ISO may want to consider putting more formal constraints on how and when energy-limited resources can provide Regulation Reserve.

### **3. Eliminating Potential Subsidies to Energy Limited Resources**

Energy-limited resources that are eligible to provide Regulation Reserve should be treated the same way as pre-existing energy limited resources such as pumped storage hydroelectric facilities. We understand there is some ambiguity in how these resources are treated relative to other energy-limited resources in the ISO control area such as pumped storage hydroelectric facilities or other storage facilities.

The REM proposal will require energy-limited resources to purchase to settle the energy they withdraw and inject at the appropriate real-time 5-minute price. This is similar to the requirement for pumped storage facilities. For example, consider a unit that purchases energy in the first 5-minute interval to maintain its operating point into the start of the third interval, and then uses that energy in the second interval to provide RegUp. In this case, the ISO proposal would require a purchase of energy at the 5-minute price in the first interval and sale at the 5-minute price in the second. We strongly support such treatment.

However, as discussed in Section 7.11 of the ISO proposal, such recharging “purchases” by REM resources would be exempt from uplift allocations to measured demand. We believe that the ISO should treat energy purchased by these units in the same manner as energy consumed by pumped storage units or energy consumed by a thermal generation unit. Computing net energy demand (total withdrawals less total injection) for the hour and charging uplifts based on the quantity of positive net demand would be consistent with how these uplifts appear to be handled for other energy-limited resources. We recognize that this change in the allocation of these uplift charges should not delay the implementation of the REM proposal, but the treatment of these charges should eventually be made consistent with how they are treated for other energy-limited resources in the ISO control area.

### **4. Concluding Comments**

We would like to reiterate our support for the intent of the ISO’s REM proposal. However, we believe that given coordination between the operation of the REM resources and 5-minute dispatch instructions in the ISO’s real-time market necessary to allow these resources to provide Regulation Reserve. A go-slow approach based on the three areas of stringent market monitoring described above is a prudent way forward to ensure a successful rollout of this product with limited risk of adverse consequences. To the greatest extent possible these resources should be treated symmetrically with existing limited energy resources in the settlement process to limit the potential for inefficient use of these resources to provide Regulation Reserve.

## **EXHIBIT C**

# Memorandum

**To:** ISO Board of Governors

**From:** Eric Hildebrandt, Director, Market Monitoring

**Date:** January 27, 2011

**Re:** **Market Monitoring Report**

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*This memorandum does not require Board action.*

## EXECUTIVE SUMMARY

This report provides comments and recommendations by the Department of Market Monitoring (DMM) on the regulation energy management proposal being presented to the ISO Board of Governors by Management at the February 3, 2011 meeting. The memo also provides an update on two market performance issues addressed in DMM's quarterly report for the fourth quarter of 2010.

- **Regulation energy management proposal.** The regulation energy management (REM) proposal will allow new energy-limited but fast-ramping storage technologies – such as batteries and flywheels – to be utilized for regulation services in the ISO system market. Over the next few years, the ISO expects limited amounts of these new storage technologies to be built and available for participation in the markets. However, these new technologies represent valuable potential system resources as increased reliance is placed on intermittent renewable resources. DMM believes the current proposal provides an adequate framework for integration of the relatively small quantity of REM capacity expected to participate in the regulation market initially, and the incremental rate at which additional capacity may be developed. This provides the ISO and potential developers of these resources with the opportunity to gain valuable experience operating these resources for regulation services in this initial phase. Key details of how the energy-limits of these technologies will be managed in the real-time market still need to be developed and refined as part of the implementation of this market enhancement. These include the extent to which these resources may be dispatched differently than conventional regulation resources and decision rules for re-charging these resources with energy from the real-time energy market. The ISO has indicated it will closely monitor the development and performance of regulation energy management resources and modify the regulation energy management requirements and design as appropriate.

This will allow the ISO and stakeholders to review and refine various market and operational elements as appropriate before the amount of REM capacity reaches significantly higher levels.

- **Real-time energy market performance.** In the fourth quarter of 2010, average prices in the 5-minute real-time energy market rose significantly above prices in the day-ahead and hour-ahead markets. Real-time prices were driven up by a significant increase in relatively short but extreme price spikes. Most of these high prices were attributable to relatively minor shortages of upward ramping capacity lasting no more than a few 5-minute intervals. These price spikes generally do not reflect an underlying shortage of total potential capacity and may be avoided by further modeling and dispatch improvements that increase the accuracy and flexibility of real-time dispatches. The ISO has been developing several such improvements that appear to have the potential to lower the frequency of such extreme price spikes. Implementation of several of these improvements has been delayed, but appears to be on track for implementation shortly before or after the implementation of convergence bidding on February 1, 2010. While convergence bidding may reduce the recent divergence of hour-ahead and real-time prices, DMM is recommending that the ISO continue to pursue modeling and operational enhancements as a more economically efficient means of reducing extreme price variations and divergences.
- **Multi-stage generating resources.** The ISO implemented functionality for multi-stage generating units on December 7, 2010. At this time, DMM has limited market and operating data upon which to assess the performance of this new market feature. A relatively limited number of generating units initially opted to participate as multi-stage generators. Several of these resources switched back to being operated as conventional generating units in the first month of this new market feature. More recently, however, numerous other generating units have opted to begin operating as multi-stage generating units, so that the overall number of units utilizing this new market enhancement has increased slightly since it was first implemented. Numerous refinements in the new software have been identified and are being initiated to address problems observed during this initial implementation period. DMM believes that a more meaningful assessment of this functionality can only be made after these refinements are fully implemented and unit owners gain more experience bidding and scheduling multi-stage generation units.

## REGULATION ENERGY MANAGEMENT

### *Background*

DMM recognizes the importance of facilitating integration of this type of non-traditional technologies into the market and the potential benefit those technologies can provide. The fast-ramping storage technologies the regulation energy management proposal is designed to promote – such as batteries and flywheels – represent particularly valuable potential system resources as increased reliance is placed on intermittent renewable resources.

Over the next few years, the ISO expects limited amounts of these new storage technologies to be built and available for participation in the markets. At this time, the potential revenues from participation in the ISO's regulation market do not appear to be a key driver of the overall economics of these new technologies. However, development of these storage technologies may reach significant levels over the longer term due to state policies to promote energy storage and renewable integration, and potential breakthroughs in technology costs.

It is important to note that some of the key operating characteristics of these new energy-limited storage resources are different than those of conventional generating resources around which the current ancillary services market has been designed and operated. On one hand, these resources are faster-ramping than conventional generators. However, these energy-limited resources will often need to be charged or discharged in the 5-minute real-time energy market in order to provide regulation in the same manner as conventional resources for a full hour. This will require development of new automated dispatch procedures or "smart algorithms" to take full advantage of their fast-ramping capabilities, while managing how these resources rely on the real-time market to be charged or discharge excess energy.

The relatively slow rate at which these new limited energy technologies are expected to be phased in over the next few years provides the ISO and potential developers of these resources with the opportunity to gain valuable experience operating these resources for regulation services during this initial phase. Based on this experience, the ISO can make any modifications that may be appropriate if the amount of this energy-limited storage capacity increases substantially.

### ***Regulation energy management proposal***

DMM has been very actively involved in the design and review of the regulation energy management proposal throughout the stakeholder process. Throughout this process, DMM has suggested numerous specific modifications and clarifications it feels would improve the proposal. DMM recommended several key modifications that have been incorporated in Management's final proposal. These include:

- **Settlement of imbalance energy.** Initially, the ISO proposed that regulation energy management resources would not be charged (or paid) for the amount of energy injected or extracted in the real-time energy market for regulation dispatches or the energy needed to maintain their state of charge. DMM noted that inefficiencies of limited energy resources typically range between 50 percent and 85 percent. The resulting 15 percent to 50 percent energy loss is the "fuel" that these resources use to provide the energy service and should therefore be charged for consuming that energy. Charging each REM resource for the net real-time energy costs incurred when charging and discharging will ensure that the true "operating cost" of alternative energy-storage technologies is factored into investment and market decisions. In addition, failure to recover these costs from regulation energy

management resources would result in uplift costs that would need to be charged to measured demand. The final proposal addresses this issue by settling each REM resource on the amount of energy injected/extracted during each interval.

- **Eligibility of conventional generating units for treatment as regulation energy management.** The initial proposal also allowed any resource the option of being treated as a regulation energy management resource. DMM questioned whether there was any potential rationale or benefit of allowing traditional thermal generating resources to choose to be treated as regulation energy management resources. This option seemed to conflict with the fundamental purpose of regulation energy management as a means of managing energy-limited resources differently so that they could provide regulation over an entire hour by being charged or discharged in the real-time energy market. As discussed in the following bullet, DMM also felt this provision could result in unintentional limitations being placed on the overall supply of regulation. The final proposal restricts the type of resources that can opt as regulation energy management to energy limited resources and does not allow traditional generators to participate as REM resources.
- **Limit on use of regulation energy management to meet regulation requirements.** The initial proposal included a 10 percent limit on the portion of regulation requirements that could be met by regulation energy management resources. This 10 percent limit was designed to enable operators to gain experience with regulation energy management resources, but limit the overall reliance placed on these resources. However, when combined with the provision allowing conventional generators to be treated as regulation energy management resources, DMM felt this 10 percent limit could have the unintended effect of restricting the overall supply of regulation resources. This could occur since traditional generators that opted to become regulation energy management capacity would only be allowed to provide up to 10 percent of regulation requirements, and would be removed from the pool of capacity available to meeting the remainder of the ISO's regulation requirements. DMM also felt the 10 percent limit was unwarranted at this time given that the ISO does not foresee the development of that level of regulation energy management resources over the next few years. The latest proposal eliminates the 10 percent limit, and includes a commitment by the ISO to monitor the development and performance of REM resources and modify the requirements and design as appropriate, based on this experience and the amount of regulation energy management resources that are actually developed.

### ***Further implementation details***

The need for management of regulation energy management resources by the ISO stems from the 15-minute energy requirement incorporated in the proposal. Resources meeting this requirement will only have enough stored energy to sustain their full regulation output for 15 minutes. In order to provide upward regulation in the same manner as conventional

resources for a full hour, these resources will often need to be charged from the real-time energy market. Similarly, to provide downward regulation in the same manner as conventional resources for a full hour, these resources will often need to discharge excess energy into the real-time energy market. In addition, these resources may be dispatched to provide more or less upward or downward regulation as conventional regulation resources in order to manage the level and timing of when these resources are charged with energy from the real-time market.

DMM's comments on the final draft proposal released in December 2010 centered on the details of the manner in which regulation energy management resources will be dispatched and managed by the ISO on a real-time basis. The final draft proposal provided a simple description and example of how the regulation dispatches and charging of regulation energy management resources with energy from the real-time market would be managed. Based on DMM's analysis of the example provided with the final draft proposal, DMM recommended that the ISO seek to develop more sophisticated algorithms or decision rules to determine when regulation energy management resources are dispatched for regulation and are charged from or supply energy to the real-time energy market.<sup>1</sup>

Depending on the specific details of these "smarter" dispatch procedures and initial operational experience, DMM also suggested that future refinements may be appropriate in the other aspects of the initial program design. These include possibly increasing the energy storage requirement per MW of regulation capacity being sold in the market (i.e., above the 15-minute requirement in the ISO's proposal) and modifying rules for when "no-pay" provisions in the tariff are applied to rescind payments for regulation services.<sup>2</sup>

In response to this analysis and recommendation, the ISO clarified that the example provided to stakeholders with the final draft proposal made simplifying assumptions of how regulation energy management resources would be dispatched and charged, and that development of the exact optimization algorithm to be used will be part of the implementation of regulation energy management and may change over time as the penetration of resources using REM increases or system conditions change.

DMM's understanding is that the ISO may manage regulation energy management resources by dispatching these resources for regulation differently than conventional regulation resources with the goal of optimizing the overall fleet of regulation resources. Also, the ISO has indicated it will develop additional details for determining the *real-time energy offset*, which is the amount of additional energy that will be dispatched (or reduced) in the real-time energy market to charge or discharge the regulation energy management resource in order to maintain its ability to provide regulation on a 5-second basis.

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<sup>1</sup> See *Comments on Draft Final Proposal for Regulation Energy Management (REM) Department of Market Monitoring*, January 6, 2011, <http://www.caiso.com/2afe/2afee17a2b670.pdf>.

<sup>2</sup> Ibid.

## ***Conclusions***

DMM feels that the current proposal provides an adequate framework for integration of the relatively small quantity of REM capacity that is expected to participate in the regulation market initially, and the incremental rate at which additional capacity may be developed. This provides the ISO and potential developers of these resources with the opportunity to gain valuable experience operating these resources for regulation services in this initial phase. The ISO has indicated it will monitor the development and performance of regulation energy management resources and modify the requirements and design as appropriate. Thus, the ISO and stakeholders will have time to review and refine various market and operational elements as appropriate before the amount of regulation energy management capacity reaches significantly higher levels.

Ultimately, if a significant amount of regulation energy management capacity is developed and/or the ISO determines it would be beneficial to have a new market for fast-ramping resources to facilitate renewable integration, a new product or different payment mechanism may be developed. This would provide a way to more explicitly recognize the differences between regulation energy management resources and conventional regulation resources, and incorporate these in resources requirements, system and market operations, and market pricing.

## **REAL-TIME ENERGY MARKET PERFORMANCE**

### ***Divergence of hour-ahead and real-time prices***

The consistency of prices across the ISO energy markets is a key measure of overall market efficiency. A high degree of price consistency – or price convergence – is an indication that resource commitment and dispatch decisions are being optimized across the markets within the ISO, as well as between the ISO and neighboring control areas. Also, as discussed in DMM's previous quarterly reports, when net imports are decreased in the hour-ahead scheduling process at relatively low prices and additional incremental energy is then purchased in the 5-minute real-time market at higher prices, this can also create substantial uplifts that must be recovered from load-serving entities through the real-time imbalance energy offset charge.

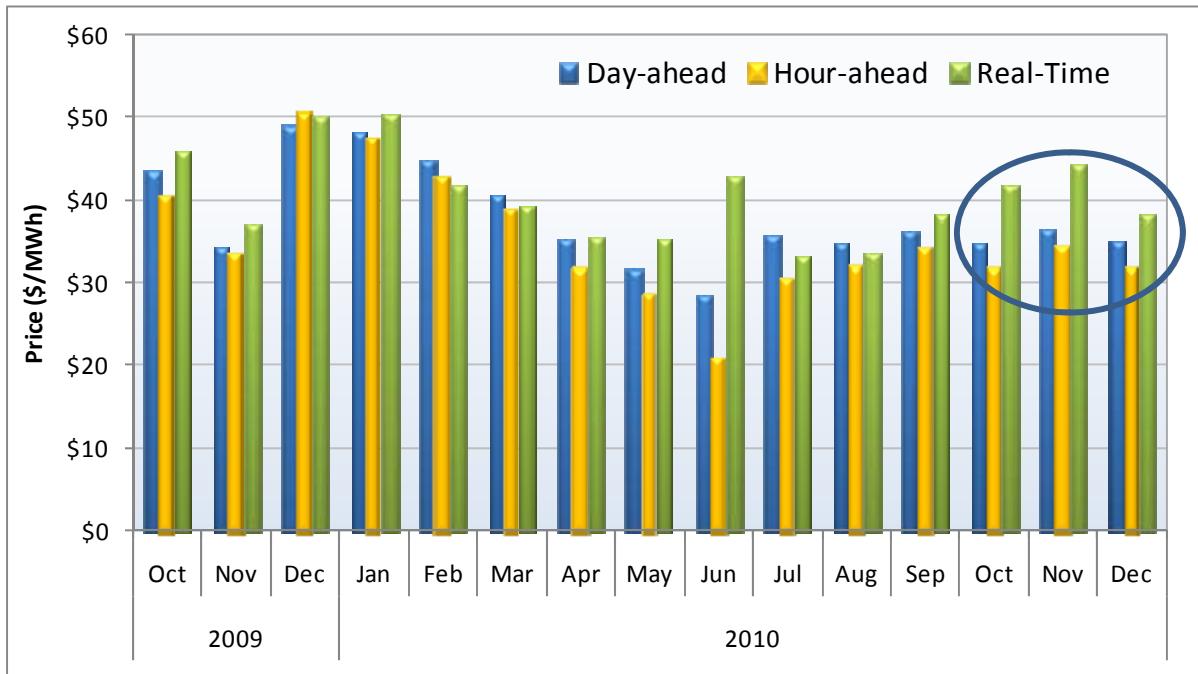
Since 2009, DMM has identified price divergence between the hour-ahead and 5-minute real-time markets as one of the most critical areas for further improvement in the new market software and processes. DMM's quarterly reports for the third and fourth quarters of 2010 have focused heavily on a continuing trend of relatively low prices in the hour-ahead scheduling process for imports and exports, followed by higher average prices in the 5-minute real-time market.<sup>3</sup> In the fourth quarter of 2010, average prices in these markets

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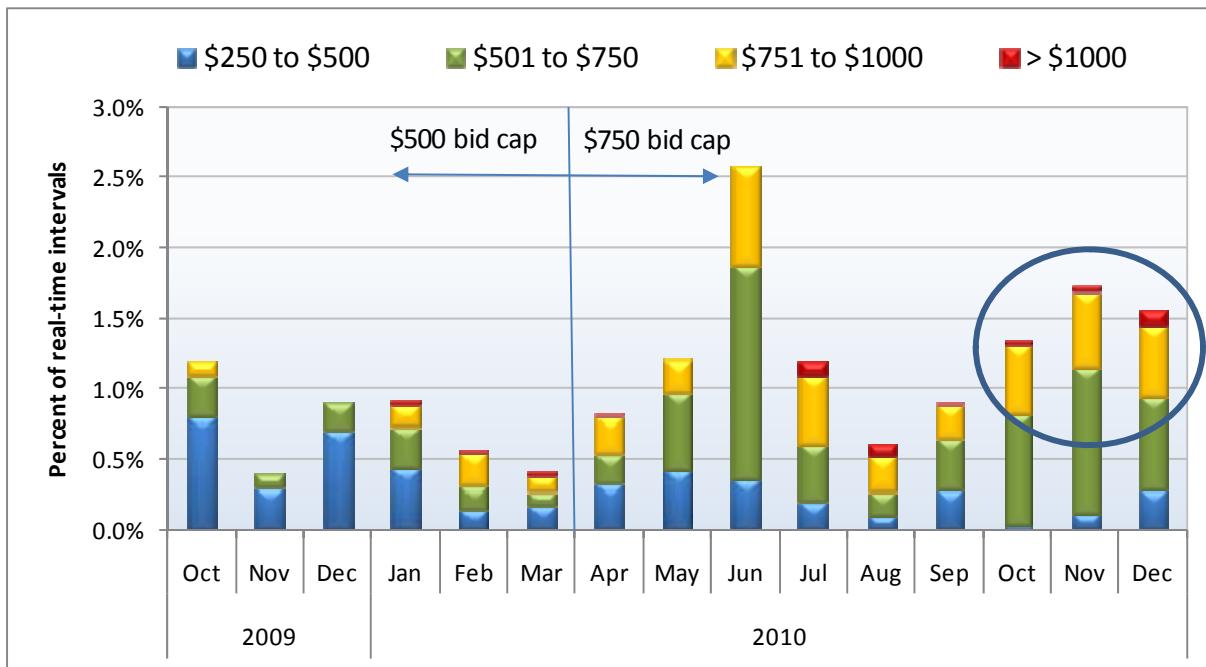
<sup>3</sup> *Quarterly Report on Market Issues and Performance*, Department of Market Monitoring, November 8, 2010, <http://www.caiso.com/2848/2848983817680.pdf>.

diverged even more significantly due to an increase in average prices in the 5-minute real-time energy market (see Figure 1).

**Figure 1. Monthly Average Prices (PG&E Area)**



**Figure 2. Frequency of Price Spikes (All LAP Areas)**



The increase in average real-time energy market prices in the fourth quarter of 2010 was driven by a significant increase in relatively extreme price spikes near or above the \$750/MWh bid cap. As summarized in Figure 2, these price spikes occurred less than 1.5 percent of hours. Without these extreme price spikes, average prices in the real-time market would have tracked very closely with the average hour-ahead prices shown in Figure 1. Average real-time prices would also have been slightly lower than average day-ahead prices if these extreme price spikes did not occur during these few intervals.

Most of the high real-time price spikes lasted no more than a few 5-minute intervals and were attributable to relatively minor short-term shortages of upward ramping capacity. For example, about three-fourths of price spikes due to shortages of upward ramping capacity persisted for only one to three consecutive 5-minute intervals (or five to 15 minutes).

One major factor that tends to create shortages of ramping capacity is the fundamental discrepancy between the 15-minute intervals used in the hour-ahead scheduling and 15-minute pre-dispatch, and the 5-minute dispatch intervals used in the real-time market. For example, schedules produced by these 15-minute processes may be optimal on a 15-minute basis, but not provide for sufficient ramping capabilities needed to balance loads and generation during the three 5-minute intervals within this 15-minute period.

The other major factor contributing to short-term shortages of ramping capacity is that actual conditions in the 5-minute market inevitably vary from projections of future conditions made in the hour-ahead scheduling process used to schedule imports and exports and the 15-minute pre-dispatch process used to commit short-start peaking resources. For example, specific factors observed to have caused or contributed to significant changes in imbalance energy needs between these scheduling processes and actual real-time conditions include the following:

- Differences between the load forecasts used in the hour-ahead and 15-minute pre-dispatch process and actual loads in the 5-minute real-time dispatch;
- Manual adjustments to these load forecasts, which may sometimes exacerbate price spikes by increasing load forecast differences or creating sudden changes in forecasted loads;
- Variable energy resources delivering more or less than forecast;
- Resources shutting down without sufficient notice;
- Contingency events, such as unit or transmission outages; and
- During some periods, high hydro run-off which decreases resource flexibility.

Thus, in most cases, these price spikes do not reflect an underlying shortage of total potential capacity and may be avoided by further modeling and dispatching improvements that increase the accuracy and flexibility of the hour-ahead and 15-minute pre-dispatch process.

### ***Initiatives to improve price convergence***

The ISO is implementing several key measures aimed at improving the consistency of hour-ahead and real-time prices and reducing the incidence of ramping capacity shortages in the 5-minute market. Implementation of several of these measures was planned in early 2010 and have been delayed, but many of these measures now appear close to final implementation. An update on these items are provided below:

- **Improving the forecast used in the hour-ahead and 15-minute pre-dispatch processes.** As previously noted, the ISO is continuing development of a new short-term forecasting tool designed to provide a more accurate and consistent forecast for both the hour-ahead scheduling process and the real-time market. Implementation of this new forecasting tool was anticipated in 2010, but is now scheduled for February 2011.
- **Providing improved guidance to the operators regarding manual load adjustment practices.** The ISO has indicated it is seeking to improve how and when to adjust or *bias* the load forecasts used in the hour-ahead and 5-minute real-time markets. As part of this effort, the ISO has provided additional training and guidance on use of load adjustments by market operators. The ISO is also developing a more systematic procedure that gives operators additional guidance to determine whether a load adjustment should be removed or continued. In addition, implementation of the new load forecasting tool should reduce the need for such manual adjustments.
- **Accounting for inter-tie ramping requirements in the hour-ahead scheduling process.** This enhancement will modify the hour-ahead scheduling process to account for ramping energy needed from the 5-minute real-time market to adjust to changes in the net import and export schedules each hour. This enhancement was implemented from December 3 until December 23, 2010, but was suspended in order to refine the rules for how this constraint impacts prices used to settle imports and exports when it is binding. The ISO anticipates this feature will be reactivated by February 2011.
- **Adding a new flexible ramping capacity constraint.** In early 2011, the ISO is seeking to implement a new *flexible ramping constraint* in the hour-ahead 15-minute pre-dispatch process. The flexible ramping constraint will explicitly require that the software optimization results include a pre-specified amount of additional ramping capacity (beyond levels needed to simply meet the energy forecast). This new constraint is designed to ensure that sufficient upward and downward ramping capability from 5-minute dispatchable resources is committed and available to balance loads and supply on a 5-minute basis, taking into account the potential variability in actual system conditions. When applied in the hour-ahead process, this constraint may cause the level of net imports to be better aligned with internal ramping energy needs. When applied in the 15-minute pre-dispatch process, this

constraint may trigger commitment of additional fast start units when additional upward ramping capacity is needed.

- **Unit start-up profiles.** Currently, when a generating unit is scheduled to start up, the market software does not account for the energy generated while the unit is ramping up to its minimum load level. On a system-wide basis, this can create several hundred megawatts of unscheduled energy during the early morning hours. Operators currently seek to compensate for this through manual load adjustments. The ISO is developing software enhancements to explicitly model the unscheduled energy expected from units starting up. The ISO expects to implement this enhancement in the second quarter of 2011.
- **Adaptive control enhancements.** The ISO has a mid-term initiative in 2011 to develop adaptive control enhancements that will explicitly predict and account for other various specific sources of uninstructed deviations. A simpler feature incorporated in the new market software to account for uninstructed deviations is currently disabled due to performance issues. Currently, operators must make adjustments, as appropriate, for uninstructed deviations through use of manual load biases.

DMM believes each of these initiatives represent important steps that will help reduce extreme price spikes due to short-term shortages of ramping capacity, which in turn will help promote convergence of average hour-ahead and real-time prices. DMM recommends that the ISO continue to seek to address the root causes of price divergence directly through these types of modeling and operational improvements even after the implementation of convergence bidding in February. Convergence bidding may reduce the recent divergence of hour-ahead and real-time prices. However, such modeling and operational enhancements are more economically efficient means of reducing extreme price variations and divergences.

## MULTI-STAGE GENERATING UNITS

The ISO implemented functionality for multi-stage generating units starting on December 7, 2010. At this time, DMM has limited market and operating data upon which to assess the performance of this new market feature. However, initial monitoring results indicate the following:

- Due to the uncertainties associated with this new market feature, only 11 generating units (representing 4,556 MW of total capacity) chose to operate as multi-stage generating units when this software was implemented. Several major combined cycle generating units switched back to being modeled as single configuration generation units within the first month of this new market feature. More recently, however, numerous other resource have opted to begin operating as multi-stage generating units, making the overall number of units utilizing this new market enhancement slightly higher than when it was first implemented.

- In some cases, it appears that performance of this new functionality from the perspective of generating unit owners may be improved as unit owners learn how to adjust bids for energy and the costs of starting up and transitioning between different unit configurations.
- Issues with the functionality have led to a notable increase in exceptional dispatches and blocked dispatch instructions for resources operating as multi-stage generating units. In most cases, these exceptional dispatches appear to be issued to “override” a dispatch from the market software in order to transition a unit to a new configuration or to keep the unit in its current configuration.
- Bid cost recovery payments appear to have increased somewhat for resources operating as multi-stage generating units. Final settlement data for these payments are not available at this time.
- Numerous refinements in the new software have been identified and initiated to address issues observed during this initial implementation period. The number of new software issues that have been identified appears to be dropping significantly.

As the ISO refines this new software functionality and participants gain more experience bidding and scheduling as multi-stage generating units, DMM notes that performance of this new market feature could improve. Over the longer run, there are several measures that will provide an indication as to how well this market feature is working:

- The frequency of exceptional dispatches and blocked dispatch instructions issued for multi-stage generating resources. To the extent the market dispatch improves as a result of this functionality, we would expect to see less frequent need for manual intervention to control these units.
- The frequency with which generation owners utilize the ISO’s outage management system (SLIC) to manage start-up, shut-down, and configuration changes by entering temporary adjustments to their unit operating characteristics. The need for such adjustments should be decreased for multi-stage generation units.
- A decrease in self-scheduling would provide an indicator that this feature is committing, de-committing, and dispatching multi-stage generating resources in a fashion consistent with what the resource schedulers believe is profitable, efficient, and consistent with their units’ operational capabilities and requirements.
- Bid-cost recovery payments made to multi-stage generating resources. Higher bid-cost recovery payments to multi-stage generating resources after implementation could indicate that resources were subject to uneconomic commitment or dispatch more than before implementation of this functionality.

- Feedback from the resource schedulers that they have observed commitment and dispatch among the resource configurations is profitable, efficient, and consistent with their unit's operational capabilities and requirements. One of the key forms of this type of feedback may be the number of units that eventually choose to operate as multi-stage generating units.

The ISO has committed to monitoring the impacts and effectiveness of the multi-stage generating units. DMM will also seek to provide an assessment of this new market feature in future market reports.