Reactive Power Requirements and Financial Compensation

Revised Straw Proposal

October 8, 2015

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1. Executive summary

The California ISO (ISO) is pursuing this initiative to propose a requirement for asynchronous[1] resources to provide reactive power capability and voltage regulation. This approach will replace the current system impact study approach to assess whether asynchronous resources must provide reactive capability.

Renewables are rapidly displacing the conventional generating facilities that have historically provided reactive power support to maintain voltage levels required for the efficient delivery of real power to serve electric load. Given the changes to the resource fleet that the ISO is experiencing, the current system impact study approach to assess reactive power capability needs risks that the actual system conditions could be far different than the conditions the ISO studied during the interconnection process. Modifications to the current interconnection study approach to mitigate its shortcomings would require an increase in the overall process timeline and an increase in the cost of interconnection studies, and even then there is no assurance that unanticipated electrical system changes, such as that experienced due to the unexpected closure of the San Onofre nuclear power plant, will expose a scenario that was not studied and reliable system operation is then threatened.

As an alternative, the ISO is proposing to adopt, on a going forward basis, a requirement for asynchronous resources to provide reactive power capability and automatic voltage control. These requirements for asynchronous resources reflect a more reliable, efficient, and equitable approach than examining this issue through case by case system impact studies. The ISO will apply this new policy beginning with interconnection customers in the first queue cluster in an interconnection request window following the effective date of the tariff revisions. The policy will not apply to projects already in the ISO interconnection process.

In addition to requirements for asynchronous resources, the ISO has explored whether it is appropriate to develop a financial compensation structure for reactive power capability and provision. The ISO currently compensates resources for the provision of reactive power outside of a standard required range when the ISO directs a resource to reduce its real power output to provide reactive power. The ISO believes that providing reactive power capability is a good utility practice, essential for generating and delivering real power to the grid, and resources have the opportunity to recover capital costs when they construct their facilities. It is also widely accepted that manufacturers now routinely include this capability in standard inverters used by asynchronous resources; therefore, this approach creates minimal incremental capital costs for interconnection customers. For these reasons, the ISO is not proposing to adopt a capability payment for reactive power.

The ISO also proposes to create a new exceptional dispatch category and provision compensation mechanism for the purposes of utilizing and compensating resources that employ a clutch to temporarily disconnect the power turbine and other resources with special operating characteristics and unusual cases (such as solar facilities at night). These resources are capable of providing valuable reactive power support, but would not be able to receive compensation under the current provision payment structure. For consistency, the cost allocation for this new category will be the same

[1] Asynchronous resource is a generator that does not use mechanical rotors that synchronize with system frequency.

as the current voltage support allocation method. The ISO also studied requests to consider allocating some of the associated provision payment costs to generators, as opposed to only loads, as is current ISO practice, and has not found sufficient support, nor a reasonable method, to do so.

2. Changes to proposal and stakeholder comments

The following section describes the changes that the ISO has made to the proposal from the last Straw Proposal iteration. Stakeholder comments that were received in response to the August 13, 2015 Straw Proposal have been included, along with ISO responses to these comments to clarify the proposal and respond to stakeholder concerns.

2.1. Changes to proposal

Technical Requirements: The ISO clarifies the following technical requirements for asynchronous resources:

- **Point of control requirements:** Controlling from the point of interconnection (POI) versus the inverter terminal (or other point of control), the ISO will allow flexibility for resource owners to choose from which location they would control. However it has always been the intent of the ISO that there is an explicit requirement that, regardless of the point of control, all resources must be electrically compensated to the POI to provide the required reactive support capability at the POI.

- **Dynamic reactive power capability requirement:** In this proposal the ISO has clarified the intent and justification for the dynamic reactive power capability requirements. The ISO reiterates proposing a 50% dynamic reactive control capability requirement at the POI. Inverter capabilities now include 100% dynamic reactive power capability as a standard feature and other regions have required 100% dynamic reactive at the inverter terminals. The 50% requirement that is proposed by the ISO is intended to allow for resource owners to have design and financial flexibility. For instance, this provision is meant to provide resources flexibility and lower compliance costs in situations where it may be cheaper to install static reactive devices such as capacitors or reactors, such as; when the POI is remote from the generator site, or several generating projects could meet the requirements collectively.

Financial Compensation: The ISO is not proposing any form of capability payments for reactive power. Current payments for provision of reactive power outside of the standard range will continue to be available for all resources. The ISO proposes to create a new exceptional dispatch category and compensation mechanism for the purposes of utilizing and compensating clutch resources and other resources with special operating characteristics and unusual cases in which those resources could provide valuable reactive power support but were unable to receive compensation under the current provision payment structure.

Effective Date: The ISO clarifies that the proposed requirements will become effective in the next interconnection cluster after the proposed changes have been filed with the Federal Energy

Regulatory Commission. There is no "cut-off" date that will apply, and only Cluster 9 resources and beyond will be subject to the proposed requirement. Any resources already in the ISO interconnection process will be exempt from these new requirements if the need for reactive power is not identified through the studies done during the interconnection process.

2.2. Stakeholder comments

The ISO has received numerous stakeholder comments on the straw proposal. Due to the length of these comments and the ISO's responses, please see the detailed description of stakeholder comments and the ISO's responses in Appendix A.

On the technical requirements, stakeholders have requested clarification on a number of areas of the proposal including: reactive power point of control issues (POI versus inverter terminals or beyond the POI), dynamic reactive power capability issues, requesting additional reactive power technical study, NERC/WECC standard consistency, and implementation/effective date issues.

The ISO also received numerous comments on various aspects of financial compensation including; capability payments, contractual interpretation concerns, provision payments, cost allocation, lost power purchase agreement (PPA) and production tax credit (PTC) revenues, and compensation for resources that may not be producing real power and unable to earn any opportunity cost based provision payments.

3. Stakeholder engagement process

The ISO has developed the following schedule for this initiative.

Milestone	Date
Issue Paper posted	May 21, 2015
Stakeholder call on Issue Paper	May 28, 2015
Issue Paper comments due	June 11, 2015
Straw Proposal posted	August 13, 2015
Stakeholder meeting on Straw Proposal	August 20, 2015
Straw Proposal comments due	September 3, 2015
Revised Straw Proposal posted	October 8, 2015
Stakeholder call on Revised Straw Proposal	October 15, 2015
Revised Straw Proposal comments due	October 23, 2015

Draft Final Proposal posted	November 9, 2015
Stakeholder call on Draft Final Proposal	November 19, 2015
Draft Final Proposal comments due	December 3, 2015
Board of Governors meeting	February 3-4, 2016

4. Background

Since 2010, when the ISO previously proposed a requirement for asynchronous resources, the rapid expansion of asynchronous renewable resources has resulted in high ratios of asynchronous to synchronous generation during a portion of the operating day. Renewables are rapidly displacing the conventional generating facilities that have historically provided reactive power support to maintain voltage levels required for the efficient delivery of real power to serve electric load.

Because generation resources are the primary source of reactive power on the transmission system, the proliferation of asynchronous resources in conjunction with the retirement of large synchronous generators closer to the load centers is significantly changing the landscape of the interconnected power grid. As the need for and location of reactive power resources changes because of future additions of asynchronous resources and previously unplanned requirements, it will become necessary for reliability for all interconnected resources to provide reactive power.

The following table shows the actual/expected increase in variable energy resources (VERs) through 2024.

Figure 1: Variable energy resources within ISO footprint through 2024 (MW)

	2011	***2012***	***2013***	***2014[2]***	***2024[3]***
Large Scale Solar PV	182	1,345	4,173	4,512	7,663
Small Solar PV[4]					3,564
Solar Thermal	419	419	419	1,051	1,802
Wind	3,748	5,800	5,894	5,894	7,028
Total	4,349	7,564	10,486	11,457	20,057

[2] Values for 2011-2014 are from: https://records.oa.caiso.com/sites/mqri/Records/Renewable%20Daily%20Watch/2014%20Renewable%20Watch/12-2014%20Renewable%20Reports/20141229_DailyRenewablesWatch.pdf

[3] Values for 2024 are from: http://www.caiso.com/Documents/Aug13_2014_InitialTestimony_ShuchengLiu_Phase1A_LTPP_R13-12-010.pdf (Table 9)

[4] Less than 20 MW and connected to the ISO controlled grid.

The current case-by-case, system impact study approach to assess whether asynchronous resources must provide reactive capability has several shortcomings. First, system impact study may not require that every project provide reactive power capability because it may conclude there will be sufficient reactive power on the transmission system due to the capabilities of existing generators with reactive power capability and other reactive power devices on the transmission system. The case-by-case approach relies heavily on the assumptions of future conditions, which may not prove true and does not plan for unpredicted events. Once an asynchronous project is interconnected and is commercially operable, actual system conditions could be far different from the conditions studied. Planned and unplanned outages and a host of other operating scenarios not covered under initial study may in fact actually cause needs for reactive power from those previously exempt generators.

A reactive power standard enhances the reactive capabilities on the system compared to an ad hoc approach based on site specific requirements determined during interconnection. North American Electric Reliability Council's (NERC's) Integration of Variable Energy Resource Task Force conducted a special reliability assessment that recommends that NERC consider revisions to reliability standards to ensure that all generators provide reactive support and maintain voltage schedules.[5] Requiring all interconnecting resources to provide reactive capability will remedy the shortcomings of the current approach and ensure distribution of the reactive power control throughout the system.

For a full background including more detailed information on: current reactive power requirements, overview of technical issues, prior case studies, current interconnection study and transmission planning process procedures related to reactive power, and regulatory review background materials please refer to Sections 4.1-4.6 of the ISO's August 13, 2015 Straw Proposal.[6]

5. Revised Straw Proposal

5.1. Proposed asynchronous resource requirements and timing

The ISO proposes to adopt a uniform requirement for asynchronous resources to provide reactive power capability and voltage regulation. This primarily includes wind, solar, and storage facilities. The ISO proposes to apply these new rules on a going-forward basis to those resources that interconnect through the Generation Interconnection Delivery Application Process (GIDAP).[7]

The ISO believes that the appropriate balance between harmonizing reactive power requirements and existing customer expectations is to apply this new policy beginning with interconnection customers in the first queue cluster having an interconnection request window following the effective date of the

[5] NERC Specific Reliability Assessment: Interconnection Requirements for Variable Generation at 2-3: http://www.nerc.com/files/2012_IVGTF_Task_1-3.pdf

[6] http://www.caiso.com/Documents/StrawProposal_ReactivePowerRequirements_FinancialCompensation.pdf

[7] New interconnection requests to the ISO grid are governed by the GIDAP, ISO Tariff Appendix DD. http://www.caiso.com/Documents/AppendixDD_GeneratorInterconnection_DeliverabiltyAllocationProcess_asof_Jun12_2015.pdf

tariff revisions. The ISO is planning for this to occur in April 2016, to be effective for resources entering the queue during Cluster 9 and beyond.

The ISO proposes to exempt all projects already in the ISO interconnection process and existing individual generating units of an asynchronous generating facility that are, or have been, interconnected to the ISO controlled grid at the same location from these new requirements for the remaining life of the existing generating unit. However, the ISO proposes that any generating units that are replaced or repowered must meet these new requirements.

5.2. Proposed requirements for asynchronous generating facilities

The ISO proposes to set asynchronous requirements equivalent to the current synchronous requirements, consistent with FERC Order 661a. Because asynchronous units typically use different technology to provide reactive power the requirements will not be identical. Instead, the ISO will set the requirements so both resource types provide reactive power equivalently.

a) An Asynchronous Generating Facility shall have an over-excited (lagging) reactive power producing capability to achieve a net power factor from 0.95 lagging up to unity power factor at the POI, at the Generating Facility's maximum real power capability.

b) An Asynchronous Generating Facility shall have an under-excited (leading) reactive power absorbing capability to achieve a net power factor from 0.95 leading up to unity power factor at the POI, at the Generating Facility's maximum real power capability.

c) Asynchronous Generating Facilities shall provide dynamic voltage response between 0.985 leading to .985 lagging at maximum real power capability at the POI as specified in Figure 3.

d) Asynchronous Generating Facilities may meet the power factor range requirement at the POI by using controllable external dynamic and static reactive support equipment.

e) Within the dynamic reactive capability range, Asynchronous Generating Facilities shall vary the reactive power output between the full sourcing and full absorption capabilities in a continuous manner.

f) Outside the dynamic range of .985 leading to .985 lagging, and within the overall reactive capability range of .95 leading and .95 lagging, the reactive power capability could be met at maximum real power capability with controllable external static or dynamic reactive support equipment.

5.3. Operational requirements for asynchronous generating facilities

When the plant real power output is at its maximum capability, the Asynchronous Generating Facility shall have the capability to provide reactive power at .95 lagging for voltage levels between .95 per unit and unity power at the POI. Likewise, the Asynchronous Generating Facility shall have the

capability to absorb reactive power at .95 leading for voltage levels between unity power factor and 1.05 per unit at the POI.

Voltage regulation and reactive power control requirements for Asynchronous Generating Facilities:

a) The Asynchronous Generation Facility's reactive power capability shall be controlled by an automatic voltage regulator (AVR) system having both voltage regulation and net power factor regulation operating modes. The default mode of operation will be voltage regulation consistent with NERC VAR standards.

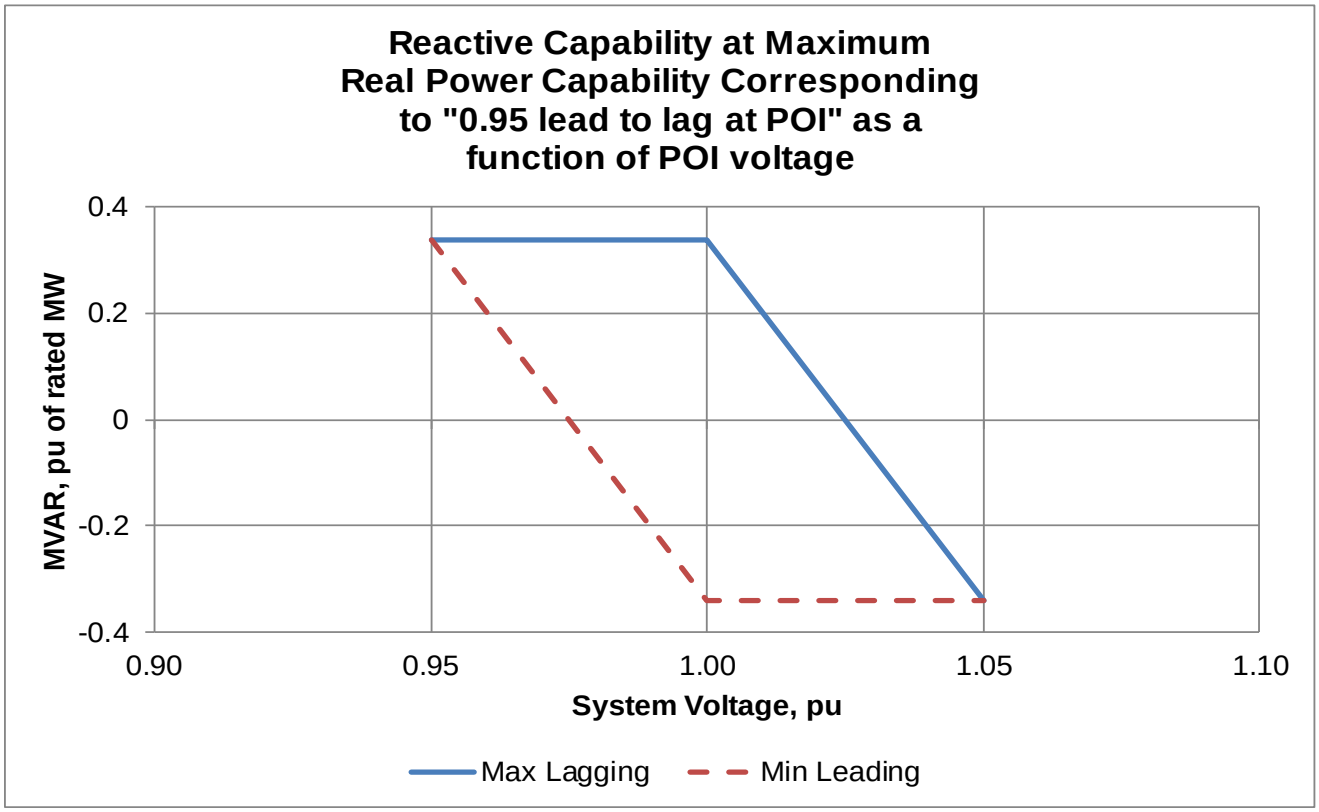
b) The voltage regulation function mode shall automatically control the net reactive power of the Asynchronous Generating Facility to regulate the POI scheduled voltage assigned by the Participating TO or ISO, within the constraints of the reactive power capacity of the Asynchronous Generation Facility.

c) The ISO, in coordination with the Participating TO, may permit the Interconnection Customer to regulate the voltage at a point on the Asynchronous Generating Facility's side of the POI. Regulating voltage to a point other than the POI shall not change the Asynchronous Generating Facility's net power factor requirements. Any regulation point other than the POI must provide the required reactive capability electrically compensated to the POI.

d) The ISO, in coordination with the Participating TO, may permit the Interconnection Customer to regulate the voltage at a point on the PTO's side of the POI. Regulating voltage to a point other than the POI shall not change the Asynchronous Generating Facility's net power factor requirements. Any regulation point other than the POI must provide the required reactive capability electrically compensated to the POI.

The Interconnection Customer shall not disable voltage regulation controls, without the permission of the ISO, while the Asynchronous Generating Facility is in operation.

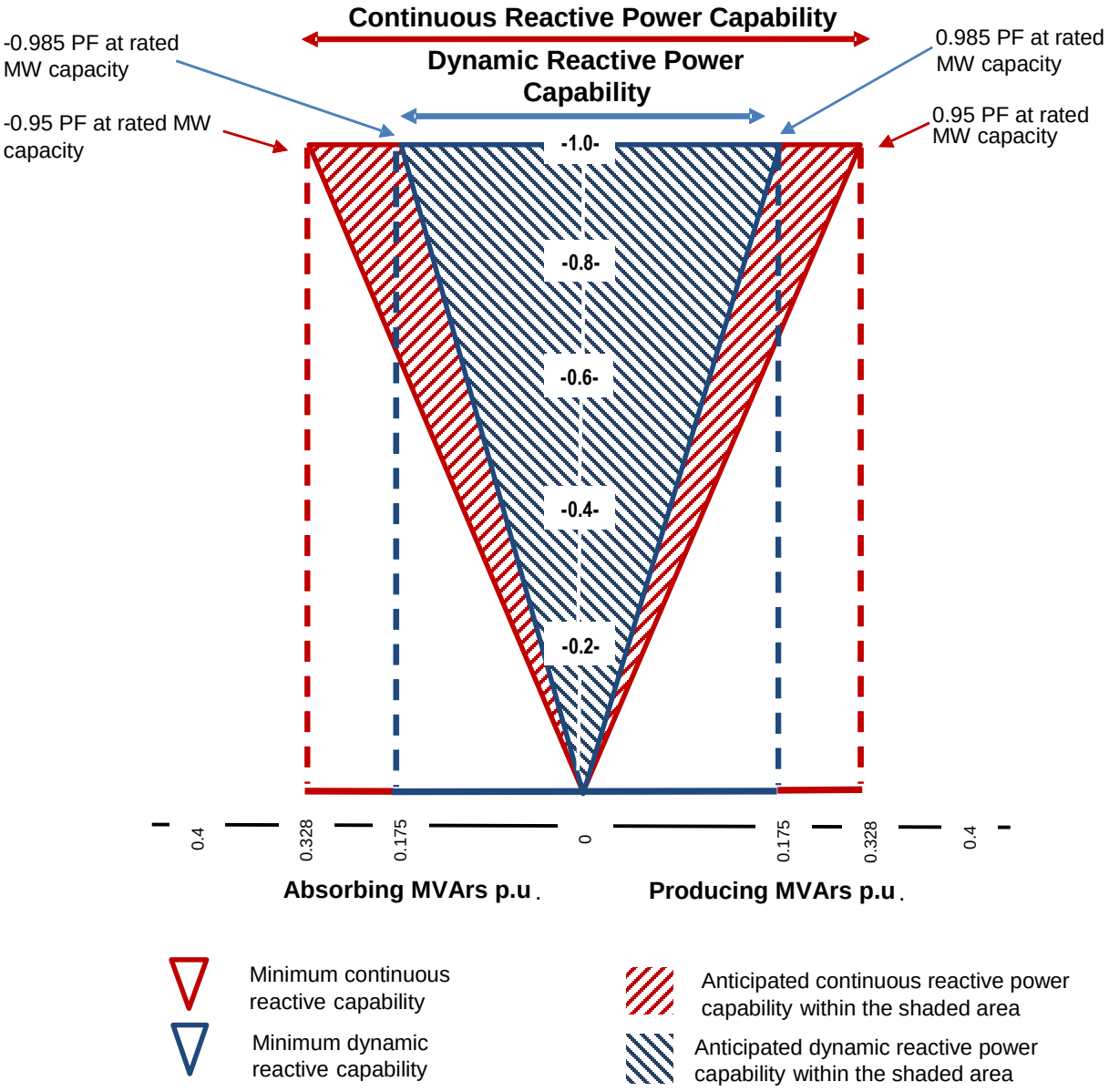
Figure 2: Proposed reactive power capability at different voltage levels



Note: The figure above specifies that when the real power output is at its maximum capability, the Asynchronous Generating Facility shall have the capability to provide reactive power at 0.95 lagging when voltage levels are between 0.95 per unit and 1 per unit at the POI. The capability to provide reactive power decreases as the voltage at the POI exceeds 1 per unit.

Likewise, the Asynchronous Generating Facility shall have the capability to absorb reactive power at 0.95 leading when voltage levels are between unity power factor and 1.05 per unit at the POI. The capability to absorb reactive power decreases as the voltage at the POI drops below unity power factor.

Figure 3: Proposed reactive power capability for asynchronous resources



Note: In the figure above, the red and blue isosceles triangles show the expected reactive capability of the Asynchronous Generating Facility at the POI. At maximum real power capability of the Facility, the expected dynamic reactive capability should be between 0.985 lagging to 0.985 leading. Also, at maximum real power capability, the overall expected continuous reactive capability should be between 0.95 lagging to 0.95 leading. As shown, as the real power output decreases both the dynamic and continuous reactive capabilities also decreases.

5.4. Financial compensation

Summary

Through this initiative the ISO has explored mechanisms to compensate resources for the capability and provision of reactive power. The ISO currently compensates resources for the provision of reactive power outside of an established range when resources need to reduce their real power output to provide reactive power outside that range.

At this time, the ISO is not proposing any form of payments for reactive power capability. The previous straw proposal considered possibly creating a limited form of capability payments that would apply only to merchant resources on a going forward basis, but after considering this option the ISO is no longer proposing this provision. The ISO will continue the current payment method for the provision of reactive power outside of the standard range. The ISO also intends to create a new exceptional dispatch category and compensation mechanism for the purposes of utilizing and compensating clutch resources and other special cases that provide reactive power support.

Provision Payments

The ISO currently compensates resources for the provision of reactive power outside of the standard lead/lag requirements and proposes to continue these provision payments. The payments are calculated based on a resource's opportunity costs when called upon under exceptional dispatch instruction for voltage support to reduce their real power output to move outside of the standard range as specified under the ISO Tariff, Section 11.10.1.4. The ISO proposes to continue the current provision payments. Further details on the current provision payment structure for voltage support were discussed in the Straw Proposal.[8]

Through this effort the ISO has explored potential enhancements to payment compensation mechanisms for the provision of reactive power. As a part of this exercise, the ISO has investigated the potential for more market based procurement and compensation for voltage support. One option considered was payments for the provision of reactive power within the standard required lead/lag range to compensate resources that were more frequently utilized for reactive power within the standard required range. The ISO determined that this concept would be impractical because it is not possible to always identify when specific generators are themselves causing the need for reactive support. Developing a compensation stream for generators that may actually be the cause of the reactive power need does not make sense. Additionally, the potential payments present gaming concerns because multiple generators situated in close proximity could potentially manipulate operations to affect reactive power needs without changing their overall MW output simply to garner additional payments.

[8] Reactive Power Requirements and Financial Compensation Straw Proposal at 29-30. http://www.caiso.com/Documents/StrawProposal_ReactivePowerRequirements_FinancialCompensation.pdf

New Exceptional Dispatch Category

As the ISO has considered provision payments for reactive power, it has identified the need to create a new exceptional dispatch (ED) category. This new ED and provision payment would utilize and compensate certain resources that provide reactive power support because of their specialized equipment, including clutches to temporarily disconnect the turbine so real power is not produced, and other resources with distinctive operating capabilities such as the ability to operate in synchronous condenser mode without the aid of a clutch device, or solar resources at night that could be used to provide reactive power. The ISO would also use this new ED category to direct resources to provide reactive power support in low/no real power output situations.

Resources/instances that could be utilized under this new ED category:

- Thermal units equipped with a clutch that can operate in synchronous condenser mode;
- Small thermal units without clutches that can operate in synchronous condenser mode;
- Solar arrays at night or under cloud cover; and,
- Wind turbines operating at below max output.

The ISO would only rely on an ED for reactive power support if the needed resources had not cleared the market optimization. It is appropriate to compensate the resources for their variable reactive power costs (such as for fuel for a thermal generator with a clutch) through a different mechanism than the current opportunity cost based provision payments for voltage support ED since these resources would not have an opportunity cost because they are “out of the money” in the energy market optimization but still are providing a service to the ISO. One option may be to provide these resources with an alternative provision payment to incent these resources to respond when they would not otherwise have any payment under the current provision compensation structure.

The ISO is proposing to call this new ED category “Reactive Power Exceptional Dispatch”. The new ED category would have a compensation mechanism to address the lack of any opportunity cost based provision payment available under the current provision payment structure. The purpose of this new payment methodology for the provision of reactive power is to compensate resources that are providing reactive power support while they are not producing real power. The intent is that the payment would make the resources whole for any costs so that they are financially indifferent to responding to provide reactive power support and are therefore willing to operate in this mode.

The ISO would calculate payments for this new ED category using the resource’s nodal LMP (for any real power consumption needed to provide reactive support) and the unit’s cost data that is already included in the Master File. The ISO proposes to include the following costs in the payment calculations:

- Costs of any real power consumed during ED for purposes of station power, or otherwise needed to provide the voltage support/reactive power paid at the unit’s nodal LMP value;
- Min Load costs including any fuel, variable O&M, or other opportunity costs (as applicable);
- Start Up costs (if resource is started up under ED instruction).

The ISO seeks feedback from stakeholders regarding any additional costs that the ISO should consider to include in the cost calculation for the new ED category.

Cost Allocation

The current cost allocation for provision of reactive power outside the standard required range is established under current tariff Section 11.10.1.4.[9] These cost allocation provisions for voltage support assign these costs to load. Each Balancing Authority (BA) that has Measured Demand is allocated and assessed voltage support charges based on the BA's relative share of Measured Demand over the CAISO Control Area. For both short-term voltage support (also referred to as supplemental reactive energy) and long-term voltage support, cost allocation is based upon load ratio share of the system-wide Measured Demand.

Some stakeholders have requested that the ISO consider assigning costs related to the provision of reactive power to generators because having enough reactive power capability is in the best interest of all resources and loads so the cost of reactive power support should be allocated among all generation as well, not just to load. The ISO notes that the current provision payments are not allocated to generation resources because there is not a reasonable methodology to accurately identify causation, which would allow allocating the costs to generators. It is not possible to accurately identify on a daily, hourly, and moment to moment basis, if specific generators are causing needs for reactive power to deliver real power themselves or not. This is due to the large variations in operating conditions, which could include large changes in generation output and load levels, planned and unplanned resource and transmission outages, and occurrence of contingencies and other constraints.

The ISO proposes to use the same cost allocation methodology for the proposed Reactive Power ED category as the current voltage support ED provision payment allocation, which allocates the cost to load and exports, as the new ED is simply a different way to pay for the provision of reactive power and the cost allocation for the provision of reactive power has already been approved by FERC. The ISO could potentially set up the charges associated with the new ED category to flow into the same settlements charge code as the current Voltage Support ED charges to simplify the settlements process and any needed changes.

Capability Payments

The ISO has considered whether it is appropriate to develop a financial compensation structure for reactive power capability. The ISO believes that capability for reactive power support by all resources is a good utility practice; therefore, the ISO is not proposing any form of payment for reactive power capability. The focus of this initiative initially was only technical requirements for reactive power from asynchronous resources. The ISO subsequently augmented the initiative to consider financial compensation. While some regions make capability payments, there are other regions where transmission providers make no payments for reactive power capability within the 0.95 leading to 0.95

[9] CAISO Tariff: Section 11. http://www.caiso.com/Documents/Section11_CAISOSettlementsAndBilling_Jan1_2015.pdf

lagging power factor range, concluding that such operation is a requirement under good utility practice and a necessary condition for conducting normal business.[10]

Some ISO/RTOs provide financial compensation for the capability of reactive power; however, the payments and cost recovery methods vary by region, which is specifically allowed by FERC. The ISO contacted PJM and MISO to better understand why they provide the opportunity for reactive power capability payments. Capability payments in PJM and MISO are largely a historical remnant of practices that were in place before the formation of the ISOs/RTOs. Historically, there were reactive power capability payments administered under a "Schedule 2" of the prior transmission operators that started with the deregulation and divestiture of generating assets in the region. Other ISOs/RTOs indicated that they have simply adopted these Schedule 2 costs when they formed their organization and continued those historically approved payment structures as a cost pass-through under each ISO's/RTO's tariff in their new Schedule 2 cost recovery. Neither PJM nor MISO conducted a stakeholder process to develop these payments; they were simply continuation of prior practices by transmission operators that had joined to form the new operator's system.

Providing reactive power capability is good utility practice. 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 resources to participate in the ISO markets.

Tariff Section 4.6.5.1 states: Participating Generators shall, in relation to each of their Generating Units, meet all Applicable Reliability Criteria, including any standards regarding governor response capabilities, use of power system stabilizers, voltage control capabilities and hourly Energy delivery. Unless otherwise agreed by the CAISO, a Generating Unit must be capable of operating at capacity registered in the CAISO Controlled Grid interconnection data, and shall follow the voltage schedules issued by the CAISO from time to time.[11]

In Order 2003, FERC 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."[12] At the time, NERC advocated that FERC require power factor capabilities to be within a range required by good utility practice. The ISO's current tariff follows this approach. Order 2003 also allowed the adoption of a different power factor requirement long as the power factor requirement applies to all generators on a comparable basis. Order 2003 also provided that an RTO or ISO may propose variations from this policy to address regional needs. FERC has addressed various rules relative to the payment for reactive power capability, but FERC has not adopted a requirement that ISO/RTOs adopt a payment for the capability to provide reactive support. Given the ISO's understanding that resources capitalize the cost of reactive power capability when they construct their facilities, there does not appear to be a valid reason to create a separate administrative payment stream from the ISO to resources for the capability to provide reactive support.

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[10] See Entergy Services, Inc., 113 FERC ¶ 61,040 (2005); Southwest Power Pool, Inc., 119 FERC ¶ 61,199 (2007), reh'g denied 121 FERC ¶ 61,196 (2007) (SPP); Bonneville Power Administration, 120 FERC ¶ 61,211 (2007) (Bonneville), reh'g denied 125 FERC ¶ 61,273 (2008); E.ON. U.S. LLC, 124 FERC ¶ 61,131 (2008).

[11] CAISO Tariff: Section 4. http://www.caiso.com/Documents/Section4_RolesAndResponsibilities_Oct1_2014.pdf

[12] *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)

FERC's April 22, 2014, Commission Staff Report under Docket No. AD14-7 identifies this position as one acceptable approach to addressing reactive power capabilities:

> "To date, the Commission has not required a uniform approach with respect to compensation for reactive power. As a result, different payment and cost recovery methods have been adopted in each region. Transmission providers in some regions pay a cost-based payment for reactive power capability, while others require reactive power capability as part of good utility practice, i.e., without compensation."[13]

Applying these proposed requirements to all asynchronous resources will provide a level playing field for all new resources. This will provide certainty to developers of new resources and does not impose new burdens on existing asynchronous generators that were built under a different set of rules. Existing generators have had the opportunity to capitalize their capability costs. Developers of new asynchronous generation will know they must install the capability for reactive power within the minimum prescribed range. With this certainty, those new resources can reflect any associated costs in their negotiations with LSEs.

6. Next Steps

The ISO will discuss this revised straw proposal with stakeholders during a conference call on October 15, 2015. Stakeholders are welcome to submit written comments by October 23, 2015 to InitiativeComments@caiso.com.

[13] FERC Staff Report: Payment for Reactive Power in AD14-7 dated April 22, 2014 at 3. https://www.ferc.gov/legal/staff-reports/2014/04-11-14-reactive-power.pdf

Appendix A: Stakeholder comments and ISO responses

Technical requirements

The following stakeholder comments and ISO responses are related to aspects of the proposed technical requirements.

Point of control issues (POI versus inverter terminals):

Comment: CalWEA and AWEA and LSA believe that the asynchronous generators should be allowed the flexibility to select their voltage regulation point. LSA commented the ISO has not explained why the PJM standard, which imposes a uniform requirement at the generator terminals, would be problematic for the ISO. In short, the ISO has still not justified the different standards for different generator types, and/or why providing a choice to developers would cause problems for the ISO.

ISO Response: The ISO agrees with the comments that the asynchronous generator should be allowed to select its voltage regulation point, provided that it is electrically compensated to the POI for the required capability. The ISO has stated previously that the proposed requirements were flexible regarding the location where resources could choose to provide reactive control. The ISO clarifies that the requirements will allow resources to choose POI or generator/inverter terminal, or even a point beyond the POI, provided the resources capabilities are electrically compensated to standard requirements at the POI, (0.95/0.95 at the POI).

There is an explicit requirement that regardless of the point of control, all resources must provide compensation to the POI to provide the required Automatic Voltage Regulation (AVR) control and reactive support capability at the POI. As noted in the prior straw proposal and responses to other stakeholder comments, the ISO's proposal is intended to be consistent with FERC Order 661A; which states that system reliability requires that reactive support from a wind/solar plant be provided at the POI.[14]

Comment: CalWEA and AWEA, and LSA requested clarification on situations where one or more interconnecting asynchronous generators could collectively offer reactive support. Specifically, how this collective scheme could be implemented within CAISO's existing GIDAP and TPP frameworks from process and technical standpoints. Additionally, how would the interconnection studies and/or TPP be revised to consider situations where the standards could be met more economically and/or efficiently collectively: (1) behind the POI; and (2) beyond the POI, through grid-level investments.

ISO Response: The ISO notes confidentiality concerns, and cannot share resource owner information or location during the interconnection process. Hunting issues will not be revealed until after the interconnection studies are completed and the generators are in service. The ISO has

[14] FERC Docket No. RM05-4-001; Order No. 661-A, Dec 12, 2005, at 22. https://www.ferc.gov/EventCalendar/Files/20051212171744-RM05-4-001.pdf

provided developers the option to control voltage at the generator/inverter terminal provided that it is electrically compensated to the POI.

The ISO is not proposing any revisions to the TPP, GIDAP, or interconnection studies processes to address hunting issues, or to consider the various situations related to the choices that resource developers make with regards to the point at which they install these capabilities. The ISO is only concerned with ensuring that the capabilities are electrically compensated to the POI at the equivalent required capabilities. During the interconnection study process, if the ISO determines multiple developers are connecting to the same POI, the ISO could inform the developers of potential alternatives to the extent that confidentiality requirements are respected. A potential alternative available to these multiple developers could be to control voltage at the generator terminal and ensure their inverters have reactive droop capability to address any potential hunting issues. The ISO may also consider other alternatives as proposed by resource owners on an individual basis.

Comment: LSA requested the ISO provide for exceptions or special arrangements for situations where: The POI is remote from the generator site; Several generating projects could meet the requirement collectively; New generators on shared gen-ties are subject to the standards while other existing ones are not; Generators are interconnecting to busses where there is already a regulation device installed; A generating project cannot effectively control the transmission voltage, e.g., a small generator connecting to a stiff high-voltage.

ISO Response: The ISO does not propose to give special requirements to resources simply for being located remotely from the POI. The ISO's proposal has provided resources the flexibility to choose the location they will control the voltages from, provided that the resources electrically compensate to the POI. The ISO's proposal is only for new resources, so all new resources that are subject to the new requirements would be required have the proposed capabilities. However, the ISO recognizes that there may be some older existing resources that do not have the capabilities and in this situation the ISO's TPP would identify any additional reactive capability needs at the POI. Should a reliability issue arise during real-time operation, the ISO could mitigate the problem by curtailing resources without reactive capability.

In addition, the ISO needs to plan for contingencies or during maintenance of regulation devices. This means that new resources interconnecting to POI's with other regulation devices installed at, or near the POI, still must be equipped with the capability to provide reactive support according to the uniform requirements. Requiring this capability allows the ISO to avoid curtailment of the resources in these types of regulation device maintenance or outage situations.

The ISO agrees with the statement that a small generator connecting to a stiff high-voltage system may have a small impact on the overall voltage conditions. However the ISO reiterates that all resources connected to the transmission system should help in controlling voltages up to the proposed capability of the resource. The ISO is requiring that all asynchronous resources have this capability at the POI and the ISO recognizes that certain smaller resources may not have a large impact on the overall system voltage, but will still provide some level of needed support.

Dynamic reactive power capability issues:

Comment: CESA questioned the basis for requiring a certain portion of the overall reactive capability to be dynamic. Why is dynamic capability necessary? CESA also seeks feedback regarding whether static capability or 'stepped' static capability through the full band of required capability could equivalently address the ISO's system needs. CESA recommends a study-based approach be used for where dynamic reactive power capability is needed.

ISO Response: Currently, dynamic reactive power capability is primarily provided by synchronous resources and is needed to prevent voltage collapse during contingencies or abnormal operating conditions. With the crowding out effect of asynchronous resources there is a need to replace the dynamic reactive capability that was previously being provided by those synchronous resources. A purely static reactive capability or 'stepped' static capability through the full band of required capability for asynchronous resources may not provide adequate response in the transient time frame necessary to prevent voltage collapse during certain events. One reason for this is that switched capacitors generally operate within the order of seconds, whereas dynamic reactive sources generally initiate operation within the order of cycles. In addition, once capacitors are disconnected from the system, they cannot be reinserted without first being discharged, which takes minutes.[15]

Asynchronous resources use inverters that have full dynamic reactive power capabilities. The ISO took into consideration that developers need to compensate for reactive support at the POI and accepting half of the requirements to be static and half dynamic, provides resource developers a lower cost option to meet requirements at the POI. The ISO reiterates that the inverters can provide 100% dynamic reactive support. Thus, a reasonable assumption that the plant could provide 50% dynamic is conservative, even though additional reactive may be needed to electrically compensate to the POI. This middle ground allows resource developers flexibility in design and cost for meeting the requirement. The ISO has also explored requiring 100% dynamic reactive support at the inverter terminals, similar to other regions, such as PJM, have required. [16]

Transient stability studies on a case by case basis are not cost effective, excessively time consuming, and very difficult to determine accurate results for a multitude of potential operating scenarios. For these reasons the ISO will not utilize a study-based approach to determining dynamic needs and instead apply the uniform requirement to ensure system needs are met.

Comment: PG&E seeks clarity for continuous and dynamic reactive power requirement under different voltage levels (combination of figures 2 & 3).

ISO Response: The ISO notes that there is a relationship between the similar Figures 2 and 3: Figure 2 shows the reactive capability needs with respect to per unit voltage. For example, for voltage levels between 0.95 per unit up to 1.0 per unit, the asynchronous resource should be able to

[15] NERC 2012 Special Assessment, Interconnection Requirements for Variable Generation, September 2012, at 26. http://www.nerc.com/files/2012_IVGTF_Task_1-3.pdf

[16] Docket No. ER15-1193, May 5, 2015, at 5-6. http://www.pjm.com/~/media/documents/ferc/2015-orders/20150505-er15-1193-000.ashx

produce maximum reactive output through a combination of dynamic and static devices. Likewise, for voltage levels between 1.0 per unit and 1.05 per unit the asynchronous resource should be able to consume maximum reactive capability through a combination of dynamic and static devices. Figure 3 shows the reactive requirement for different levels of MW output. For example, at rated capacity, the resource should be able to provide approximately .175 per unit of dynamic reactive support. The transition from dynamic to static needs to be continuous. In other words, the transition needs to be continuous so that the dynamic and static capability will be provided in a continuous manner without waiting for the static response to kick in once the dynamic response is provided.

Comment: CESA asked; Will the CAISO need dynamic reactive capability for all MW levels at any time, or only when providing market services, e.g. delivering energy under an energy award? These detailed implementation concepts need review in order to avoid unintended risks of noncompliance and to inform planning and resource development.

ISO Response: Figure 3 of the ISO's proposal outlines the reactive support needed as the MW output of the unit changes. The ISO is not requiring reactive support when resources are off-line.

Comment: LSA comments on the proposed dynamic response requirement for asynchronous resources to be "similar to a synchronous resource, i.e., within one second," stating that the definition of "within one second" is not clear. Does that timing include an event recognition time, rise time and voltage settling time? In addition, this does not accurately reflect current dynamic response requirements for synchronous resources. There are a variety of AVR designs for synchronous resources, and they have different response capabilities. Also, synchronous resources with power system stabilizers (PSSs) will have a faster response than those without PSSs.

ISO Response: The "within one second" response requirement is intended to encompass the full response, including event recognition, rise time, and voltage settling time. Regarding differences in AVR designs and resources with PSS: The ISO acknowledges that current resources may have varying capabilities related to AVR design and that those with PSS equipment may be faster responding. The ISO reiterates that the response time requirement for asynchronous resources will require a response time within one second and these resources will have to meet the voltage ride-through requirements outlined in NERC's PRC-024-2.[17]

Requests for additional reactive power technical study:

Comment: CESA and LSA requested further study of reactive power needs.

CESA recommends further study on the expected needs of reactive power so that excessive amounts are not developed. As CESA understands it, the basis for the CAISO's asynchronous resource standard is equivalence to the performance capabilities of synchronous resources.

[17] NERC Standard PRC-024-2; Generator Frequency and Voltage Protective Relay Settings. http://www.nerc.com/pa/Stand/Reliability%20Standards/PRC-024-2.pdf

CESA believes it may be excessive to have all generators provide this capability at all locations without testing the need.

LSA believes that the CAISO should perform a rigorous analysis of the amount and likely locations of its future reactive capability needs and use the results to craft a more calibrated set of requirements that it can be reasonably sure will meet its future needs, without imposing unnecessary costs on suppliers for reactive capability that is not needed.

ISO Response: As stated in the ISO whitepaper, the crowding out effect of asynchronous resources makes it very difficult to study all operating scenarios. The ISO is proposing uniform requirements because the case by case study of each resource is inefficient and insufficient to identify all reactive power needs. The ISO will not conduct additional assessments in lieu of these uniform requirements. The ISO believes it is reasonable to forego these studies to reduce interconnection study cost and timeframes. Synchronous resources already provide 100% dynamic reactive capability within the standard 0.95 lead/0.90 lag range at the generator terminal. The ISO's proposed requirements for asynchronous resources are consistent with synchronous requirements and are necessary due to the crowding out effect of asynchronous resources. The ISO believes that these universal requirements will not impose unnecessary costs and the incremental costs to new resources is minimal.

Other technical requirement comments:

Comment: LSA stated that the CAISO should explicitly recognize NERC/WECC efforts toward more uniform standards across the West and nationally in the future and should commit to complying with such standards. The applicable CAISO rules should not be more stringent than applicable standards adopted by NERC/WECC, unless the CAISO can show that its stronger requirements are needed for the CAISO Controlled Grid.

ISO Response: The ISO disagrees with the comment. The ISO is proposing tariff provision to address the fact that the system impact study process is insufficient to determine whether asynchronous resources should provide reactive power. If, in the future, NERC/WECC adopt specific reactive power requirements for asynchronous resources, the CAISO will consider modifying its tariff to align its requirements with those adopted by NERC/WECC.

Comment: CalWEA and AWEA stated that many synchronous generators do in fact have limited ability to ride through system voltage and frequency disturbances and request that the same Low Voltage Ride Through (LVRT) requirements apply to synchronous generation.

ISO Response: FERC has already approved ISO tariff requirements for low voltage ride through that apply to synchronous resources. Additionally, both synchronous as well as asynchronous resources will have to abide by NERC's Standard PRC-024-2 "Generator Frequency and Voltage Protective Relay Setting", which goes into effect on July 1, 2016.[18] The ISO is not proposing to change these requirements.

[18] NERC Standard PRC-024-2; Generator Frequency and Voltage Protective Relay Settings. http://www.nerc.com/pa/Stand/Reliability%20Standards/PRC-024-2.pdf

Comment: PG&E believes that providing reactive power should be limited to a threshold active power output (e.g., 20% of the nominal resource output) as a must have capability for asynchronous resources.

ISO Response: As noted above in response to CESA's comment on dynamic capability; Figure 3 of the ISO's proposal outlines the reactive support needed as the MW output of the unit changes. The ISO is not proposing requiring reactive support when the plant is off-line but will require some amount of reactive support throughout the full range of output when units are online.

Comment: CalWEA and AWEA seek clarification on application of the new requirements: Will the requirements apply to any existing asynchronous generator that seeks to convert its existing interconnection agreement to a CAISO-compliant interconnection agreement ("paper/contract conversion") or any existing asynchronous generator that is requesting an incremental increase in capacity or energy output using existing or refurbished hardware?

While the requirement will apply to projects that plan to repower with new turbines, will it apply to existing turbines that remain (or are simply refurbished) in an otherwise repowered project (turbines remaining at the same capacity with essentially the same technology)?

ISO Response: Once FERC approves the new form of the GIA, the CAISO will begin using it for project that have not substantially completed their GIA negotiation. For contract conversions while we may use the new GIA form, the unit would not be responsible to modify an existing generator to meet the reactive requirements. For any generator, synchronous or asynchronous, that wants to increase the capacity output of its generator the developer will need to submit an interconnection request to the queue, and thus, be subject to the reactive power requirements.

The ISO continues to propose that generating units that are replaced or repowered must meet these new requirements. To specifically address the issue raised regarding a unit repower with existing turbines that remain (or are simply refurbished) in an otherwise repowered project; If a generating unit is undergoing a repowering or refurbishing, but not replacing turbines, then the unit will not be subject to the new reactive power requirements. Eventually, all units will need to be retired, repowered, or refurbished, and if a unit is undergoing repowering, at that time, should the unit choose install new replacement turbines, the unit would be required to meet minimum power factor requirements. To do so, all that would be required would be setting the plant control system to control VAR output or absorption.

Comment: PG&E requests more clarity for reactive power requirement definition in straw proposal. In sections 5.2 and 5.3 of the straw proposal the following terms are used "maximum real power output", "maximum real power capability", "rated MW capacity" and "real power capability". It is recommended that CAISO to utilize common terminology as much as applicable to avoid confusion.

ISO Response: The ISO agrees and has made the correction, the ISO uses "maximum real power capability" consistently in this revised straw proposal.

Comment: CalWEA and AWEA note that the ISO was in agreement with CalWEA and AWEA at the stakeholder meeting of August 3, 2015 that the reactive power capability curve requirement for

an asynchronous generator (Figure 2) should be based on “actual MW” output and not “rated MW” output.

ISO Response: After additional review of Figure 2, the ISO disagrees and has confirmed that the Y axis should still be labeled: Per unit of “Rated MW”, and it is more appropriate to add “at maximum real power capability” to the title label of Figure 2. The diagram shows the maximum lead/lag reactive capability for voltage levels between 0.95 to 1.05 per unit at the POI. Figure 2 is a representation of the reactive capability at maximum real power capability, and is not intended to show the reactive capabilities at any other output levels.

Comment: CalWEA and AWEA fully support PG&E’s position particularly when it comes to DERs and believe that the universal reactive power requirements should be simultaneously applied to both transmission and distribution interconnection processes.

ISO Response: The ISO’s proposal applies to resources interconnecting to the ISO grid. Distributed Energy Resources should meet any applicable distribution interconnection requirements. The CPUC’s proposed decision (R.11-09-011) on revisions to Rule 21 requires the installation of smart inverters on DER. One of the requirements of the smart inverters is to provide voltage control.

Financial compensation

The following stakeholder comments are related to financial compensation aspects of the proposal.

Comment: Several stakeholders including; SDG&E, CDRW, SCE, Six Cities, and PG&E, submitted comments that generally oppose capability payments for meeting standard reactive power requirements:

SDG&E believes existing compensation mechanisms should continue to be used and the ISO’s proposal to permit generators to demonstrate that their costs for the capability of providing reactive power have not been fully recovered is administratively inefficient and could result in higher costs. It does not make business sense that a generator would enter into a contract, and participate in markets, where the revenues are not sufficient to earn a minimum acceptable return on the investment needed to build the real and reactive power capability.

CDWR does not support any form of capability payments to resources for meeting standard reactive power requirements, regardless of how limited in scope these payments may be.

SCE states that providing existing resources a capability payment would entail not just a determination of whether a resource is compensated within its contract but also the mechanism for delivery of payment by the CAISO to ensure no double payment occurs and that the appropriate payment is received by the right party.

Six Cities oppose the ISO’s proposal to provide financial compensation for the capability to produce reactive power to certain new resources based on some as-yet unspecified demonstration that their fixed costs for reactive power capability are not covered under existing contracts. The ISO should not adopt it and should instead revert back to its existing approach

of compensating resources only for the production of reactive power outside standard design ranges.

PG&E believes the ISO's proposal to compensate asynchronous resources where compensation occurs in the contract will inappropriately interfere with the contracting process. It incents parties not to include the reactive power capability compensation in contracts. Providing reactive power by generating resources (synchronous and asynchronous) in the normal range is viewed as a necessary condition for conducting business

ISO Response: After review of stakeholder responses and internal assessment, the ISO is not proposing any form of capability payments for reactive power. The ISO believes that providing reactive power capability constitutes good utility practice and should be a necessary condition of interconnecting a resource to the ISO grid.

Comment: Several stakeholders including; LSA, CalWEA-AWEA, and CalPeak and Malaga, submitted comments requesting that provision payments take into account the potential costs/profits associated with resources PPA agreements and associated revenues, including lost PTC revenues.

CalWEA-AWEA state this payment should principally cover the opportunity cost to the asynchronous generator for withholding real power generation in order to provide the requested reactive power, which corresponds to lost revenue based on the PPA price and lost PTC, if any, rather than the generator's LMP.

LSA commented that most PPAs for asynchronous generators contain per-MWh payments only, so fixed costs as well as variable costs are recovered in energy payments; thus, the entire amount of the PPA payment is lost. LSA suggests that the ISO avoid the need for that interpretation by broadening its current relationship with Potomac Economics to include establishment of project-specific provision payments.

CalPeak and Malaga comment this payment should principally cover the opportunity cost to the asynchronous generator for withholding real power generation in order to provide the requested reactive power, which corresponds to lost revenue based on the Power Purchase Agreement (PPA) price and lost PTC, if any, rather than the generator's LMP.

ISO Response: The ISO believes its current reactive power provision payment methodology continues to be appropriate. Utilizing the higher of the LMP or generator bid opportunity cost calculation for provision payments is a reasonable and appropriate methodology. The ISO does not believe feasible to include PPA and PTC values in opportunity cost based provision payments due to verification and gaming concerns.

Comment: Several stakeholders including; LSA, CalWEA-AWEA, NRG, WPTF, and CESA, comment on the need to compensate all resources for reactive power capabilities:

LSA recommends that the ISO reinstate capability payments to existing resources, for the reasons explained below.

CalWEA and AWEA express concerns with the ISO's backtracking on cost compensation for reactive power capability and its proposed requirement that the generator first demonstrate that it is not receiving double payment for providing reactive power capability – one time as part of the interconnection process and a second time as part of its PPA payment. CalWEA and AWEA object to this provision of the Straw Proposal.

CalWEA and AWEA comment that given the highly competitive resource auction process in California and the ensuing PPA payments, it is nearly impossible for a generator to demonstrate that it did not receive double payment for its reactive power capability.

CESA expects the ISO should develop rules that promote market efficiency, fairness, and other important principles. While out-of-the-market contractual issues may occasionally require consideration, the ISO should generally avoid rules based primarily on assumptions about contracts. The ISO should also reasonably expect that contracts may have provisions for the sharing, acceptance, or avoidance of regulatory risks, which likely factor into contract valuations. This viewpoint will liberate the ISO to make changes primarily based on an independent assessment of best-practices, reasonableness, and market efficiency. Finally, the ISO should not assume all resources have long-term contracts. This assumptions may hinder market participation by discouraging participation from uncontracted "merchant" resources.

NRG states the CAISO's proposal to pay reactive power compensation only to new resources that demonstrate those costs are not covered in their bilateral contracts is both discriminatory and requires that the CAISO interpret bilateral contracts.

NRG can find no examples of bilateral contracts that include reactive power compensation. Not every resource that provides reactive power to the CAISO also has a bilateral contract. Denying compensation on the basis that such costs are covered by bilateral contacts discriminates against resources that do not have bilateral contracts. Furthermore, bilateral contracts often only cover parts of the year or specific months. The most common type of bilateral contract is a Resource Adequacy contract, which is not intended to allow for recovery of fixed costs, such as those incurred to provide reactive power support.

NRG stated that if the ISO is going to impose a uniform reactive power requirement regardless of whether the resource actually needs to provide reactive power at that location, the ISO must ensure that the reactive power that is provided is compensated.

WPTF stated that not all interconnected resources have a capacity contract. The presumption that reactive power costs are recovered through contracts ultimately can only to apply to resources that have a contract in the first place.

WPTF stated that not all interconnected resources have going forward fixed costs covered in their contract. As the ISO noted, the Resource Adequacy construct leads to many different contractual provisions. It is possible that costs to provide reactive power may or may not be included in any given contract. Therefore some resources may be compensated for the service to the grid while other resources are not.

ISO Response: Based on stakeholder comment and further internal review, the ISO does not intend to propose any form of capability payments for reactive power. Providing reactive power capability constitutes good utility practice as a condition of interconnecting to the ISO grid.

Comment: WPTF states the ISO suggested that ultimately market participants may recover these costs will through the energy market by adding a small portion of the resource's reactive power fixed costs to their energy bid.

ISO Response: The ISO does not advocate that resources include any fixed costs for reactive power capability in their energy market bids.

Comment: CalPeak and Malaga: CalPeak and Malaga ask the ISO to take the necessary steps to publish historic reactive power production and consumption data to better inform the stakeholders in this process. We recognize that recording, reporting, and analyzing information associated with reactive power will be time-consuming and expensive for the ISO. We submit, however, that the effort is needed to better understand the reactive power resources currently available that are capable of ensuring reliability prior to designing structures such as compensation for new asynchronous resources.

ISO Response: The ISO no longer intends to provide reactive power capability payments. For this reason, the ISO does not believes that the data analysis requested by CalPeak and Malaga is necessary.

Comment: CDWR states the CAISO should acknowledge that having enough reactive power capability is in the best interest of all resources – generators, loads, exports, and imports. Therefore, the cost of providing or absorbing "extra" reactive power should be allocated among all resources within a specific region, not just ISO load in general.

ISO Response: The ISO is no longer proposing capability payments to any resources and the current provision payments are not allocated to resources because there is not a reasonable methodology for accurately identifying and subsequently allocating the costs to resources.

Comment: Several stakeholders, including Wellhead, Siemens, and CalPeak and Malaga, comment on the need to compensate resources that may not be producing real power and unable to earn any opportunity cost based provision payments under the current structure as well as other related issues:

Wellhead believes it is appropriate for market participants to be able to earn a profit from providing reactive support services, we believe, as a minimum, that all resources should be eligible for cost recovery even when it is minimal as is the case with asynchronous resources.

Siemens believes fair compensation for this additional clutch/STATCOM-mode service would produce a fair rate of return for the system owner that takes into account the cost of the equipment and the operational costs (i.e. system losses associated with the conversion), as well as some incentive for making this capability available, e.g., an annual reactive capacity payment, as used in New York and New England.

CalPeak and Malaga support a structure allowing a Default Energy Bid value that allows for a provision payment when resources are providing reactive power. Ultimately, there should be linkage between the real energy price at the LMP and the reactive power value, as the voltage support is directly enabling the delivery of real power for which a market price exists. In lieu of an LMP-linked structure, CalPeak and Malaga would also support a Negotiated Rate Option for the Default Energy Bid. To most effectively implement provision payments for reactive power in special cases, CalPeak and Malaga recommend exploration of changes to the loading order to recognize the fact that certain "non-typical" resources provide reactive power without emitting GHGs and without consumption of water.

ISO Response: The ISO is proposing a new Exceptional Dispatch category and provision payment to address cost recovery for resources that provide reactive power without real power output. This new ED and payment structure will address those situations when resources may not have any calculated opportunity costs under the current provision payment structure.

This provision payment need not be linked to the LMP for the real energy price because the ISO does not conduct a market based procurement and optimization of reactive power along with the energy market. The components of LMPs reflect the system's topology condition (congestion), energy bids, and real power losses, and when calculated the LMP would not correctly signal the value of reactive power in that location. Simply because the LMP at a location is relatively high or relatively low would not accurately reflect a market based value for reactive power in that location, which is essentially a reliability service with very specific locational needs. There are some instances that the production of reactive power is necessary to allow for the delivery of a resources own real power but there are also instances that reactive power may need to be absorbed to provide the network with voltage support. It is simply too complex to determine what needs are being caused by generators themselves and the other factors including topology of the system and other items such as overall load and generation conditions on the system and in specific locational areas.

The ISO is not proposing to change the loading order of resources for the purposes of reactive power provision, and believes this request is outside of the current scope of this initiative.

Comment: CESA requests clarification regarding the costs of provisioning reactive power from asynchronous resources like energy storage in cases where no real power is being provided to the extent that this is not covered by exceptional dispatch cases. CESA expects resources under this possible case to receive fair cost-recovery. Relatedly, costs for energy storage 'fuel' and energy storage default-energy bids need clarification by the CAISO.

ISO Response: As noted above, the ISO is proposing a new Exceptional Dispatch category and provision payment to address cost recovery for resources that provide reactive power without any real power output. This new ED and payment structure will address those situations when resources may not have any calculated opportunity costs under the current provision payment structure. Additionally, the ISO believes that the provision of reactive power within the standard lead/lag range constitutes good utility practice. The ISO fully supports compensation according to the current provision payment methodology for reactive power provided outside of the standard required range.

Appendix B: Uniform requirement technical issues

Hunting

Multiple asynchronous 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 asynchronous resources share a common generation tie and are assigned to regulate voltage at a common POI.

The ISO's proposal is expected to mitigate this concern by allowing asynchronous resources to control its terminal voltage. The ISO proposes to allow developers the flexibility to develop a control scheme to utilize a voltage droop function with necessary supervisory control to allow reactive power sharing among the asynchronous resources.

The ISO proposes that developers can work together and elect to control the schedule voltage at a common station beyond the POI with other plant-level reactive support equipment.

Collective generation projects

Many asynchronous resources comprise multiple devices aggregated for production at the wholesale level. The ISO proposes a uniform interconnection requirement to ensure the availability of sufficient and usable reactive capability in the operations horizon. Under the proposed reactive power requirements each resource must meet a power factor of 0.95 leading and lagging at or near the POI. Asynchronous resources may use a variety of means to meet this requirement, such as oversizing inverters, or using fast switching devices. The ISO will not discriminate based on technology aggregated within the participating resource. If all individual devices comprising an aggregated resource can meet this reactive requirement under the same participating resource, then the resources can participate in the market in any way it prefers. If the aggregated resource depends upon devices or sub-parts of the combined resource to meet this requirement, it must be dispatched under a single Resource ID in the market.

The ISO proposes to allow any collective generation project to participate in the market however it sees fit, provided that the resource can fully meet this requirement thus ensuring visibility, reliability, and availability of the reactive capability in the operations horizon. This proposal will serve as a universal planning requirement that ensures the availability of sufficient reactive capability in the operations horizon. Allowing a resource to participate in the market without this capability circumvents this process and creates the possibility of a generation dispatch and power transfer scenario in the operations horizon not reviewed via the planning process.

Metering and telemetry

All resources participating in ISO markets must execute a meter service agreement and have ISO meters. There are no exemptions for size or unit type. The Metering BPM, appendix B, outlines

technical specifications required for these meters. These include reactive power metering requirements.

Generating Units connected to the electric grid within the ISO balancing authority area (BAA) must install telemetry equipment and/or software that can interface with the ISO's Energy Management System (EMS) to supply telemetered real-time data.

These rules apply to all resources that:

(1) Have a capacity of ten MW or greater, or

(2) Provide Ancillary Services, or

(3) Are Eligible Intermittent Resources

The BPM for telemetry defines reactive power telemetry requirements. Resources must provide MVAR value at the point of delivery (POD/POI) - where the unit connects to the ISO controlled grid. POD MVAR establishes reactive power delivery to the system and the impact on system voltage. This value may be obtained by installing instrument devices at or on the unit side of the POD. It can be calculated by providing an accurate conversion of another data point measured at the same voltage level as the POD. The value must represent an accuracy of +/-2% of the true value of POD MVAR represented in the ISO revenue meter.

Inverter size

During the Interconnection Request (IR) validation process, the ISO validates that the generating resources net MW equal gross MW minus auxiliary load. The gross MW is the total installed capacity of the inverters. When inverters are used to provide reactive power, we ask the interconnection customer to note that the gross MW is a lower number than nameplate MW, which is at unity power factor.

Item 2A[19] of the Interconnection Request asks for the Total Generating Facility rated output (MW) that represents the gross output number at the generator terminals. Typically, the inverter MW capacity provided by the manufacture is at unity power factor. The MW capacity under a different power factor is lower than that under unity power factor. If the Interconnection Customer uses inverters to meet the reactive power capability requirement, the ISO requests that the MW capacity and the associated power factor is indicated on the form.

The ISO proposes to explicitly change the Interconnection Request form to include both MVA rating and MW rating for inverter based generators for ease of compliance verification.

The Generator Management BPM, section 3.5.4.1, describes how the ISO evaluates inverter changes that would cause a capacity increase greater than the project net capacity listed in the Interconnection Customer's interconnection request. However, at no time may the Generating Facility's inverter configuration increase the project's net capacity by more than the greater of:

[19] https://www.caiso.com/Documents/SampleInterconnectionRequest-TechnicalData-Solar-Wind.pdf

- Ten percent (10%); or
- Three (3) MW

One stakeholder submitted a comment that appears to express concern that this limitation would prohibit a generation project from meeting the 0.95 lead/lag reactive power requirement if a resource voluntarily provided reactive power. During the August 20, 2015 stakeholder meeting the ISO explained that a generator that increased its inverter capacity by 5.2% could improve its power factor capability from a 1.0 power factor to a 0.95 lead/lag power factor, which is within the 10% limit.

Inverter cost

The cost of including reactive power capability as a percentage of project costs is relatively small.[20] Some entities contest this fact and argue that applying a uniform reactive power requirement to asynchronous resources creates significant capital and operational costs.[21]

The ISO recognizes the possible concern that a uniform requirement for asynchronous resources to provide reactive power capability and voltage regulation could impose higher inverter costs on those projects that would otherwise avoid such requirements through the system impact study approach currently in use. In this context the ISO conducted outreach with inverter manufacturers such as General Electric and Siemens to learn more. The ISO found that:

- Approximately 5 percent of total plant cost is attributable to inverters and associated equipment (e.g., transformer, controller). This is a sunk cost because all asynchronous resources must have inverters. Given the sunk costs, the incremental costs for adding reactive power capabilities are less.
- Reactive power capability is now a standard feature of inverters used in both wind and solar PV applications and there is no additional cost for reactive power capability. Typically, these inverters can provide 0.95 leading and lagging power factor at full real power output at the POI.

Based on these observations, the ISO believes the additional costs, if any, due to a uniform requirement would likely be *de minimis*.

[20] *Id*. at 141:10-124:6.

[21] *See e.g.* Comments of the American Wind Energy Association in response to the April 22, 2014 workshop on Third Party Provision of Reactive Supply and Voltage Control and Regulation and Frequency Response Services filed in FERC Docket AD 14-7 at 7-8. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13567273