California ISO
Shaping a Renewed Future

Energy Storage Interconnection

Draft Final Proposal

November 18, 2014

Table of Contents

Energy Storage Interconnection

Draft Final Proposal

1 Executive summary

Interest in storage is significant and continues to grow. Policy makers and regulators at both the state and federal level have recently expressed interest in, and support for, energy storage. Expanding the use of energy storage systems is viewed as a means to optimize the use of wind and solar generation, assist in integrating increased amounts of renewable energy resources into the grid, and reduce emissions of greenhouse gases. Developers have responded to this growing interest by submitting 34 interconnection requests to the ISO for over 2,000 MW of projects with an energy storage component in Queue Cluster 7. This represents 46 percent of all projects in Cluster 7.

The ISO is committed to helping facilitate the development of energy storage, and through this energy storage interconnection initiative has been working with stakeholders to assess whether any potential policy and process changes to existing ISO interconnection rules are needed to accommodate storage. Through this effort an approach was developed whereby existing tariff rules can accommodate the interconnection of storage to the ISO controlled grid without the need for tariff changes. Key to this approach is that storage projects are treated as generators for both aspects of their operation. This means that a storage resource is treated as a generator that produces positive energy (i.e., positive generation) during discharge mode and negative energy (i.e., negative generation) during charge mode. This is consistent with how storage is presently treated in ISO markets under the non-generator resources (NGR) model. In addition, just like conventional generation, the resource must respond to ISO dispatch instructions, including curtailment to manage congestion. In the context of storage, this would apply during both discharge and charge modes. This approach is limited to grid-level interconnections of stand-alone storage and storage combined with generation, but not storage combined with load.

Storage interconnection requests in Cluster 7 are successfully being processed under existing tariff rules using the developed approach and their Phase I study results are expected on December 17, 2014. To ensure that technical data unique to energy storage was provided by projects requesting interconnection through Cluster 7, the ISO modified its interconnection request form to include technical data relevant to storage projects. Based on experience gained with Cluster 7 the ISO will continue to review information requirements and consider further improvements to the interconnection request form for future queue clusters.

This initiative also has been used to discuss other storage issues such as: processes for modifying existing projects to add storage (both those still in the queue and those that have already achieved commercial operation); resource adequacy and deliverability issues; rate treatment issues; and, the SCE-suggested topic of a "charging deliverability assessment," among others. These and other issues are discussed in this paper.

The ISO would also note that it has joined with the CPUC and CEC to develop an Energy Storage Roadmap to ensure that the broad array of challenges and barriers confronting storage are addressed in a coordinated fashion.

This paper is being presented as the final paper in this initiative until there is a need to consider further issues. If later there is a need to examine additional interconnection issues related to storage, the ISO will consider those at that time either through a continuation of this initiative or through another initiative, as appropriate. Since it has been concluded that no changes to existing tariff rules have been identified as necessary to accommodate storage interconnection to the ISO grid, approval from the ISO Board of Governors is not necessary at this time. The ISO will hold a stakeholder web conference on November 25 to discuss this paper and is inviting stakeholders to submit comments by December 12.

As a next step following this initiative, the ISO will consider which of the clarifications contained in this paper may be appropriate to reflect in the relevant Business Practice Manual(s).

2 Introduction

Policy makers and regulators, at both the state and federal level, have recently expressed interest in, and support for, energy storage. In 2010, California Assembly Bill 2514[1] found that expanding the use of energy storage systems could optimize the use of wind and solar generation, assist in integrating increased amounts of renewable energy resources into the grid, and reduce emissions of greenhouse gases. This bill required the California Public Utilities Commission (CPUC) to determine targets for energy storage procurement to be achieved by each load-serving entity. In 2013, pursuant to this bill, the CPUC adopted an energy storage procurement framework and established a target of 1,325 MW of energy storage to be procured by Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), and San Diego Gas and Electric Company (SDG&E) by 2020, with installations required no later than the end of 2024.[2]

[1] California Assembly Bill 2514 was approved by the Governor on September 29, 2010.
[2] CPUC Decision 13-10-040 issued on October 7, 2013.

Also in 2013, the Federal Energy Regulatory Commission (FERC) issued Order No. 792, wherein FERC made the determination to revise the definition of a Small Generating Facility in the *pro forma* Small Generator Interconnection Procedures (SGIP) and Small Generator Interconnection Agreement (SGIA) to explicitly include storage devices.[3] FERC revised the definition of Small Generating Facility in Attachment 1 to the SGIP and Attachment 1 to the SGIA as follows: "The Interconnection Customer's device for the production and/or storage for later injection of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer's Interconnection Facilities."[4] The ISO incorporated this into the definition of the term Generating Facility used for both the SGIA and the Large Generator Interconnection Agreement (LGIA) in appendix A of the ISO tariff (and in appendices EE and FF). The FERC accepted the ISO's tariff revisions regarding electric storage devices in its November 3, 2014 order.[5]

The ISO is committed to helping facilitate the development of energy storage, and through this energy storage interconnection initiative has actively worked with stakeholders to identify any potential policy and process changes needed to address interconnection challenges faced by storage developers. Prior to starting this stakeholder initiative in March of this year, the ISO began an examination of its generator interconnection process in late 2013 to consider whether the unique characteristics of energy storage – its ability to behave as either a positive generator (i.e., in discharge mode) or a negative generator (i.e., in charging mode) and its potential to quickly switch between these two modes – presented any challenges for the ISO's interconnection process. This examination indicated that the existing interconnection process would be able to accommodate energy storage interconnection requests without any further tariff changes.

The CPUC order establishing procurement targets for energy storage had the effect of triggering a significant amount of energy storage interconnection requests in the ISO's Cluster 7 application window that closed on April 30, 2014. In total, the ISO received interconnection requests for approximately 1,042 MW of stand-alone storage (23 projects) and approximately 1,016 MW of storage combined with generation (11 projects).[6] In total, this represents over 2,000 MW of energy storage (34 projects), or 46 percent of all projects in Cluster 7. An additional amount of interconnection requests for energy storage were submitted through the distribution interconnection processes of the participating transmission owners. Of these latter requests, those requesting full or partial capacity deliverability status will be studied for deliverability purposes in the ISO's interconnection study process pursuant to the Generator Interconnection and Deliverability Allocation Procedures (GIDAP).

---

[3] *Small Generator Interconnection Agreements and Procedures*, FERC Order No. 792, 145 FERC ¶ 61,159 (2013).
[4] FERC Order No. 792 at PP 227, 228.
[5] 149 FERC ¶ 61,100.
[6] The ISO generator interconnection queue as of October 24, 2014 (in both spreadsheet and PDF formats) can be found at: http://www.caiso.com/participate/Pages/Generation/Default.aspx

These storage interconnection requests were accommodated, and are being processed, under existing tariff rules without the need for tariff changes and the Phase I study results for Cluster 7 are expected on December 17, 2014. Thus the ISO has used this stakeholder initiative to present its approach for processing these interconnection requests of storage resources under existing tariff rules, and refine the approach based on stakeholder feedback. A summary of the most recent stakeholder feedback is provided in section 4. Section 5 of this paper provides more details on how this is being accomplished.

This initiative also has been used to discuss other storage issues such as processes for modifying existing projects, both those in the queue and those that have already achieved commercial operation, to add storage (section 6), resource adequacy and deliverability issues (section 7), rate treatment issues (section 8), the suggested topic of a charging deliverability assessment (section 9), dual use assets (section 10), metering and telemetry related questions (section 11), fast track (section 12), and power factor requirements (section 13).

The ISO would also note that it has joined with the CPUC and CEC to develop an Energy Storage Roadmap[7] to ensure that the broad array of challenges and barriers confronting storage are addressed in a coordinated fashion.

3 Stakeholder process

The ISO launched the energy storage interconnection initiative in late March 2014 in anticipation of receiving interconnection requests for energy storage in the Cluster 7 application window (i.e., the window that would close April 30, 2014). The initial purpose of the initiative was to provide a forum for issue identification and solution development related to energy storage interconnection requests to the ISO controlled grid.

The ISO's first step in this initiative was to reach out to stakeholders, present its proposed approach for accommodating storage interconnection requests under existing rules, and solicit stakeholder feedback. To accomplish this the ISO held a stakeholder web conference on April 7 to discuss existing processes available for the interconnection of energy storage facilities to the ISO controlled grid and how it intended to use these existing processes to accommodate the storage interconnection request applications anticipated in Cluster 7. Following this initial web conference, stakeholders were invited to submit written comments by April 14 on issues of immediate concern – i.e., those related to interconnection request applications planned to be in Cluster 7. Stakeholders were also invited to raise issues of a policy nature.

In response to issues of more immediate concern raised by stakeholders, the ISO posted supplemental information for the interconnection request on the ISO website on April 22.[8] This

---

[7] http://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx

document clarified the technical data necessary to ensure that the ISO studies Cluster 7 energy storage projects appropriately. The document also clarified that the ISO will use information from the discharge cycle in the deliverability assessment for Cluster 7 – i.e., the ISO will use the four-hour discharge capacity, which is at most the total storage capacity in MWh divided by four.

In a June 24 issue paper and straw proposal the ISO further clarified its approach for applying the GIDAP to Cluster 7 storage projects based on further development by the ISO and a consideration of feedback received from stakeholders. The ISO held a stakeholder web conference on July 1 and invited stakeholder comments by July 15.

The ISO then held an in-person stakeholder meeting on August 13 to further clarify for stakeholders its application of existing GIDAP rules to Cluster 7 storage projects as well as subsequent queue clusters, review existing processes for project modification, and begin to discuss resource adequacy-related interconnection issues. The ISO also used this meeting to further explore with stakeholders whether changes to the GIDAP were needed. Written stakeholder comments were requested by August 20.

Based on a review of stakeholder comments the ISO has concluded that no changes to the GIDAP have been identified as necessary to accommodate storage interconnection to the ISO grid. As a consequence, the stakeholder process schedule has been modified to eliminate the step of going to the November ISO Board meeting. Also, this paper is being presented as the final paper in this initiative until there is a need to consider further issues. If later there is a need to examine additional interconnection related to storage, the ISO will consider those at that time either through a continuation of this initiative or through another initiative, as appropriate.

The following table summarizes the stakeholder process schedule for the remainder of the energy storage interconnection initiative.

Stakeholder process schedule

Step	Date	Activity
Issue identification and collection	April 7	Stakeholder web conference
	April 14	Stakeholder comments due
Issue paper and straw proposal	June 24	Post issue paper / straw proposal
	July 1	Stakeholder web conference
	July 15	Stakeholder comments due

[8] http://www.caiso.com/Documents/EnergyStorageProjects-SupplementalInformation.pdf

Stakeholder process schedule		
Step	**Date**	**Activity**
Additional stakeholder outreach	August 13	Stakeholder meeting
	August 20	Stakeholder comments due
Draft final proposal	November 18	Post draft final proposal
	November 25	Stakeholder web conference (10am – 12pm)
	December 12	Stakeholder comments due

4 Summary of stakeholder comments

Following the August 13 stakeholder meeting, the ISO received nine sets of written comments on or about August 20 from the following stakeholders: California Energy Storage Alliance (CESA), California Public Utilities Commission (CPUC) staff, Clean Coalition, Large-scale Solar Association (LSA), Pacific Gas and Electric (PG&E), RES Americas, Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside, California (Six Cities), Southern California Edison (SCE), and Terra-Gen Power. These comments are summarized below.

CESA – Believes that the ISO's framework developed under existing GIDAP rules for accommodating energy storage interconnection requests represents a significant step forward in providing a fair and transparent interconnection process for energy storage resources. While recognizing that rate treatment issues are out of scope in this initiative, CESA believes it to be important that the charging of energy storage devices for wholesale market functions not receive distorted price signals versus discharging, nor should wholesale storage subsidize end use load by paying demand charges or other retail rate components. Recommends that the ISO clearly articulate the process by which it will determine the "worst case" reliability study scenario (i.e., peak versus partial peak) for a project. CESA agrees that the interconnection process (as narrowly defined in this stakeholder initiative) likely does not require tariff changes to accommodate energy storage. CESA supports unbundling flexible capacity from system/local capacity. CESA supports developing a flexible capacity study process during the interconnection process that would evaluate the ability of resources to meet the spring partial peak system needs and result in 'flexible deliverability status' and effective flexible capacity value tied to the system's ability to support those specific needs. Flexible Deliverability would be a separate status from Full Capacity Deliverability Status (which is actually Peak Deliverability status); a resource seeking deliverability could seek one or both Flex Deliverability and Peak Deliverability. CESA does not support a charging deliverability study specific to grid-charged energy storage resources, because to do so would unfairly burden energy storage resources to pay for network upgrades to obtain a level of fuel availability that no other generation resource must obtain. This would artificially make network upgrades for an energy storage resource look more expensive than, for example, a natural gas plant which is not required to provide the same guaranteed level of fuel availability. CESA believes the issue of dual use assets—resources that provide a transmission and distribution deferral or system reliability function as well as a wholesale market function—is still a significant open question and barrier to the cost effective deployment of energy storage.

CPUC staff – The framework proposed by the ISO for accommodating Cluster 7 energy storage interconnection requests appears to provide a workable starting point. For storage interconnection purposes going forward, it appears that changes to the GIDAP will be desirable to develop some method for determining the "deliverability" of charging. Such a charging deliverability assessment should be part of an integrated storage interconnection process that accounts for both charging and discharging. Believes it may ultimately be possible to unbundle flexible capacity from system/local capacity; the CPUC may consider unbundling issues in its upcoming resource adequacy proceeding.

Clean Coalition – While no changes to the GIDAP tariff appear currently necessary to accommodate most storage interconnections at this time, some refinement in the study processes and Fast Track eligibility should be considered as soon as practical. The application of devices and operational settings limiting the maximum total export to the grid should be allowed when determining Fast Track review eligibility and in grid impact studies; it is the maximum impact of the total facility as measured at the point of common coupling with the grid system that should be considered, rather than the additive impact of each component of the facility. Supports reconsideration of bundling; limited exceptions to bundling requirements for storage will have limited impact on the larger RA market and would provide real world testing of any such impacts while maximizing access and contribution of these resources.

LSA – Agrees that a behind the meter capacity addition request could be submitted through a material modification assessment request if the original generation project has not yet begun construction (i.e., still in the queue). However, LSA believes that an interconnection customer should be allowed to request a behind the meter capacity addition through a material modification assessment regardless of the construction status of the original project. LSA believes that such requests that raise potential materiality concerns can be processed through the independent study process, whether or not the original project is operational, as a secondary path if necessary.

PG&E – Strongly supports accommodating Cluster 7 energy storage interconnection requests and future energy storage interconnection requests under the existing GIDAP framework based on two criteria. First, this approach is limited to storage devices interconnected to the ISO controlled grid that are stand-alone storage or storage combined with a generator, but not storage combined with load. Second, this approach is limited to storage devices that respond to ISO dispatch instruction, including curtailment to manage congestion, during both charging and discharging. If a storage facility elects not to respond to ISO dispatch for its charging, it can request firm load service from the PTO through existing load interconnection processes. A firm load request to PG&E will reside under CPUC jurisdiction. Reliability studies for the discharge operation should be studied the same way as conventional generators. For charging mode, network upgrades should only be identified for overloads that cannot be mitigated through congestion management. Cautions against developing worst case scenarios to study for informational purposes as it may add significant cost and time to the interconnection study process and not provide commensurate value. Believes that the current GIDAP is mostly sufficient to accommodate storage generator interconnections; however, the interconnection request should be updated to include technical data relevant to storage projects. Believes that the CPUC's resource adequacy proceeding is the appropriate venue for discussion of whether flexible capacity should be unbundled from system/local capacity. Believes having good information about the ability of a storage device to charge, with respect to congestion and/or other constraints would be extremely helpful. The concept of a "charging deliverability assessment" is fundamentally different from the current deliverability assessment that evaluates a generator's ability to discharge under worst case scenario conditions. A lot of the value of a storage device is its ability to operate (charge and discharge) in a manner that alleviates stress on the grid by mitigating some operational challenges, not by operating under worst case conditions. PG&E is supportive of an effective "charging deliverability assessment" if one can be developed, but again cautions against costly and time intensive studies without commensurate value. PG&E's understanding is that storage projects that are asynchronous generating facilities will need to meet the same power factor requirements as generating facilities in both 'charge' and 'discharge' modes. If a Phase II charging or discharging mode study requires +/- 0.95 power factor at the point of interconnection, then the storage facility will need to be capable of meeting it in both modes. If a Phase II study does not require +/- 0.95 power factor in both charging and discharging modes, then the storage facility needs to maintain unity power factor at the point of interconnection. While PG&E recognizes that metering and telemetry are out of scope for this initiative, it believes it is critical to quickly move forward with establishing metering and telemetry rules for storage devices. In particular, storage resources should be able to respond to ISO real-time dispatch instructions through the automated dispatch system (ADS).

RES Americas – RES would like the ISO to contemplate scenarios where a storage resource may not necessarily be developed for resource adequacy purposes and/or be under a more merchant ownership model where the resource would be providing other services to the system. Specifically, if the ISO is dispatching a storage resource without considering its state of charge or the general wear on the facility from excessive cycling, project economics could be greatly impacted.

Six Cities – Generally supports treating storage projects as generators for both aspects of their operation (i.e., charging and discharging). At this time the Six Cities have not identified any changes to the GIDAP tariff necessary to accommodate interconnection of energy storage facilities. Supports further consideration of unbundling flexible capacity from system/local capacity.

Allowing energy storage resources to elect qualification as "Flexibility Only" RA, as System/Local RA, or as System/Local/Flexible RA will allow energy storage resources to tailor interconnection arrangements so as to enhance the economic value of the projects and potentially expand the flexible attributes available to the ISO; however, this will require rigorous adherence to the cost causation principle in identifying and assigning the costs associated with interconnection and deliverability of energy storage resources based on the requested qualifications and operating options. Disagrees with the ISO's suggestion that an energy storage resource's ability to charge is analogous to a conventional generator's ability to obtain fuel and, therefore, outside the scope of interconnection analysis. An energy storage resource's ability to charge both depends upon and affects the transmission grid, unlike fuel delivery arrangements for conventional generators. Tests should be conducted to confirm that an energy storage resource is able to fully charge at least once during each 24-hour day in order for that resource to qualify to provide resource adequacy. The nature of the required tests should depend on the type of resource adequacy for which the resource desires to qualify. If the resource requests qualification to provide flexible resource adequacy, then the ISO should test for ability to charge during peak hours. For energy storage resources that wish to qualify for system/local resource adequacy, it should be sufficient to confirm that the resource can charge fully during off-peak periods.

SCE – Supports utilizing the existing GIDAP provisions to process interconnection requests from energy storage developers in Cluster 7; however, SCE recommends that the ISO revisit treating energizing load for energy storage as negative output to discern whether such treatment is sustainable for Cluster 8 and beyond or whether tariff modifications are warranted. Because there is the possibility that an energy storage project may seek a higher degree of freedom in terms of when/time of day it would like to charge its storage device and not be subject to ISO dispatch instructions including curtailment, thus requiring use of the PTO load interconnection process, the ISO should consider revising its GIDAP so that there would be a more holistic and streamlined approach to the interconnection of energy storage projects. For energy storage projects that do not want to be treated as generators and therefore subject to ISO dispatch instructions and curtailment, SCE suggests that the ISO consider whether the storage developer could propose network upgrades as merchant transmission facilities under section 24.4.6.1 of the ISO tariff. SCE asks the ISO to clarify what it means by "unbundling" and how the ISO's definition of "unbundling" differs from simply determining different net qualifying capacity and flexible qualifying capacity values for the resource. SCE believes that the deliverability of both the charging and discharging functions should be fully evaluated through the GIDAP. In particular, SCE believes that a "charging deliverability assessment" is necessary to ensure the storage facility can fully charge in order to provide energy sufficient so that the amount which qualifies for resource adequacy is actually made available. A "charging deliverability assessment" would model minimal local area generation at various local area load demand conditions and evaluate if incremental charging requirements drive the need for congestion management. The assessment should ascertain if sufficient hours are available to fully charge every single storage resource seeking interconnection which also has sought out full capacity deliverability status. If the studies do not identify sufficient hours available to fully charge every single storage resource seeking full capacity deliverability status due to transmission limitations, then a delivery network upgrade should be identified to address such transmission limitation(s) and such upgrade should be classified as a delivery network upgrade since it would be necessary to ensure every single storage resource seeking interconnection which also has sought out full capacity deliverability status are fully charged. Cost responsibility for network upgrades (for the charging element) and rate treatment for energy storage may not be in scope in this initiative but are critically important issues that require urgent resolution in order to assist developers to reach their determination of whether or not their energy storage projects are economically viable. To defer these issues to the energy storage roadmap process is impractical. SCE believes that the Cluster 7 projects will not post the interconnection financial security in the first quarter of 2015 without knowing all of the cost responsibility for the triggered network upgrades (including for the charging element of storage) and rate treatment for the energy consumed during charging. SCE proposes that these costs and rate treatment issues be taken up immediately and not wait for the energy storage roadmap process to address them.

Terra-Gen Power – Anticipates that some minor changes to the GIDAP tariff or business practices manual may be needed to accommodate the technology spectrum for energy storage projects. Not all energy storage technologies have the ability to freely operate between zero megawatts and full charging load megawatts. The ISO needs to distinguish between energy storage projects based on the flexibility of their charging mode when identifying the need for system reliability upgrades to mitigate any charging mode overloads. Energy storage projects with flexible charging mode can mitigate these overloads by operating at a lower charging load (while the duration to fully replenish the stored energy will be longer these projects are less likely to be stranded for next day operation). In contrast, energy storage projects with inflexible charging mode can only mitigate charging mode overloads by not charging and thus risk being stranded for next day operation. To avoid the risk of these energy storage projects being stranded, any charging mode overloads caused by energy storage projects with inflexible charging mode may have to be resolved with network upgrades. Requests the ISO evaluate whether the existing GIDAP tariff or business practices manual accommodate the need to identify and assign network upgrade cost responsibility (to resolve charging mode overloads) to only energy storage projects with inflexible charging mode.

5 Applying the GIDAP to energy storage projects

New interconnection requests to the ISO grid are governed by the Generator Interconnection and Deliverability Allocation Procedures (GIDAP) approved by FERC in 2012. The GIDAP rules are contained in ISO Tariff Appendix DD. This section highlights considerations specific to applying the

GIDAP to storage interconnection and the approach the ISO is using to process these interconnection requests.

As a next step following this initiative, the ISO will consider which of the clarifications contained in this section may be appropriate to reflect in the Business Practice Manual for Generator Interconnection and Deliverability Allocation Procedures.

5.1 General approach

Stakeholders support consolidating the interconnection process for grid-connected storage under the GIDAP in order to avoid the inefficiencies of a bifurcated process that separates a storage facility into generation and load.

The ISO has concluded that existing GIDAP rules accommodate the interconnection of storage projects to the ISO controlled grid that want to be treated as generators for both aspects of their operation. This means that a storage resource is a generator that produces positive energy (i.e., positive generation) during discharge mode and negative energy (i.e., negative generation) during charge mode. This is consistent with how energy storage participates in ISO wholesale markets under the non-generator resource model (the non-generator resource model is discussed in section 8).

In addition, just like conventional generation, the resource must respond to ISO dispatch instructions, including curtailment to manage congestion. In the context of storage, this would apply during both discharge and charge modes.

This approach is limited to grid-level interconnections of stand-alone storage and storage combined with generation, but not storage combined with load.

The existing GIDAP provisions will not be utilized to assess requests by storage projects to obtain a higher level of service for their charging functions (i.e., comparable to firm load service). The GIDAP study process and cost responsibility framework do not apply to firm load. If a storage resource requests interconnection to the ISO controlled grid but does not want to respond to ISO dispatch instructions during charge mode, then it must seek such firm load service from the appropriate participating transmission owner through its existing load interconnection process. This topic is discussed in more detail in section 5.5.

5.2 Information requirements

In their comments, PG&E suggests that the interconnection request forms should be updated to include technical data relevant to storage projects. The ISO agrees and has taken actions to accomplish this.

To ensure that technical data unique to energy storage was provided by projects requesting interconnection through Cluster 7, the ISO modified its interconnection request form to include technical data relevant to storage projects and posted the revised form on the ISO website on April 11.[9] The storage-specific information is listed under item 4c in the interconnection request form and includes:

- Storage type (e.g., pumped-storage hydro, battery (with type), etc.)
- Maximum Instantaneous Capability (MW)
- Total Storage Capability (MWh)
- Maximum Charge Duration (hours)
- Maximum Discharge Duration (hours)
- Charge/Discharge Cycle Efficiency (%)

Prior to these additions, the interconnection request form only asked for the maximum net megawatt electrical output in megawatts. This should be consistent with the maximum instantaneous capability in megawatts listed above.

On April 22 the ISO posted the document "Supplemental Information for Energy Storage Projects"[10] to provide further information and request additional storage-specific technical data beyond that in the interconnection request form. This served two specific purposes. First, it provided expanded descriptions of the parameters requested in item 4c of the interconnection request form (listed above). These expanded descriptions are as follows:

- Maximum Instantaneous Capability: the highest steady-state discharging output level from the storage facility (maximum output power)
- Total Storage Capability: the maximum energy stored by the storage facility
- Maximum Charge Duration: the time to recharge the facility from full depth of discharging to maximum power
- Maximum Discharge Duration: the longest continuous operation time for the facility
- Charge/Discharge Cycle Efficiency: the efficiency between charging and discharging in a complete cycle

Second, it requested additional technical data as follows:

- Maximum demand power in megawatts. The highest steady-state charging level for the storage facility.

[9] http://www.caiso.com/Documents/GIDAPAppendix1-AttachmentA-Appendix1-InterconnectionRequest-GeneratingFacilityData.doc
[10] http://www.caiso.com/Documents/EnergyStorageProjects-SupplementalInformation.pdf

- Different discharging capacity for different duration. For example, a 1 MWh battery can be operated at 0.5 MW for 2 hours, 0.333 MW for 3 hours, 0.25 MW for 4 hours, 0.2 MW for 4 hours, and 0.167 MW for 6 hours. If a matrix of this information is more convenient to provide, the ISO asked that the applicant provide this information in matrix form.
- Power factor of load.
- Starting current of load.

All projects in Cluster 7 that proposed energy storage as a component of their project provided the additional data. The ISO will use its experience with the Cluster 7 energy storage projects to identify any additional information and modifications to the form that may be beneficial to implement prior to the Cluster 8 interconnection requests.

5.3 Reliability studies

Reliability studies performed under GIDAP on energy storage projects will consider both the discharge and charge modes. These studies are intended to identify network upgrades needed to mitigate reliability problems caused by a project that cannot be mitigated through congestion management (i.e., network upgrades to relieve operational limitations will not be identified if congestion management is the appropriate mitigation measure). These studies involve testing the reliability impacts of the project under worst-case conditions. Worst-case conditions may differ between discharge and charge modes. In its comments CESA recommends that the ISO clearly articulate how it will determine "worst-case" reliability scenarios.

For discharge mode, energy storage projects will be studied at the maximum instantaneous capability in megawatts (which, as previously described, is the highest steady-state discharging output level from the energy storage facility). Both peak[11] and off-peak[12] periods are studied. Energy storage facilities, together with other generating facilities in the electrical vicinity, are typically dispatched at maximum output level to stress the transmission system. All adverse impacts of the generators, including energy storage projects in discharge mode, on the transmission system must be mitigated by system upgrades or through congestion management. If mitigated through congestion management, the interconnection study will explain the relevant transmission limitation and how the generation can be re-dispatched.

For charge mode, energy storage projects will be studied at the highest steady-state charging level for the facility in megawatts. Both peak[13] and off-peak[14] are studied. However, depending on the circumstances of the energy storage facility, the worst-case scenario in charge mode may be

---

[11] Summer peak load – typically 1-in-10 peak load forecast is used.

[12] Spring weekend daytime peak load – 50% ~ 65% of the summer peak load.

[13] Summer peak load – typically 1-in-10 peak load forecast is used.

[14] Nighttime minimum load – about 40% of the summer peak load.

partial-peak[15] rather than peak. Study results will provide information regarding potential overload issues under assumed conditions and will identify network upgrades needed to mitigate reliability problems that cannot be mitigated through congestion management similar to analysis done for non-energy storage projects. Any identified RNUs may include SPS. However, it is unlikely that any such requirements would be identified that are in addition to or beyond those required for discharge mode.

In its comments Terra-Gen Power states that not all energy storage technologies have the ability to freely operate in charge mode between zero megawatts and full charging megawatts. Terra-Gen Power suggests that the ISO should distinguish between energy storage projects based on the flexibility of their charging mode when identifying the need for system reliability upgrades to mitigate charging mode overloads. The ISO disagrees. When conducting reliability studies to assess the worst-case impacts of an energy storage project in charge mode, all energy storage projects (regardless of the flexibility of their charging mode) are studied at the highest steady-state charging level for the facility in megawatts as previously discussed. Accordingly, assignment of network upgrade cost responsibility (to resolve charging mode overloads) does not distinguish between projects based on the flexibility of their charging mode. Flexibility of the charging mode could be incorporated into the evaluation of congestion management. If an operating limit is binding in the charging study where all the energy storage facilities are dispatched at the highest steady-state charging level, reducing charging to lower levels (given such data is available from the interconnection request), could be the first measure of the congestion management for study purposes. If this measure is not sufficient, other generating resources, such as local generation and import could be re-dispatched. The last resort would be to completely turn off the energy facilities in charging mode. Regardless of the charging flexibility, network upgrades are not needed as long as the limit violation could be mitigated through congestion management. The generation interconnection studies do not involve benefit-cost economic evaluation. If it is more economic to build network upgrades than relying on congestion management, such determination should be made through the transmission planning process.

5.4 Deliverability studies

For energy storage projects requesting Full or Partial Capacity Deliverability Status (FCDS or PCDS), deliverability studies performed under GIDAP will consider only discharge mode (deliverability is a specific measure applicable to the state's resource adequacy program; the ISO performs these studies in a manner consistent with current CPUC resource adequacy counting rules). Projects requesting FCDS will be studied at the energy storage facility's highest steady-state discharge

---

[15] Average load of summer weekday two hours before and two hours after the peak period – 75% of the summer peak load.

output level in megawatts sustainable for a four-hour period during the peak[16] period (consistent with CPUC resource adequacy counting rules). If the customer does not specify this value, then the ISO will calculate it as the total storage capability in MWh (the maximum energy stored by the facility) divided by four hours. Projects requesting PCDS will be studied at the energy storage facility's highest steady-state discharge output level in megawatts sustainable for a four-hour period and corresponding to the partial capacity for which it is requesting deliverability. Study results will provide information regarding potential overload issues under assumed conditions and will identify network upgrades necessary for the energy storage facility to achieve its requested deliverability status.

5.5 Flexibility to charge at any time

ISO interconnection studies will not identify or determine network upgrades that may be necessary to allow a storage facility to have complete flexibility to charge at any time of the day it may desire regardless of system conditions.

As was discussed in section 5.1 above, the GIDAP can accommodate the interconnection of storage projects to the ISO controlled grid that want to be treated as generators for both aspects of their operation—i.e., both charge and discharge modes. This means that a storage resource must respond to ISO dispatch instructions, including curtailment to manage congestion, during both charge and discharge modes.

The GIDAP does not apply to the situation where an interconnection customer wants the flexibility to charge at any time, e.g., to receive service on par with treatment provided to firm end-use customer load. To ensure that such charging energy can be delivered to the storage facility on demand may require network upgrades in addition to those needed to accommodate the discharge functions in accordance with ISO dispatch instructions. However, this level of service for drawing power from the grid is not afforded through the GIDAP study process and cost responsibility framework for upgrades, which relates to wholesale output responding to market dispatch. Thus, the ISO does not believe that the current GIDAP provisions can apply to such load-driven upgrades to support unrestricted charging.

If an interconnection customer wants the flexibility to charge at any time, comparable to firm load service with low risk of being subject to possible curtailment during charging mode, then the customer must seek such service from the appropriate PTO through means other than the GIDAP. For example, the interconnection customer should work directly with the appropriate PTO to request that its charging function be treated as firm load – either retail industrial load or wholesale load, depending on the regulatory determination as to whether such load is retail or wholesale in

[16] Summer peak load – 1-in-5 peak load forecast is used.

nature.[17] In its comments, PG&E suggests that such a firm load request will reside under CPUC jurisdiction. In the case of firm retail load service, the PTO's existing rules for determining cost responsibility for any identified upgrades needed to connect retail load would apply. However, the ISO understands that the charging service would then be in its entirety under retail terms. On the other hand, if a storage project's charging function is determined to be wholesale load, the PTO's existing rules for determining cost responsibility for any identified upgrades needed to connect wholesale load would apply. Another possible approach would entail the interconnection customer working with the PTO (and ISO) to identify any network upgrades needed that could be funded through a "merchant" model in which the interconnection customer would fund the network upgrades without reimbursement. Under all of these approaches, any agreements needed to address study scope and study costs would be a matter between the interconnection customer and the PTO.

Another approach suggested by some stakeholders would involve the PTO including the unrestricted charging load in its retail load forecast as part of its grid expansion planning process. As the ISO understands this approach, the PTO would present to the ISO a set of upgrades needed to accommodate growth in its retail load, and the PTO would request that the ISO approve these upgrades within the context of the ISO annual transmission planning process and allow the upgrade costs to be recovered through the ISO's transmission access charge (TAC). The ISO opposes this approach for several reasons. First, as previously stated in this paper, the ISO believes that the procurement of electric energy to charge an energy storage facility participating in ISO markets is a sale for resale and therefore a wholesale rather than retail transaction. Second, the load forecast used in the ISO's annual transmission planning process is that approved by the California Energy Commission through its Integrated Energy Policy Report process and reflects only retail load growth. Third, to include such charging load in a retail load forecast would be inconsistent with the interconnection customer intent seeking access to wholesale rates to charge its facility. Lastly, such an approach could incent the perverse outcome of identifying and approving TAC-funded upgrades to support unrestricted charging. Such an outcome contradicts the potential for energy storage to increase generation and transmission utilization and reduce the need for additional transmission upgrades. The ISO believes that such a contradictory outcome should be avoided, and is thus opposed to this suggested approach.

In its comments SCE suggests that for energy storage projects that do not want to be treated as generators and subject to ISO dispatch instructions and curtailment, the ISO consider whether the storage developer could propose network upgrades as merchant transmission facilities under section 24.4.6.1 of the ISO tariff. From a market standpoint, it is unclear from SCE's comments why a storage facility may want its discharge and charge modes to be treated distinctly separate rather

[17] The ISO's view is that for stand-alone storage or storage integrated with other generation, energy purchased to charge such projects would constitute sales for resale, and therefore should be treated as wholesale in nature.

than as simply positive and negative energy from the same generator and accommodated under existing GIDAP rules. SCE has not demonstrated why the GIDAP should include load interconnection and the ISO does not support including load interconnection in the GIDAP. However, if an energy storage developer were to seek firm load service from the PTO (through means other than the GIDAP), the ISO does believe it possible for the PTO to identify any network upgrades needed and for PTO or storage developer to propose those network upgrades under section 24.4.6.1 (and pay the full cost of construction and operation of the merchant transmission facility).

5.6 Metering and telemetry

Requisite metering and telemetry are based on the number of transformers interconnecting the project. If there is only one transformer and a separate meter and resource ID are needed for both on-site generation and storage, then low side metering is allowed pursuant to Section 10.2.10 of the ISO Tariff, provided that (1) the interconnection customer requests and receives an exemption from the ISO, and (2) the losses between the low side meter and the high side of the transformer are static.[18] An additional reason for separate metering is to allow for the different electrical characteristics to be model for resource adequacy. As an example, if the energy storage component were paired with a wind project, the capabilities of a wind project are studied at approximately 40 percent on-peak whereas storage would be considered 100 percent capability on-peak. Thus to ensure that the net qualifying capacity evaluation is correct, separate meters would need to track the various technologies.

6 Modifying projects to include storage

The ISO recognizes that developers may want to modify their projects to add storage. The purpose of this section is to clarify how two existing processes—the Material Modification Assessment and the modification review—can be used to accommodate such requests, including behind-the-meter changes. The Material Modification Assessment (MMA) and modification review processes are very similar. MMA is provided in Section 4.4 of Appendix U, Section 6.9.2 of Appendix Y (GIP) and Section 6.7.2 of Appendix DD (GIDAP). The modification review process is provided in Article 5.19 of the LGIA and Article 3.4.5 and 6.2 of the SGIA. In both cases, the interconnection customer requests an assessment to modify their project, the modification is evaluated by the ISO and PTO,

[18] "Static" means that the losses are always assumed to be constant or fixed percentage at a specific calculated amount. Static losses assume maximum generation with maximum transformer losses. This is in contrast to dynamic loss calculations where losses vary and are calculated based on actual generation levels. A separate meter and resource ID are needed in order to calculate a qualifying capacity for each generation type for resource adequacy purposes.

and the interconnection customer is charged the actual cost of the assessment; however, the process to get to the result is slightly different. In the case of a project in the queue that has not achieved their final commercial operation date, in accordance with Appendix U, Y or DD, the customer submits an initial $10,000 deposit. If the project has already achieved their final commercial operation date, then a request is made in accordance with their executed agreement to QueueManagement@caiso.com and the customer is billed after-the-fact for the study. The other difference between the MMA and modification review is the criteria used to determine whether a requested modification is approved. These scenarios and the appropriate process steps are described in greater detail below.

As a next step following this initiative, the ISO will consider which of the clarifications contained in this section on modifying projects to include storage may be appropriate to reflect in the Business Practice Manual for Queue Management.[19]

6.1 Projects in the interconnection queue

This section addresses modification of projects in the queue (i.e., under the provisions of the serial study process, the generator interconnection procedures (GIP), or the generator interconnection deliverability and allocation procedures (GIDAP)) based further on whether or not the project has achieved the project's final commercial operation date. These process steps address LSA's concern (as expressed in their comments) that a customer should be allowed to request a behind-the-meter capacity addition through a modification assessment and not be required to use the independent study process.

6.1.1 Pre-COD

If the project in the queue has not yet achieved final commercial operation date (i.e., it is pre-COD) and the customer wants to modify its project, then the ISO would use the Material Modification Assessment process. A change is deemed to be material if the modifications have a material impact on the cost or timing of any interconnection request or any other valid interconnection request with a later queue priority date.[20] If not material, then the modification is approved. If material then the project must submit a new interconnection request. The following options can be considered:

---

[19] Proposed Revision Request (PRR) 784 has, among other things, proposed to change the title of this BPM to "Generator Management." http://bpmcm.caiso.com/Lists/PRR%20Details/Attachments/784/PRR-AddRepowering-ChangeBPM-Name.docx

[20] LGIP § 4.4.3 and 4.4.5; SGIP § 1.3.4; SGIA § 6.2 and 3.4.5; GIP § 6.9.2.1 and 6.9.2.2; and GIDAP § 6.7.2.2, 6.9.2.1 and 6.9.2.2

- For projects seeking full capacity deliverability status (FCDS) above the original project's FCDS amount, one of the following two options may be used:
    - Submit a new FCDS interconnection request in the next cluster study open window.
    - Submit an ISP interconnection request if the project can meet the independent study process (ISP) technical and business eligibility criteria. This can be submitted at any time of the year with the FCDS being studied during the next cluster's Phase I and Phase II deliverability studies.
- For projects that do not seek to exceed the original project's studied FCDS amount, one of the following three options may be used:
    - Submit a new energy-only (EO) interconnection request in the next open window for the cluster study process.
    - Submit an EO ISP interconnection request (any time of the year) if the project can meet the ISP technical and business eligibility criteria.
    - Submit an ISP behind-the-meter (BTM) interconnection request if the project can meet the ISP BTM technical and business eligibility criteria (any time of the year). An automatic tripping scheme will be needed for any capacity above the original project's capacity.

6.1.2 Post COD

If the project has achieved its commercial operation date (i.e., it is post-COD) and the customer wants to modify its project, then the project would request a modification review.[21] The ISO would approve the modification request if the total capability of the project is equal to or less than its existing capability and the electrical characteristics are substantially unchanged. If the ISO does not approve the modification request, then the project must submit a new interconnection request. The following options could be considered:

- For projects seeking FCDS above the original project's FCDS amount one of the following two options may be used:
    - Submit a new FCDS interconnection request in the next cluster study open window.
    - Submit an ISP interconnection request if the project can meet the ISP technical and business eligibility criteria. This can be submitted at any time of the year with the FCDS being studied during the next cluster's Phase I and Phase II deliverability studies.
- For projects that do not seek to exceed the original project's studied FCDS amount one of the following three options may be used:
    - Submit a new EO interconnection request in the next open window for the cluster study process.

[21] LGIA § 5.19 and SGIA § 6.2 and 3.4.5

  - Submit an EO ISP interconnection request (any time of the year) if the project can meet the ISP technical and business eligibility criteria.
  - Submit an ISP BTM interconnection request (any time of the year) if the project can meet the ISP BTM technical and business eligibility criteria. An automatic tripping scheme will be needed for any capacity above the original project's capacity.

6.2 Projects already approved for repowering

This section addresses projects that have been approved for repowering and want to further modify their project[22] either before the repowered project achieves final commercial operation date or after the repowered project achieves the final commercial operation date. If the total capability is equal to or less than existing capability and the electrical characteristics are substantially unchanged, then the modification is approved. If the modification is not approved, then the project must submit a new interconnection request. The following options can be considered:

- For projects seeking FCDS above the original project's FCDS amount one of the following two options may be used:
  - Submit a new FCDS interconnection request in the next cluster study open window.
  - Submit an ISP interconnection request (any time of the year) if the project can meet the ISP technical and business eligibility criteria, with the FCDS being studied during the next cluster's Phase I and Phase II deliverability studies.
- For projects that do not seek to exceed the original project's studied FCDS amount one of the following three options may be used:
  - Submit a new EO interconnection request in the next open window for the cluster study process.
  - Submit an EO ISP interconnection request (any time of the year) if the project can meet the ISP technical and business eligibility criteria.
  - Submit an ISP BTM interconnection request (any time of the year) if the project can meet the ISP BTM technical and business eligibility criteria. An automatic tripping scheme will be needed for any capacity above the original project's capacity.

7 Resource adequacy and deliverability

As previously discussed in section 5.4, the ISO performs deliverability studies in a manner that aligns with current CPUC resource adequacy counting rules.

[22] ISO Tariff § 25.1.2

For a resource to qualify for resource adequacy (RA), it must meet certain requirements of the CPUC's or local regulatory authority's (LRA's) RA program[23]. A primary requirement of the CPUC's RA program is that the resource have both a qualifying capacity (QC) and a net qualifying capacity (NQC) greater than zero. A resource's qualifying capacity (QC) is the maximum number of megawatts eligible to be counted towards meeting a load serving entity's (LSE) system and local RA requirements. The QC is equal to the maximum output level in megawatts at which it is capable of producing for at least four consecutive hours over three consecutive days. The QC of each resource is set by methodologies established by the CPUC or the LRA.[24]

The NQC is a revised QC determined by the ISO through annual deliverability studies[25] and is the output level in megawatts that is deliverable to the aggregate of ISO load. In other words, if a resource's QC is not fully deliverable (as determined by the ISO through deliverability studies), then it is adjusted to its deliverable capacity resulting in its NQC (NQC is always less than or equal to QC).

As previously stated, the ISO performs deliverability studies in a manner aligned with current CPUC or LRA resource adequacy counting rules. At present, this means that the four consecutive hour requirement used by the CPUC remains in place and that specific to storage, charge mode does not count for RA, only discharge mode. Further it means that even if a storage resource could produce at an output greater than its QC value but could not sustain that output for more than four hours, the ISO would only assess the deliverability of the resource up to that level. If those rules were to change in the future as a result of CPUC action, then the ISO would review the need for corresponding changes in its deliverability study methodology.

The most current CPUC resource adequacy rules are described in CPUC Decision 14-06-050[26] issued June 2014 in which the CPUC made refinements to its RA program applicable to LSEs beginning

---

[23] In 2004 the CPUC adopted a resource adequacy (RA) policy framework in the aftermath of the electricity crisis of 2000-2001. The RA framework was established to ensure that sufficient resources are procured and available to the ISO for dispatch when and where needed for safe and reliable operation of the grid in real time (consistent with the ISO's operational needs). This framework established RA obligations applicable to all load serving entities (LSEs) within the CPUC's jurisdiction, including investor owned utility (IOUs), energy service providers (ESPs), and community choice aggregators (CCAs) to ensure that LSEs procure sufficient capacity. Each LSE must forward contract its peaking needs a year in advance. The CPUC's RA program requires LSEs to make filings demonstrating that they have procured sufficient capacity resources including reserves (i.e., 100 percent of its total forecast load plus a 15 percent reserve) to serve its aggregate system load on a monthly basis. In addition, each LSE is required to make filings demonstrating procurement of sufficient local RA resources to meet their RA obligations in transmission constrained local areas. System RA filings are required annually and also monthly, while local RA filings are only required annually.

[24] In the event that a Local Regulatory authority does not have QC counting rules, the ISO has default QC counting rules in section 40.8 of the ISO tariff.

[25] See Section 40.4.6.1 for a description of the ISO deliverability study process. Further, resources may have their NQC reduced based on testing (Section 40.4.4) or performance criteria (Section 40.4.5)

[26] http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=97619935

with the 2015 compliance year issued. In its decision the CPUC adopted QC and effective flexible capacity (EFC) determinations for energy storage. Storage resources included in the scope of the CPUC decision are those that bid or self-schedule into ISO markets and are subject to a must-offer obligation (MOO). Just like for conventional resources, to qualify for system RA a storage resource must be capable of discharging for at least four consecutive hours over three consecutive days. For storage resources the output level in megawatts at which the resource is capable of discharging for four or more uninterrupted hours is defined as its $Pmax_{RA}$ (i.e., the maximum output that can be considered for RA calculations). Under CPUC rules, the QC will be equal to this $Pmax_{RA}$ value. Like conventional resources, a storage facility must submit to testing by the ISO to verify that it can be dispatched at this $Pmax_{RA}$ level, and its QC is subject to adjustment by the ISO to a level that is deliverable to the aggregate of ISO load (i.e., its NQC).

The CPUC decision also adopted an interim "flexible capacity" framework for 2015 through 2017 as an additional component of the CPUC's RA requirements and establishes effective flexible capacity (EFC) counting conventions. A resource's effective flexible capacity (EFC) is the number of megawatts eligible to be counted towards meeting an LSE's flexible RA requirements. The CPUC defines "flexible capacity need" as the quantity of resources needed by the ISO to manage grid reliability during the greatest three-hour continuous ramp in each month.[27] In general, resources will be considered as "flexible capacity" if they can sustain or increase output, or reduce ramping needs, during the hours of the ramping period of "flexible need." Under the CPUC EFC rules, a resource's EFC applicable in 2015 is the greater of its NQC and (NQC – $Pmin_{RA}$), where $Pmin_{RA}$ is the minimum sustainable operating level of a facility.[28] For storage, $Pmin_{RA}$ is a negative megawatt value at which the facility is capable of charging for 1 ½ or more uninterrupted hours.[29] Thus since EFC is the greater of NQC and (NQC – $Pmin_{RA}$), storage resources may count for a larger megawatt amount of flexible capacity than it might as system RA (i.e., a larger EFC than NQC) because the difference between the NQC and $Pmin_{RA}$ is actually their sum in the case of storage due to the subtraction of a negative value.

The CPUC decision stipulates that storage resources shall receive an EFC in accordance with "the bundling principle" which holds that all flexible RA resources must also qualify as system RA resources. This means that storage wishing to qualify for flexible RA must also be qualified for system RA and must receive QC values. In contrast, unbundling a resource's flexible capacity and system capacity values could enable a storage resource to provide flexible capacity without having to deliver at peak system conditions. If "the bundling principle" were to remain intact going

---

[27] EFC values are based on the currently adopted definition of flexibility: the ability to ramp and sustain output over three hours.

[28] The ISO has default EFC counting rules for non-generator resources that differ slightly from those used by the CPUC.

[29] It should be noted that the ISO's FRAC-MOO proposal only considers the change in output that a resource can provide over 3 hours with no distinction between charging and discharging.

forward, then a storage resource would need to continue to obtain FCDS in order to provide flexible RA as is the case today.

To put this bundling versus unbundling issue in perspective, it may be helpful to consider the following example where unbundling is aligned with a particular use case scenario. One beneficial use of storage to the system could be to use a storage resource's flexible capacity (both charging and discharging modes) to raise the "belly of the duck" by charging when solar energy on the grid is plentiful (e.g., the over generation scenario) and then to support the upward ramp by discharging as net load increases in later afternoon. In such a use case scenario, the EFC value of a storage resource may be fully utilized for system benefits without the resource having to deliver energy during peak load conditions. In comments submitted in this initiative, stakeholders broadly support a reexamination of "the bundling principle" in the recently opened CPUC RA proceeding, R.14-10-010.[30] The CAISO allows for a resource to be shown as flexible capacity without also being shown as a system RA resource. The CPUC intends to consider a similar provision in the recently opened RA proceeding.

The CPUC decision, D.14-06-050, further required that resources that wish to be qualified as flexible RA must comply with the bidding and availability requirements expressed in the ISO's flexible RA criteria and must offer obligations (FRAC-MOO) proposal.[31] However, the CPUC decision stipulated that storage resource operators that wish to receive flexible RA credit for charging capacity need not meet all of storage-specific requirements of FRAC-MOO. The CPUC will also be reassessing these rules in R.14-10-010.

Again, if CPUC resource counting rules were to change in the future as a result of CPUC action, then the ISO would review the need for corresponding changes in its deliverability study methodology. Potential examples relevant to storage include elimination of "the bundling principle" with respect to flexible capacity and reducing the consecutive hour requirement from four to two for local capacity needs. These examples and others are in scope to be examined in the CPUC's recently opened RA proceeding.

---

[30] The CPUC conducts annual RA proceedings to refine its RA program. On October 23, the CPUC issued an order opening a rulemaking to make refinements to its RA program applicable to LSEs beginning with the 2016 compliance year (R.14-10-010). Of note, the preliminary scope of issues contained in the order included the following issues, in addition to others: "Should flexible resources be exempt from satisfying system RA requirements (i.e., should flexible and system RA resources be unbundled)?" and "Refinements to the counting conventions for QC and EFC." The recently opened RA proceeding can be found at the following link: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M127/K317/127317787.PDF

[31] http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleResourceAdequacyCriteria-MustOfferObligations.aspx

8 Rate treatment issues

Among other questions raised in this initiative, stakeholders have asked: (1) what price should energy storage resources pay for energy that is temporarily stored during charge mode for later injection back onto the grid during discharge mode; (2) what price should energy storage resources pay for station power; and, (3) what load based charges should energy storage resources be subject to such as transmission access charges (TAC) and measure demand uplifts.

Stakeholders have voiced concern that the lack of clarity on these rate treatment issues may create cost uncertainty for proposed energy storage resources currently in the ISO's interconnection process as well as in the distribution-level interconnection processes of the PTOs. Although rate treatment issues are not typically considered topics within the scope of an interconnection initiative, the ISO agrees these are critical issues that need to be addressed for the successful development of energy storage resources.

Thus, the ISO has included this section on rate treatment issues to both acknowledge the importance of these issues and to attempt to reduce some of the uncertainty surrounding these issues by clarifying where existing ISO rules may provide some insight at least for resources that intend to participate exclusively in ISO markets.

The ISO also would emphasize that it has joined with the CPUC and CEC to develop an Energy Storage Roadmap[32] to ensure that the broad array of challenges and barriers confronting storage, including rate treatment issues, are addressed in a coordinated fashion.

For purposes of discussion in this section, the ISO believes that its existing non-generator resources (NGR) model already address some rate treatment issues for resources that participate exclusively in the wholesale market. Accordingly, this section provides a discussion of the NRG model and provides background information relevant to the topic of station power.

8.1 The non-generator resources (NGR) model

The ISO developed the non-generator resources (NGR) model as the initial model for energy storage devices to participate in ISO markets. NGR was implemented during 2011- 2012 as reflected in its business requirements specifications[33] and other documents.[34]

NGRs are generation resources (as defined by the ISO tariff) with a MWh limitation that can be seamlessly moved within an operational range consisting of positive generation only, negative generation only, or positive and negative generation. The ISO settles the energy dispatches for

---

[32] http://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx

[33] http://www.caiso.com/Documents/RegulationEnergyManagementBusinessRequirementsSpecificationV016Clean.pdf

[34] http://www.caiso.com/participate/Pages/Storage/Default.aspx

positive or negative energy (i.e., when discharging or charging) at the locational marginal price (LMP). The ISO does not consider NGR resources in the charging mode as “consuming” energy, but rather storing energy for later resale in the ISO’s markets. The NGR model allows scheduling coordinators to manage a resource’s state of charge (SOC) through the real-time market.[35] SOC is the actual stored energy (MWh) in the device.

NGRs are interconnected to either the ISO controlled grid or a utility distribution system served by the ISO grid and participate solely in the ISO’s wholesale markets.

Round-trip efficiency losses[36] for an NGR could reasonably be argued are part of charging, since the energy is not being used for any other purpose. Moreover, the ISO does not consider “losses” generally as end-use consumption.

Regarding the question of whether storage charging is subject to ISO charges normally assessed to load such as TAC and measured demand uplifts, storage charging is not subject to these under the NGR model. The ISO does not allocate TAC to NGRs because NGRs are treated as generators and the TAC is allocated to load and exports, not generators. Similarly, measured demand uplifts are not allocated to generators, thus NGRs are not subject to these either.

The following table summarizes rate treatment for energy storage under the NGR model.

Energy	Settlement Price?	Allocated TAC?	Subject to measured demand uplifts?
Positive generation (discharge mode)	LMP	No	No
Negative generation (charge mode)	LMP	No	No

To participate as an NGR, the ISO uses existing ISO business processes and agreements. These processes include requiring the NGR to be represented by a scheduling coordinator and to execute a participating load agreement (PLA), participating generator agreement (PGA), and ISO metered entity agreement (CAISOME) and to complete a resource data template (RDT).

[35] This is relevant to RES Americas comment that if the ISO dispatches a storage resource without considering its state of charge, project economics could be impacted.

[36] This is called the “Charge/Discharge Cycle Efficiency (%)” in the storage specific information listed under item 4c in the interconnection request form.

As a next step following this initiative, the ISO will consider which of the clarifications contained in this section on the NGR model may be appropriate to reflect in the Market Operations Business Practice Manual.

8.2 Station power

Station power is energy for operating electric equipment, or portions thereof, located on the generating unit site owned by the same entity that owns the generating unit, which electrical equipment is used exclusively for the production of energy and any useful thermal energy associated with the production of energy by the generating unit;[37] and for incidental heating, lighting, air conditioning and office equipment needs of buildings or portions thereof, that are owned by the same entity that owns the generating unit; located on the generating unit site; and used exclusively in connection with the production of energy and any useful thermal energy associated with the production of energy by the generating unit. Station power includes the energy associated with motoring a hydroelectric generating unit to keep the unit synchronized at zero real power output to provide regulation or spinning reserve.

For an energy storage facility, station power would be any energy actually consumed and not energy that is used to charge the storage device. Since NGRs are treated as generators, the rules for settlement of station power are the same as for conventional generators. For traditional gas generators, it is relatively simple to distinguish what portion of station power is to be treated as retail station power consumption. Because the ISO tariff allows for simultaneous netting of consumption against output within a five-minute interval, station power is measured as the amount of consumption that exceeds output within a five-minute interval. However, although NGRs are treated as generators, it may be difficult to distinguish station power consumption from charging unless the two activities are metered separately for storage facilities, in which case simultaneous netting would not be a factor, but this seems the best means to distinguish charging from end-use consumption.

As part of implementation, the ISO reviews whether new resources have station service arrangements in place prior to commercial operation. An energy storage facility should consult with its load serving entity to determine how retail charges may apply to its station power consumption.

[37] The energy used to maintain the operating temperatures required of molten-salt batteries such as sodium-sulfur batteries may be a potential example.

9 Charging deliverability assessment

SCE expressed the concern that a storage resource, in order to be able to discharge to provide its full resource adequacy (RA) value, must be able to fully charge at some time during each 24-hour day. Based on this concern, SCE suggests that the interconnection study process should test to ensure that this is possible through a "charging deliverability assessment" to be applied to energy storage resources requesting full capacity deliverability status.

Regarding the rationale and approach for such an assessment, SCE states the following in their August 20, 2014 comments:

> "Charging" of storage resources is expected to occur at a time when price signals for energy are low which is concurrent with the time that local area generation resources may not be dispatched (due to the same price signals). As a consequence, the resiliency of the system to move additional power from outside the local area in order to provide for such "charging" aspects under a minimal local area generation dispatch condition will be tested. To ensure the system can provide for such "charging" requirement, a "charging deliverability assessment" is necessary. Conceptually, the "charging deliverability assessment" would model minimal local area generation at various local area load demand conditions and evaluate if the incremental "charging" requirements drives the need for congestion management. The assessment should ascertain if sufficient hours are available to fully charge every single storage resource seeking interconnection which also has sought out Full Capacity Deliverability Status. If the studies do not identify sufficient hours available to fully charge every single storage resource seeking Full Capacity Deliverability Status due to transmission limitations, then a Delivery Network Upgrade should be identified to address such transmission limitation(s) and such upgrade should be classified as a Delivery Network Upgrade since it would be necessary to ensure every single storage resource seeking interconnection which also has sought out Full Capacity Deliverability Status are fully charged.

CESA believes such an assessment would unfairly burden energy storage resources to pay for network upgrades to obtain a level of fuel availability that no other generation resource must obtain. CESA believes that this would artificially make network upgrades for an energy storage resource look more expensive than, for example, a natural gas plant which is not required to provide the same guaranteed level of fuel availability.

CPUC staff believe that such an assessment should be part of an integrated storage interconnection process that accounts for both charging and discharging.

PG&E states that such an assessment is fundamentally different from the current deliverability assessment that evaluates a generator's ability to discharge under worst case scenario conditions. PG&E points out that a lot of the value of a storage device is its ability to operate (both charge and discharge) in a manner that alleviates stress on the grid by mitigating some operational challenges, not by operating under worst case conditions. Although PG&E is supportive of an effective "charging deliverability assessment" if one can be developed, PG&E cautions against costly and time intensive studies without commensurate value.

Six Cities disagrees with the ISO's suggestion that an energy storage resource's ability to charge is analogous to a conventional generator's ability to obtain fuel and, therefore, outside the scope of interconnection analysis. Six Cities states that an energy storage resource's ability to charge both depends upon and affects the transmission grid, unlike fuel delivery arrangements for conventional generators. Six Cities believes that tests should be conducted to confirm that an energy storage resource is able to fully charge at least once during each 24-hour day in order for that resource to qualify to provide resource adequacy. Six Cities further suggests that the nature of the required tests should depend on the type of resource adequacy for which the resource desires to qualify. For example, if the resource requests qualification to provide flexible resource adequacy, Six Cities suggests the ISO should test for ability to charge during peak hours; and for energy storage resources that wish to qualify for system/local resource adequacy, Six Cities suggests that it should be sufficient to confirm that the resource can charge fully during off-peak periods.

The unique attributes of storage are raising many potential issues and interesting questions. The ISO appreciates SCE raising this subject and the variety of opinions expressed by stakeholders on it. However, based on a review of this feedback and after giving this subject due consideration, the ISO continues to believe that a "charging deliverability assessment" should not be implemented at this time and offers a number of reasons for this determination below. The ISO notes that a "charging deliverability assessment" has not been defined as an ISO or industry term, and the ISO's understanding of SCE's use of the term is inferred from the comments provided. In that context, the ISO understands SCE to be considering a study to determine the ability of all storage projects in a potentially locally constrained area to charge simultaneously at minimum generation without requiring an increase in local generation dispatch. The use of the word "deliverability" in the term "charging deliverability assessment" is meant to refer to a testing of charging ability, such that the resource can qualify for full capacity delivery status.

The ISO agrees with PG&E's observation that such a charging deliverability assessment is fundamentally different from the current deliverability assessment that evaluates a generator's ability to discharge under resource shortage conditions. The peak deliverability methodology is based on the requirement that FCDS resources within a given sub-area must be able to generate simultaneously at their RA capacity levels or associated exceedance levels and export to other parts of the balancing area under peak load conditions. The system assumptions and mathematical models used in the peak deliverability assessment are developed around this requirement. In contrast, there is no specific system condition when the energy storage facilities must be able to charge.[38] While the idea of a worst-case study may sound appealing, it is not clear how a worst case would be defined or that it actually would prevent the storage resource from charging. For example, if an energy storage facility cannot operate at its maximum charging level when there is minimum local generation, as SCE suggests, more local generation could be dispatched to enable charging. The increased demand from the charging of the storage resource would then raise the locational price. Or if an energy storage facility is not able to charge under peak conditions, then it could be charged during off-peak, such as mid-day when there is excess solar energy or during the night. Thus, no matter how the ISO tries to define a worst-case situation, it cannot definitively demonstrate the impossibility of the resource achieving its full state of charge some time during the 24-hour period. Of course, the reliability studies performed under GIDAP will assess the charge mode of storage resources and will identify any needed upgrades, but this would not indicate anything about deliverability.

At this early point in the growth trajectory of energy storage, there is significant uncertainty regarding precisely how energy storage resources will be operated, which in turn is a central factor in determining how they should be studied. Current CPUC rules regarding flexible resource adequacy (RA) capacity require that a resource seeking to provide flexible RA capacity meet all the qualifications to provide system RA capacity. As a result, developers of energy storage resources typically will request full capacity deliverability status (FCDS)[39] even though there is broad recognition that providing on-peak energy output may not be the optimal use of the energy storage resource.

For example, a frequently discussed use of storage is for it to charge during times of low net load during the middle of the day (i.e., when solar generation is at its peak) and discharge during the early evening ramp as net load rapidly increases (i.e., when solar generation falls off as the sun goes down). Under this scenario the storage resource could then charge again as demand on the system decreases into the later evening hours. Energy storage used in this manner would not produce energy on peak as system or local RA resources must be able to do, which has led some developers to question the appropriateness of the standard deliverability assessment performed as part of the ISO's interconnection procedures.

---

[38] The logical structures of these two types of assessment are very different. The discharging deliverability assessment is structured to show that a certain amount of energy production is possible under specified conditions. In contrast, the proposed 'charging deliverability assessment' must show that full charging is impossible under any conditions, i.e., that there are no hours in the course of a 24-hour period during which the resource can accumulate a full state of charge. From a methodological perspective, constructing a test to demonstrate the impossibility of something is extremely challenging. The fact that something is not possible under one set of conditions does not prove that it is not possible under *any* conditions. Moreover, if such a test is then used to justify a need to build additional network upgrades, or to deny an interconnecting project its FCDS, it will certainly be strenuously challenged and would be difficult to defend methodologically.

[39] Case in point, all of the stand-alone energy storage projects in the ISO's Queue Cluster 7 requested full capacity deliverability status.

Thus, the uncertainty about how storage will be operated raises the question of the relevance of performing charging deliverability studies to verify whether a storage resource can be counted on (for RA purposes) to generate during the peak. Moreover, as pointed out by PG&E, a lot of the value of a storage device is its ability to operate (charge and discharge) in a manner that alleviates stress on the grid by mitigating operational challenges; not by exacerbating these challenges by operating under worst-case conditions. The ISO would add that storage has the potential to increase the efficient utilization of transmission infrastructure and reduce the need for additional transmission upgrades rather than being the cause or driver for additional network upgrades. All of this suggests that applying a charging deliverability assessment may actually lead to a counter-intuitive and costly result: the identification of incremental deliverability upgrades to fix an off-peak problem in order to enable a storage resource to discharge during peak conditions which in turn may trigger another set of incremental deliverability upgrades. This approach may not be in the best interest of ratepayers.

Based on these considerations the ISO does not at this time believe a charging deliverability assessment is necessary or appropriate. The ISO's current path, of testing that there is some reasonable window for charging available for new storage projects in each interconnection queue cluster in the course of the interconnection studies, remains the most reasonable course at this time.

10 Dual use assets

CESA, in its comments, refers to dual use assets as resources that provide a transmission and distribution deferral or system reliability function as well as a wholesale market function. CESA believes that the issue of dual use assets is still a significant open question and barrier to the cost effective deployment of energy storage.

The concept of developing resources that are compensated partly through the TAC and partly through the wholesale markets has been previously raised before FERC. FERC has ruled that such arrangements are not appropriate and the facility would have to decide to be either a transmission asset and be approved as such through the ISO's transmission planning process, or to be a market participant, but could not be both.

Given this, a storage resource fully dedicated to serving a reliability function and receiving all of its compensation through the TAC would be a woefully underutilized asset prohibited from participating in the market and therefore unable to provide its full potential. Thus, the ISO continues to hold the expectation that rather than getting TAC recovery, preferred resources such as storage will participate in the market so that they aren't limited as they would be if compensated through the TAC.

11Metering and telemetry related questions

The ISO's current metering and telemetry processes can be applied to storage resources for accurate revenue metering, visibility, and control of resources providing wholesale services.

However, stakeholders are introducing a variety of different resource use models that are challenging the most standard resource practices and configurations. For example, stakeholders have expressed the desire to maximize revenue and value of storage resources by providing energy services to both the transmission and distribution level. While this is not standard practice, it may be possible to do this as long as the metering and telemetry can be applied in a way that captures the services provided and maintains the level of visibility and control required by the ISO. Cases such as these are typically studied by the ISO engineering staff and developed in partnership with the resource owner in the ISO's New Resource Implementation processes.

Stakeholders have also raised questions and concerns about meeting ISO metering and telemetry requirements and related costs for behind the meter resources that wish to participate in the wholesale market.

It should be recognized that the metering and telemetry questions being raised are not strictly related to storage resources, but can be associated with other resources types as well and are outside the scope of this stakeholder initiative.

That said, the ISO agrees that these are important issues and is working to identify the correct forums to address these. For example, the joint California agency effort to produce an energy storage roadmap includes action items that will directly contribute toward resolving some of these concerns.

12 Fast track

In its comments, Clean Coalition suggests that some refinement in Fast Track eligibility should be considered as soon as practical. Clean Coalition believes that the application of devices and operational settings limiting the maximum total export to the grid should be allowed when determining Fast Track review eligibility and in grid impact studies; and, that it is the maximum impact of the total facility as measured at the point of common coupling with the grid system that should be considered, rather than the additive impact of each component of the facility.

In response to Clean Coalition's comment, the ISO emphasizes that as part of its FERC Order 792 compliance filing the ISO included the following tariff revision under section 3.1 – Interconnection Requests – General:

> *An Interconnection Customer with a proposed Small Generating Facility shall be evaluated using the maximum rated capacity that the Small Generating Facility is capable of injecting into*

the CAISO's electric system. However, if the maximum capacity that the Small Generating Facility is capable of injecting into the CAISO's electric system is limited (e.g., through use of a control system, power relay(s), or other similar device settings or adjustments), then the Interconnection Customer must obtain the CAISO's agreement, with such agreement not to be unreasonably withheld, that the manner in which the Interconnection Customer proposes to implement such a limit will not adversely affect the safety and reliability of the CAISO's system. If the CAISO does not so agree, then the Interconnection Request must be withdrawn or revised to specify the maximum capacity that the Small Generating Facility is capable of injecting into the CAISO's electric system without such limitations. Furthermore, nothing in this section shall prevent the CAISO from considering an output higher than the limited output, if appropriate, when evaluating system protection impacts.

This was approved by FERC in its order issued November 3, 2014.[40]

13 Power factor requirements

In its comments, PG&E states its understanding that storage projects that are asynchronous generating facilities will need to meet the same power factor requirements as generating facilities in both charge and discharge modes. PG&E states that if a Phase II charging or discharging mode study requires +/- 0.95 power factor at the point of interconnection, then the storage facility will need to be capable of meeting it in both modes. PG&E further states that if a Phase II study does not require +/- 0.95 power factor in both charging and discharging modes, then the storage facility needs to maintain unity power factor at the point of interconnection.

Under the ISO's current tariff, if the interconnection system impact study results for an asynchronous facility show a need for reactive power capability, then the resource must have at least a +/- 0.95 power factor range at its point of interconnection.

Currently, the ISO assesses each asynchronous resource individually to determine whether the resource needs to provide reactive power capability to interconnect to the system based on a range of operating conditions. If the study results show a need for reactive power capability, then the resource must have at least a +/- 0.95 power factor range at its point of interconnection. If the study results do not show the need, then the ISO does not require the resource to provide reactive power capability or impose a requirement to control voltage at the resource's point of interconnection. The ISO believes that this case-by-case approach has several shortcomings and intends to examine in an upcoming stakeholder initiative a uniform requirement that asynchronous resources seeking to interconnect to the ISO grid have reactive power capability.

---

[40] http://www.caiso.com/Documents/Nov3_2014_Order-InterconnectionProcessEnhancements4-5Amendment_ER14-2586.pdf

14 Next steps

The storage interconnection requests received in Queue Cluster 7 are being accommodated and processed under existing tariff rules without the need for tariff changes. Based on this and a review of stakeholder comments received in this initiative, the ISO has concluded that no changes to the GIDAP have been identified as necessary to accommodate storage interconnection to the ISO grid. As a consequence, there is no need to invoke the step of making a presentation to the ISO Board of Governors and seeking Board approval of proposed tariff changes.

The ISO has used this stakeholder initiative to present its approach for processing storage facility interconnection requests under existing tariff rules, and refine the approach based on stakeholder feedback. This approach has enabled the projects in Queue Cluster 7 to move forward and provide meaningful results to these customers. This initiative also has been used to discuss other storage issues such as processes for modifying projects to add storage, resource adequacy, and rate treatment, to name a few.

The ISO has scheduled a stakeholder web conference on November 25 to discuss this paper. Following the web conference the ISO will invite stakeholders to submit any final comments by December 12.

Although this paper is being presented as the final paper in this initiative, the ISO recognizes that additional energy storage issues may come up in the future. To the extent there is a need to consider additional issues, the ISO can determine at that time through what initiative those issues can best be addressed. Also, as suggested by the Energy Storage Roadmap effort, there are a number of storage related issues that the ISO will give consideration to examining in 2015 through existing and/or new stakeholder initiatives.

As a next step following this initiative, the ISO will consider which of the clarifications contained in this paper may be appropriate to reflect in the relevant Business Practice Manual(s).