

December 5, 2016

The Honorable Kimberly D. Bose  
Secretary  
Federal Energy Regulatory Commission  
888 First Street, NE  
Washington, DC 20246

**Re: California Independent System Operator Corporation  
Docket No. ER17-\_\_\_\_\_ -000  
Reactive Power Requirements – Automatic Voltage Regulator Systems**

Dear Secretary Bose:

The California Independent System Operator Corporation (CAISO) submits this filing to revise its tariff rules regarding automatic voltage regulation for resources providing reactive power capability.<sup>1</sup> The CAISO requests that the Commission issue an order accepting the tariff revisions contained in this filing by March 6, 2017, and make them effective as of that date.

## **I. Introduction**

Most generators include a device known as an automatic voltage regulator to control their output voltage. This device regulates plant level voltage automatically, by controlling voltage to a scheduled level. By using this device, resources interconnected to the CAISO grid can help maintain voltage schedules provided by transmission operators and avoid the costs associated with equipment damage and outages that may arise from voltage deviations at their facilities. Automatic voltage regulators are standard equipment for synchronous resources, but inverter-based technologies supporting asynchronous resources such as solar photovoltaic or wind resources can also incorporate voltage control capabilities.<sup>2</sup> As the Commission has recognized, a large volume of asynchronous resources have interconnected or will seek to interconnect to the CAISO grid, creating the

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<sup>1</sup> The CAISO submits this filing pursuant to Section 205 of the Federal Power Act, 16 U.S.C. § 824d, and Section 35.13 of the Commission's regulations, 18 C.F.R. § 35.13. Capitalized terms not otherwise defined herein have the meanings set forth in Appendix A to the CAISO tariff.

<sup>2</sup> See North American Electric Reliability Corporation Essential Reliability Services Task Force Concept Paper dated October 2014 at pp. 11-12.  
<http://www.nerc.com/comm/Other/essntlrbltysrvscstskfrcl/ERSTF%20Concept%20Paper.pdf>

See also *A Grid Friendly Plant*, IEEE Power & Energy Magazine May/June 2014 at pp. 87-95.  
<http://magazine.ieee-pes.org/files/2014/04/12mpe03-morjaria-2302221.pdf>

potential for a deficiency in reactive power.<sup>3</sup> In this filing, the CAISO proposes tariff revisions to clarify technical requirements associated with automatic voltage regulators for resources providing reactive power capability. These requirements are consistent with reliability standards of the North American Electric Reliability Corporation (NERC) and Western Electric Coordinating Council (WECC). These technical requirements will also help ensure that resources operate to support voltage schedules. The Commission should accept the CAISO's tariff revisions without modification.

## II. Background

The CAISO commenced a stakeholder process to examine reactive power requirements for asynchronous resources in 2015. The scope of the initiative included, *inter alia*, examining a uniform requirement for asynchronous resources to provide reactive power capability and voltage regulation. In late 2015, the CAISO suspended this initiative pending the outcome of the Commission's rulemaking on reactive power requirements for non-synchronous generators.<sup>4</sup> On June 16, 2016, the Commission issued Order No. 827, requiring all newly interconnecting non-synchronous generators to provide reactive power capability. Order No. 827 also requires existing non-synchronous generators making upgrades to their facilities to provide reactive power if the CAISO finds through an interconnection study that reactive power is necessary to ensure the safety and reliability of the electric grid.<sup>5</sup>

As part of the rulemaking proceeding leading to Order No. 827, the CAISO encouraged the Commission to allow transmission providers to propose additional technical requirements for interconnecting non-synchronous generators related to voltage support, such as requiring automatic voltage control.<sup>6</sup> In response, the Commission stated, "transmission providers may propose additional technical requirements, to the extent they believe such requirements are necessary, in a separate filing pursuant to section 205 of the Federal Power Act."<sup>7</sup> This tariff amendment filing represents the CAISO's effort to adopt

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<sup>3</sup> *Reactive Power Requirements for Non-Synchronous Generation*, 155 FERC ¶ 61,277 (2016) (Order No. 827) at P 4 and fn 8. The CAISO has referred to asynchronous resources in this initiative while FERC uses the term non-synchronous resources in Order 827. Both terms refer to resources connected to the bulk power system through power electronics, but do not produce power at system frequency (60 Hz). These resources do not operate in the same way as traditional generators and respond differently to network disturbances. See, Order 827 at P 10 and fn 24.

<sup>4</sup> See generally *Proposal to Revise Standard Generator Interconnection Agreements re Reactive Power Requirements for Non-Synchronous Generation* under RM16-1, dated November 19, 2105. <http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14049832>

<sup>5</sup> The CAISO has submitted a compliance filing with Order No. 827 in Commission Docket No. ER17-114. That filing remains pending before the Commission.

<sup>6</sup> Order 827 at P 70.

<sup>7</sup> *Id.*

additional technical requirements not addressed in Order No. 827 that the CAISO believes are necessary to ensure resources providing dynamic reactive power support can automatically control voltage.

In August 2016, the CAISO completed its reactive power requirements stakeholder process. On August 31, 2016, the CAISO's Board of Governors authorized the CAISO to propose requirements that non-synchronous generators providing dynamic reactive support install automatic voltage control capability. This capability is necessary for a resource to automatically maintain scheduled voltage at a reference point, such as the high side of the station step-up transformer bank. The CAISO has included copies of the materials presented to the CAISO's Board of Governors and a record of the Board's vote as part of Attachment A hereto.

### III. Proposed Tariff Amendments

The proposed tariff revisions clarify technical requirements associated with automatic voltage regulators for resources providing reactive power capability.<sup>8</sup> Specifically, the CAISO proposes to clarify that a generating unit (either synchronous or asynchronous) providing reactive support to the CAISO grid must be under the control of automatic voltage regulators at all times and will operate in voltage regulation mode.<sup>9</sup> Currently, the CAISO tariff provides that a generating unit providing voltage support must be under the control of generator automatic voltage regulators throughout the period during which the generating unit must provide voltage support. The proposed change clarifies the CAISO's expectation that resources will automatically control voltage when they are providing reactive support and the mode in which they will operate their automatic voltage regulators.

These requirements align with NERC Reliability Standard VAR-002-4, which generally provides that a generator operator shall operate each generator connected to the interconnected transmission system in the automatic voltage control mode with its automatic voltage regulator in service.<sup>10</sup> These requirements are also consistent with WECC Reliability Standard VAR-002-WECC-2. This standard provides, with limited exceptions, that synchronous generators and condensers connected to the bulk electric system shall have automatic voltage regulation in service and operate in automatic voltage

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<sup>8</sup> The CAISO also proposes to delete text in the header of section 8.4.1.3 that specified an effective date of existing tariff language in this section. The CAISO proposes a similar change to tariff section 8.4.1.2 because this subsection is part of the same eTariff record as subsection 8.4.1.3.

<sup>9</sup> See proposed revision to tariff section 8.4.1.3. The CAISO has included revised tariff sheets in clean and red-lined format in Attachments B and C hereto.

<sup>10</sup> NERC Reliability Standard VAR-02-004, Requirement 1.  
<http://www.nerc.com/layers/PrintStandard.aspx?standardnumber=VAR-002-4&title=Generator%20Operation%20for%20Maintaining%20Network%20Voltage%20Schedules>

control mode 98 percent of all operating hours.<sup>11</sup> The CAISO's tariff language recognizes that a generating unit may not provide reactive support at all times, but it requires a generating unit to have its automatic voltage regulator in service when it is doing so. By having its automatic voltage regulator in service, a generating unit can maintain voltage schedules in order to protect equipment and maintain reliable operation of the electric grid.<sup>12</sup>

The CAISO tariff revisions also clarify that a generating unit with an automatic voltage regulator must automatically control the net reactive power of the generating unit to regulate to the scheduled voltage as assigned by the participating transmission owner or the CAISO, within the constraints of the reactive power capability of the generating unit. The purpose of this language is to make clear that resources need only control voltage within the design of their facilities, *i.e.* consistent with their power factor range at the specific point of measurement.

As a general matter, participating transmission owners issue voltage schedules at substations to which participating generators must adhere.<sup>13</sup> These resources must be able to move within their power factor range in order to maintain those voltage schedules. A generator (either synchronous or asynchronous) maintains a scheduled voltage by adjusting its reactive power injection or absorption. For example, a generator can generally increase the voltage at an electrical substation by injecting reactive power into the substation. Conversely, a generator can lower the voltage at a substation bus by absorbing reactive power. The generator's automatic voltage regulator will automatically adjust the injection or absorption of the generator's reactive power in order to maintain the scheduled voltage. The automatic voltage regulator will not allow the generator to provide or absorb reactive power beyond the preset limits identified by the power factor range. During the course of a day, the actual voltage at a given substation continually fluctuates as the loading on transmission equipment and demand on the system changes. The voltage regulator automatically adjusts the reactive power of the generating unit, within its power factor capability, to maintain a scheduled voltage, thus supporting stable voltages independent of other changes on the grid.

The proposed tariff revisions ensure resources can provide voltage support but do not require the resource to perform beyond the capabilities of their facilities as established in their interconnection agreements.<sup>14</sup> Instead, the proposed tariff revisions merely clarify that resources must have the capability to control voltage automatically. By way of

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<sup>11</sup> WECC VAR-002-WECC-2, Requirement 1.  
[http://www.nerc.com/\\_layouts/PrintStandard.aspx?standardnumber=VAR-002-WECC-2&title=Automatic%20Voltage%20Regulators%20\(AVR\)](http://www.nerc.com/_layouts/PrintStandard.aspx?standardnumber=VAR-002-WECC-2&title=Automatic%20Voltage%20Regulators%20(AVR))

<sup>12</sup> See VAR-002-4 — Generator Operation for Maintaining Network Voltage Schedules, Purpose.

<sup>13</sup> See CAISO tariff section 8.2.3.3. The CAISO may also issue these schedules, if necessary.

<sup>14</sup> See CAISO tariff 8.2.3.3.

example, a participating transmission owner will issue voltage schedules at a substation. Resources interconnected to that substation will need to control voltage within the constraints that apply to the resource. In the case of an asynchronous resource subject to the requirements of Order No. 827, the resource will need to control voltage at the substation remotely compensating for any impedance between the high side of the resource's step-up transformer and the resource's point of interconnection. The resource will need only to control reactive power within the constraints of the facility, *i.e.* design requirements to provide 0.95 leading/lagging reactive power capability at the high side of the step up transformer.

The CAISO also proposes to prohibit a generating unit from disabling voltage regulation controls while the unit is operating, without the permission of the CAISO. This is consistent with existing CAISO tariff language applicable to asynchronous resources that prohibits the resource owner from disabling power factor equipment while the asynchronous generating facility is in operation.<sup>15</sup> In response to stakeholder input, the CAISO proposes to apply this requirement to all resources providing reactive support pursuant to tariff section 8.4.1.3.

Finally, the CAISO proposes to clarify that for asynchronous resources, the requirements of section 8.4.1.3 apply to asynchronous generating facilities required to provide reactive power capability pursuant to the requirements of FERC Order No. 827. The requirements of Order No. 827 require that newly interconnecting asynchronous resources provide dynamic reactive power, which requires a resource to respond automatically to voltage fluctuations. An automatic voltage regulator normally controls dynamic power flow from a resource. As a result, these resources will need to install automatic voltage regulators. Although existing asynchronous resources may have reactive power capability requirements set forth in their applicable interconnection agreements, the CAISO's tariff change ensures that on a going forward basis asynchronous resources install and operate automatic voltage regulators in a manner similar to other resources. The CAISO's proposed language is consistent with stakeholder feedback that the technical requirements it is proposing should only apply to asynchronous resources on a going forward basis.

#### **IV. Stakeholder Process**

As referenced above, the CAISO conducted a stakeholder process during 2015 and 2016 to examine reactive power requirements for asynchronous resources.<sup>16</sup> The CAISO received numerous comments from stakeholders regarding whether the CAISO should apply uniform reactive power requirement to asynchronous resources and whether the

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<sup>15</sup> See Appendix BB to the CAISO tariff, Appendix H, Section A.iii.

<sup>16</sup> Information and materials regarding the CASIO's stakeholder process is available at the following website: <http://www.caiso.com/informed/Pages/StakeholderProcesses/ReactivePowerRequirements-FinancialCompensation.aspx>

CAISO market should compensate resources for installing reactive power capability or providing reactive power. The CAISO received only a few comments concerning automatic voltage regulation. Where appropriate, the CAISO changed its tariff language to address those comments.

**A. The proposed automatic voltage regulation requirements will treat synchronous and non-synchronous resources comparably**

In response to stakeholder concerns that the CAISO should treat asynchronous resources comparably to synchronous resources, the CAISO has drafted its technical requirements in a manner that applies generally to all resources when they are providing reactive support. The proposed technical requirements align with existing Reliability Standards and should not provide a problem for their interconnection agreements. In response to another stakeholder comment, the CAISO revised the proposed tariff provisions to state that the requirements in section 8.4.1.3 will apply only to those asynchronous generating facilities subject to the requirements of Commission Order No. 827. This ensures that existing asynchronous resources do not face new technical requirements because of these tariff changes. For existing asynchronous resources that already provide reactive support that may not be dynamic, the terms of their interconnection agreements will continue to apply. Asynchronous resources subject to the requirements Order No. 827 must provide dynamic reactive support, which will necessitate an automatic voltage regulator.

**B. The CAISO is not proposing to compensate resources to install and operate automatic voltage regulators**

One stakeholder raised a concern that the CAISO's proposal does not compensate resources for the additional costs to install and operate automatic voltage regulators. The CAISO undertook an extensive discussion with stakeholders about whether the CAISO market should compensate resources for installing reactive power capability. The CAISO determined that it was not appropriate to propose tariff revisions to compensate resources for installing equipment necessary to provide reactive support. In the CAISO's balancing authority area, resources generally recover the fixed costs of their plant as part of financing their project and cover the costs of financing through power purchase agreements. Installing automatic voltage regulators is included in that cost.

The CAISO currently does not generally compensate resources for the capability to provide reactive power capability and does not propose to do so in this tariff amendment filing. The CAISO continues to believe that providing reactive power constitutes good utility practice. In Order 2003, the Commission adopted a standard power factor requirement of 0.95 leading to 0.95 lagging for large synchronous generators "because it is a common practice in some NERC regions."<sup>17</sup> At the time, NERC advocated that the Commission

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<sup>17</sup> See *Standardization of Generator Interconnection Agreements and Procedures* 104 FERC ¶ 61,103 (2003) ("Order 2003") at P 542 <http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=9746398>

require power factor capabilities to be within a range required by good utility practice. The CAISO's current tariff follows this approach. The Commission has not required that transmission providers implement payments for the capability to provide reactive support, including installing automatic voltage regulators, except if they compensate their own or affiliated generators for this capability.

In Order No. 827, the Commission did not to change the Commission's existing policies on compensation for reactive power.<sup>18</sup> In the CAISO's balancing authority area, resources have the opportunity to capitalize fixed costs and recover those costs through power purchase agreements, including the cost of installing an automatic voltage regulator when they construct their facilities. Accordingly, there does not appear to be a valid reason to create a separate administrative payment stream from the CAISO market to compensate resources for the capability to install automatic voltage regulators in order to provide reactive support.

**C. The CAISO will amend its Business Practice Manual to include guidance for implementing the proposed tariff rules**

During the CAISO's stakeholder initiative, some parties raised questions regarding implementation proposed requirements for automatic voltage regulators. One stakeholder requested that the CAISO explain how generators should operate their automatic voltage regulators if the voltage regulation mode were not available. The CAISO expects all resources to operate in voltage regulation mode. This approach is consistent with NERC Reliability Standard VAR-002-4. The CAISO, however, is developing guidance for resources regarding operation of automatic voltage regulators when a resource's automatic voltage regulator cannot operate in voltage regulation mode. The CAISO would have to evaluate each situation independently and could elect to have the generating unit operate at a constant power factor or maintain a constant MVAR output during the time the automatic voltage regulator is out of service.

Another stakeholder expressed concerns regarding multiple resources using the same generator tie line that may "hunt" to control voltages. Multiple resources in close electrical proximity can cause unstable voltage control when their controls are not coordinated. Uncoordinated voltage control can also surface when two or more resources share a common generation tie and attempt to regulate voltages. This issue exists today and does not result from the tariff changes the CAISO is proposing. The CAISO has committed to work with interconnection customers to coordinate this issue and ensure each resource coordinates operation of their automatic voltage regulators. Specifically, the CAISO plans to allow interconnection customers the flexibility to develop a control scheme to utilize a voltage droop function with necessary supervisory control to allow reactive power sharing among resources. Interconnection customers can work together and elect to control scheduled voltage at a common station with other plant-level reactive support

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<sup>18</sup> Order No. 827 at P 52.

equipment. The CAISO plans to describe the procedures to address this issue in its Business Practice Manuals.

## **V. Effective Date**

The CAISO requests that the Commission issue an order accepting the proposed tariff amendments by March 6, 2017 and make the tariff revisions effective as of that date. This effective date will provide sufficient time for the CAISO to work with participating generators and interconnection customers to understand the proposed requirements and complete any necessary changes to the CAISO's Business Practice Manuals.

## **VI. Communications**

Pursuant to Rule 203(b)(3), 18 C.F.R. § 385.203(b)(3), please provide communications regarding this filing to the following individuals, whose names should appear on the official service list established by the Commission with respect to this submittal:

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Deputy General Counsel  
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## **VII. Service**

The CAISO has served copies of this transmittal letter, and all attachments, on the California Public Utilities Commission, the California Energy Commission, and all parties with effective scheduling coordinator service agreements under the CAISO tariff. In addition, the CAISO is posting this transmittal letter and all attachments on its public website.



### **VIII. Attachments**

The following attachments, in addition to this transmittal letter, support the instant filing:

Attachment A	August 2016 Board of Governors' Materials
Attachment B	Revised CAISO tariff sheets that incorporate the proposed changes described above
Attachment C	The proposed changes to the CAISO tariff show in red-line format

### **IX. Conclusion**

The CAISO requests that the Commission accept the proposed tariff revisions without modification. These amendments will advance reliable operation of the grid to ensure resources providing reactive power capability have the means to control voltage schedules. Please contact the undersigned if you have any questions regarding this matter.

Dated: December 5, 2016

Respectfully submitted,

**By: /s/ Andrew Ulmer**

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**Attachment A – Materials Presented to Board of Governors**  
**Reactive Power Requirements – Automatic Voltage Regulator Systems**  
**California Independent System Operator Corporation**



# Memorandum

**To:** ISO Board of Governors

**From:** Keith Casey, Vice President, Market and Infrastructure Development

**Date:** August 24, 2016

**Re:** **Decision on reactive power requirements for non-synchronous generators**

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*This memorandum requires Board action.*

## EXECUTIVE SUMMARY

This memorandum presents Management's proposed tariff changes resulting from the reactive power requirements for non-synchronous generators and financial compensation policy initiative. The ISO proposes to apply a uniform requirement for non-synchronous generators to provide reactive power capability as a condition of interconnection. Management suspended this stakeholder initiative in November 2015 in light of a Federal Energy Regulatory Commission rulemaking on reactive power requirements for non-synchronous generators.<sup>1</sup> On June 16, 2016, FERC issued Order No. 827, requiring all newly interconnecting non-synchronous generators to provide reactive power capability. Order No. 827 also requires existing non-synchronous generators making upgrades to their facilities to provide reactive power if the ISO finds through an interconnection study that reactive power is necessary to ensure the safety and reliability of the electric grid. The ISO will submit a compliance filing in October 2016.

In addition, in previous orders FERC has requested that the ISO look into a market based mechanism for compensating resources for providing reactive power. As a result, this initiative addressed two issues: additional technical requirements for non-synchronous generators providing reactive power that were not included in FERC Order No. 827 and the ISO's rules for reactive power compensation. Specifically, Management seeks authority to require non-synchronous generators to install automatic voltage control, which is necessary for generators providing reactive power to maintain voltage schedules.

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<sup>1</sup> The ISO has also referred to "asynchronous resources" in its policy initiative. FERC uses the term non-synchronous generators in Order No. 827. Both terms refer to resources connected to the bulk power system through power electronics, but that do not produce power at system frequency (60 Hz). These resources include solar photovoltaic, wind resources and battery storage.



Management has also determined that the ISO's current compensation method is consistent with the provisions of Order No. 827 and remains appropriate. Therefore, Management is not proposing any changes to the financial compensation for reactive power and voltage support at this time.

Management recommends the following motion:

***Moved, that the ISO Board of Governors approves the proposed revisions for reactive power requirements for non-synchronous generators, as described in the memorandum dated August 24 2016; 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.***

## DISCUSSION AND ANALYSIS

### ***Technical Requirements***

The ISO will comply with Order No. 827 through the adoption of uniform requirements for non-synchronous generators to provide reactive power capability and voltage regulation. In addition, Management proposes to request authority under Section 205 of the Federal Power Act to require non-synchronous generators providing reactive support to install automatic voltage control capability. Generators must be able to move within their required power factor range to maintain voltage schedules, which requires automatic voltage control regulator systems.

### ***Financial Compensation***

In response to FERC directives regarding compensation methods for reactive power, Management explored alternative methods of compensation, including mechanisms to compensate generators for both the capability and provision of reactive power. Management has concluded that the ISO's current tariff provisions for reactive power compensation are consistent with Order No. 827, which does not change FERC's existing policy on compensation for reactive power. This policy requires transmission providers to compensate an interconnecting generator for reactive power service when the transmission provider requests that the interconnecting generator operate outside of the specified reactive power range. This policy also provides that if the transmission provider compensates its own or affiliated generators for reactive power service within



the specified reactive power range, it must compensate all generators for this service, and at what rate such compensation should be provided.

The tariff provides for compensation for the provision of reactive power outside of a standard required range when the ISO asks generators to reduce their real power output. In these circumstances, which are extremely rare, the ISO compensates generators for their lost opportunity costs of providing energy. Because the current compensation methods are already compliant with Order No. 827, and the proposed requirements impose minimal incremental costs for market participation, Management has determined it is appropriate not to pursue any changes to the financial compensation for reactive power at this time.

The initiative also considered the appropriateness of developing an additional financial compensation structure for reactive power capability, essentially a capacity-type capability payment. After review, Management is not recommending any form of payment for reactive power capability, and believes that requiring reactive power capability from all generators is considered a good utility practice in the ISO's region. Reactive power capability and voltage support requirements are necessary for the reliable operation of the transmission system, and support the delivery of real power from generation to loads, which allows those generators to participate in the ISO market. Developers have the opportunity to capitalize the costs of installing this capability when they finance their projects.

Finally, in response to FERC's directive to explore a more market-based compensation mechanism for voltage support, Management has reconsidered the potential for market-based voltage support procurement and compensation, and has determined that market-based voltage support is infeasible given the localized nature of reactive power and voltage support and associated concerns about the potential exercise of market power.

## **POSITIONS OF THE PARTIES**

The majority of stakeholders are generally supportive of the proposed technical requirements for non-synchronous generators providing reactive power. With respect to automatic voltage regulation requirements, some suppliers have stated that a generator cannot provide both voltage control and power factor control at the same time, and raised the question of why the ISO has listed both in its proposed requirements. Management is not proposing that a generator provide both voltage control and power factor control at the same time. The ISO stated that the generator must have the capability to operate in the voltage control mode or the power factor mode of operation, with the default being the voltage control mode. In other words, Management is requesting the generator maintain a voltage schedule while operating within the



specified power factor range. The voltage control mode would be the primary mode of operating, and ISO operators would not direct generators to operate in power factor mode other than in limited circumstances when temporary equipment malfunction occurred which limited the ability to utilize the voltage control mode.

Stakeholders have also requested clarification on how the ISO would deal with “hunting” issues, which occurs when two or more generators have the same point of interconnection and their efforts to control voltage schedules counteract each other causing the generators to boost and buck. One stakeholder suggested that the ISO take responsibility for any damage to equipment that might occur due to hunting. Management has proposed several options to deal with potential hunting issues, including allowing non-synchronous generators to control terminal voltage with proper compensation to the point of interconnection or any location between the generator terminal and the point of interconnection with compensation to the point of interconnection. Management has also proposed to allow developers the flexibility to develop a control scheme to utilize a voltage droop function with necessary supervisory controls to allow reactive power sharing among the non-synchronous generators, and generator owners have the option to consult with a technical expert in the reactive field to develop a mitigating scheme. Management will specify these mitigation options in its business practice manuals.

Management understands that stakeholders are largely split on certain aspects of the proposal with strong opinions in particular on the financial compensation issues. Most load serving entities believe that additional capacity payments may create over-recovery by existing generators that have already had the opportunity to capitalize their fixed costs when they installed reactive power equipment. Importantly, reactive power capability is an integral feature of synchronous generators and now part of standard inverter packages for non-synchronous generators. Suppliers have consistently argued that reactive power capital costs are not covered in contracts or market revenues and the ISO must pay capacity payments in addition to currently-approved provision payments. Management agrees with the load serving entities position and is not proposing additional compensation mechanisms at this time.

## **CONCLUSION**

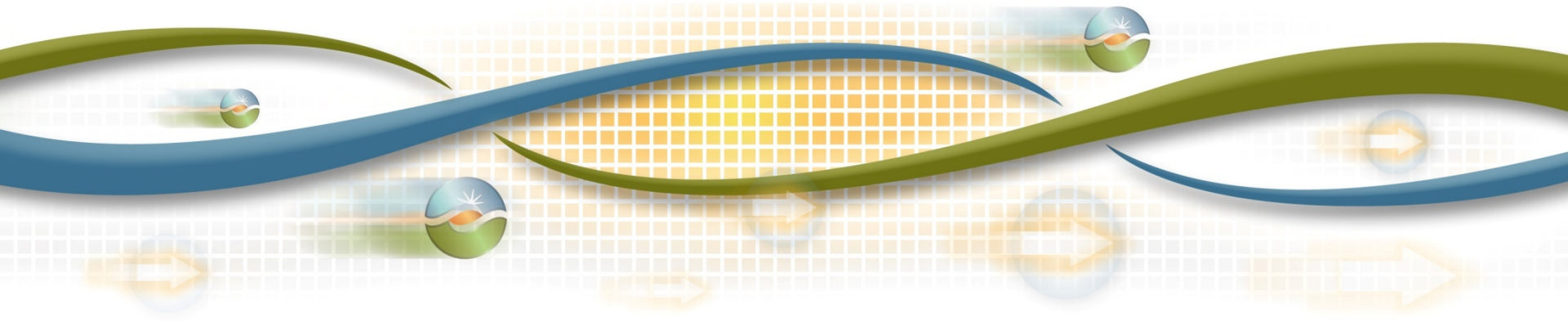
Management recommends that the Board approve the modifications to the reactive power requirements for non-synchronous generators described in this memorandum. The proposal will help to ensure that the ISO can maintain reliable grid operations as non-synchronous generators continue to make up a larger portion of the ISO’s generation fleet.



# Decision on reactive power requirements for non-synchronous generators

Keith Johnson  
Manager, Infrastructure Policy

Board of Governors Meeting  
General Session  
August 31, 2016 – September 1, 2016



Management proposes new reactive power requirements for non-synchronous generators that would be applied prospectively.

- Propose technical requirements for non-synchronous generators providing reactive power
  - FERC has issued an order that prescribes requirements
  - Management is seeking additional requirement for generators to install automatic voltage control equipment so generators can maintain voltage schedules
- Management also considered whether the ISO's current reactive power compensation provisions need to be revised as a result of the new technical requirements



## FERC Order No. 827 includes provisions for new reactive power requirements for non-synchronous generators.

- In January, Management suspended its stakeholder initiative to establish reactive power requirements for non-synchronous generators in light of FERC's rulemaking
- In July, FERC issued Order No. 827, which requires
  - All newly interconnecting non-synchronous generators to have reactive power capability
  - System impact studies for upgrades to existing generators to determine their reactive power requirements

# Management proposes additional requirement that automatic voltage control equipment be installed.

- Order No. 827 does not require automatic voltage control capability
  - However, it allows for the ISO to propose additional technical requirements in a separate filing
  - Automatic voltage control is necessary because default mode of operation is for generators to be able to automatically maintain a voltage schedule while operating within specified power factor
- Management proposes to make a compliance filing on October 14 that includes
  - FERC's ordered requirements
  - Plus, a separate filing for a requirement for automatic voltage control capability

# Management is not proposing changes to the current financial compensation methodology.

- ISO currently compensates generators for the provision of reactive power
  - When the ISO dispatches a generator down to provide reactive power, it is paid its opportunity cost for any lost energy revenues
- Management has determined the current compensation method is appropriate
  - Method complies with provisions in FERC Order No. 827
  - Generators have opportunity to recover capital costs associated with reactive power equipment when they construct or retrofit facilities through power purchase contracts

# Stakeholders support the voltage control capability, but are split on financial compensation.

- Stakeholders generally support the automatic voltage control requirement
- Regarding financial compensation
  - Load serving entities believe the ISO's current compensation method is appropriate – argue equipment has already been paid for in contracts
  - Generators believe capital costs should be covered through the ISO's market provisions
  - Management is concerned with potential double-payments and disruption to bilateral contracting market through introduction of a new capacity payment

Management recommends the Board approve the proposal for new reactive power requirements for non-synchronous generators.

- Proposal will help ensure the ISO can maintain reliable grid operations as non-synchronous generators continue to make up a larger portion of the ISO's generation fleet
- Proposal addresses requirements of FERC Order No. 827 and FERC's request that the ISO review its current compensation methodology



**Board of Governors    August 31, 2016**  
**General Session**

**Decision on reactive power requirements for non-synchronous generators**

**Motion**

**Moved, that the ISO Board of Governors approves the proposed revisions for reactive power requirements for non-synchronous generators, as described in the memorandum dated August 24 2016; 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: Ferron**

**Second: Bhagwat**

Board Action:	<b>Passed</b>	Vote Count: <b>5-0</b>
Bhagwat	Y	
Ferron	Y	
Galiteva	Y	
Mullin	Y	
Olsen	Y	

**Motion Number: 2016-08-G1**

**Attachment B – Clean Tariff**

**Reactive Power Requirements – Automatic Voltage Regulator Systems**

**California Independent System Operator Corporation**

### **8.4.1.3 Voltage Support**

A Generating Unit providing reactive power must be under the control of generator automatic voltage regulators at all times. A Generating Unit may be required to operate underexcited (absorb reactive power) at periods of light system Demand to avoid potential high voltage conditions, or overexcited (produce reactive power) at periods of heavy system Demand to avoid potential low voltage conditions. Unless the CAISO directs the Generating Unit otherwise, the automatic voltage regulator will operate in voltage regulation mode and automatically control the net reactive power of the Generating Unit to regulate to the scheduled voltage as assigned by the Participating TO or the CAISO, within the constraints of the reactive power capability of the Generating Unit. A Generating Unit shall not disable voltage regulation controls, without the permission of the CAISO, while the Generating Unit is in operation.

For Asynchronous Generating Facilities, these provisions also apply to Generating Units required to provide reactive power capability pursuant to the requirements of FERC Order No. 827.



**Attachment C – Marked Tariff**

**Reactive Power Requirements – Automatic Voltage Regulator Systems**

**California Independent System Operator Corporation**

### 8.4.1.3 Voltage Support

~~THIS TARIFF SECTION WILL BECOME EFFECTIVE ON NOVEMBER 27, 2012.~~

A Generating Unit providing ~~reactive power~~~~Voltage Support~~ must be under the control of generator automatic voltage regulators ~~at all times throughout the time period during which Voltage Support is required to be provided.~~ A Generating Unit may be required to operate underexcited (absorb reactive power) at periods of light system Demand to avoid potential high voltage conditions, or overexcited (produce reactive power) at periods of heavy system Demand to avoid potential low voltage conditions.

Unless the CAISO directs the Generating Unit otherwise, the automatic voltage regulator will operate in voltage regulation mode and automatically control the net reactive power of the Generating Unit to regulate to the scheduled voltage as assigned by the Participating TO or the CAISO, within the constraints of the reactive power capability of the Generating Unit. A Generating Unit shall not disable voltage regulation controls, without the permission of the CAISO, while the Generating Unit is in operation.

For Asynchronous Generating Facilities, these provisions also apply to Generating Units required to provide reactive power capability pursuant to the requirements of FERC Order No. 827.