Deliverability Assessment Methodology Revisions

Straw Proposal

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Regional Transmission

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Deliverability Assessment Methodology Straw Proposal

1 Introduction

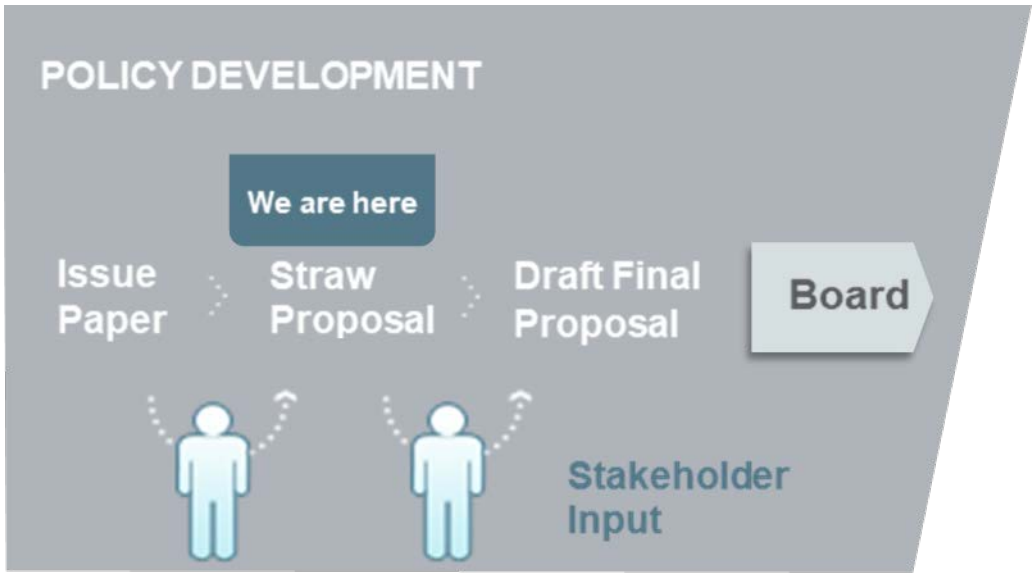
The deliverability assessment methodology is a CAISO methodology developed for generation interconnection study purposes pursuant to the CAISO tariff, and is used in support of resource adequacy assessments. The CAISO last modified the existing methodology in 2009, and it has largely remained unchanged since its initial development in 2004. Given the significant changes in the composition of the existing generation fleet and the further changes anticipated over the forecast horizon, the CAISO is considering revisions to the study assumptions used in the existing methodology.

The focus of these CAISO's deliverability assessment methodology considerations is to adapt the study assumptions in the On-Peak Deliverability Assessment methodology to changing system conditions that affect or drive when resource adequacy resources are needed the most. The CAISO initially proposed revisions in the course of its 2018-2019 transmission planning cycle, and based on stakeholder feedback, the CAISO has undertaken this separate stakeholder initiative to review the issue more comprehensively and address stakeholder concerns with the potential impacts of the proposed revisions.

2 Stakeholder Process

The CAISO first proposed possible revisions to the on-peak generation deliverability assessment methodology originally discussed in the 2018-2019 transmission planning process meeting on November 16, 2018. The CAISO then held a stakeholder call on December 18, 2018 to offer a more in-depth review of the proposed revisions. Stakeholders' written comments were generally supportive of the proposed changes, but raised various concerns regarding impacts to other processes and existing generation and recommended that the CAISO take more time to address these concerns. The CAISO considered those comments and decided to reconsider the proposed revisions through a broader stakeholder initiative and to continue to apply the current methodology in studies required by the Generation Interconnection and Deliverability Allocation Procedures for Cluster 11 phase 2 and Cluster 12 phase 1 efforts. The CAISO posted an issue paper and started the stakeholder initiative on April 25. The first stakeholder call was held on May 2, 2019 to garner additional stakeholder input needed to develop a straw proposal that addresses the comments provided on the proposed on-peak generation deliverability methodology revisions. The CAISO has reviewed comments to the issue paper and categorized them below. The CAISO is at the "Straw Proposal" stage in the policy development process. The purpose of the straw proposal is to propose solution options to address the stakeholders' concerns regarding the methodology modification.

Figure 1: Stakeholder Process for Deliverability Assessment Methodology



3 Background and Issues

In the Issue Paper the ISO explained that the addition of large amounts of solar resources have resulted in reducing the resource adequacy value of these resources, and therefore the deliverability assessment methodology needs to be revised to reflect these changing system conditions. The Issue Paper notes that starting in 2018, the CPUC has replaced the exceedance based Qualifying Capacity (QC) calculation with an Effective Load Carrying Capability (ELCC) approach to account for the growth of intermittent resources. In response to this change, the CAISO began this initiative to revise the on-peak deliverability methodology assumptions. An objective of this initiative is to examine the impacts of load peak shifting and the factors underpinning the shift to ELCC-based QC calculations on the appropriateness of the current deliverability methodology. As noted previously, the ELCC methodology considers the potential contribution of the particular resources in supporting additional firm load while maintaining an overall probabilistically determined reliability level over a period of time, generally a year, so the transmission system reasonably also needs to be able to deliver that contribution over a broader range of times than a single peak load period. Regarding the load peak shifting to later in the day, the load shape seen from the transmission grid will continue to change as the behind-the-meter distributed generation grows significantly in the future. The load peak will continue to shift to a later hour in the day when the solar production has dropped and the load consumption is still high. As well, a certain amount of the solar resources can be needed for system resource adequacy during the peak gross consumption hour, which occurs earlier in the day when customers' gross consumption is at its highest, but sales have been reduced by behind-the-meter generation. However, the incremental reliability benefit to the peak gross consumption hour of adding more solar hits a saturation point after enough capacity is installed. Additional solar resources provide a much lower incremental reliability benefit to the system than the initial

solar resources, because their output profile ceases to align with the need during the peak sale hour that has shifted from the gross consumption period to later in the day. As a result, the need for transmission upgrades identified under the peak gross consumption condition to support deliverability of additional solar resources becomes more of an economic or policy decision focused on reducing curtailment of solar resources due to transmission limitations than a reliability decision. In other words, there may be an economic or policy benefit derived from these transmission upgrades relieving curtailment, but there is less likely to be a substantial capacity benefit because there is more likely to be sufficient capacity during the peak gross consumption hour with very high solar production both behind the meter, and in other unconstrained areas.

4 Stakeholder Inputs

4.1 The Need for a Revised Deliverability Assessment Methodology

Stakeholder Input

In response to the Issue Paper, stakeholders agreed that the deliverability methodology needs to be changed and with the ISO's reasoning on why it needs to be changed. The CPUC staff states that the CAISO appropriately discusses the changing nature of the electric grid, with increasing solar and wind generation covering electric demand in the middle of the day, what used to be the peak reliability time. EDP Renewables North America LLC (EDPR NA) supports the basic methodological change discussed in 2018, which assesses generation deliverability in hours where system or area Unloaded Capacity Margin is below a threshold indicative of a capacity need. Such a methodology is consistent with ELCC and standard industry practice. AWEA-California, the Bay Area Municipal Transmission group (BAMx), and the Independent Energy Producers Association (IEP) also generally support the changes to the Generation Deliverability Assessment Methodology that were discussed during the end of 2018.

However, some stakeholders questioned the need for a change to the deliverability methodology. First Solar and Golden State Clean Energy (GSCE) requested that the CAISO elaborate on why studying capacity under the current methodology no longer yields valuable results for deliverability, for identifying transmission needs or for meeting the state's increased renewables portfolio goals.

CAISO Response

As stated in the Issue Paper, the CAISO continues to believe that the deliverability methodology needs to be changed. The majority of stakeholders agree with the CAISO on this recommendation. Deliverability needs to correlate with a resource's ability to deliver its output during peak demand conditions. Peak demand conditions have shifted later in the day, which alone warrants review of the deliverability assessment. Moreover, the existing deliverability methodology identifies the need for transmission upgrades during the peak gross consumption condition, and the need for transmission upgrades identified under the

peak gross consumption condition to support deliverability of additional solar resources becomes more of an economic or policy decision focused on reducing curtailment of solar resources due to transmission limitations than a reliability decision. In other words, there may be an economic or policy benefit derived from these transmission upgrades relieving curtailment, but there is less likely to be a substantial capacity benefit because there is more likely to be sufficient capacity during the peak gross consumption hour with very high solar production both behind the meter, and in other unconstrained areas.

4.2 Impacts of the Deliverability Methodology Revisions Proposed in 2018

The CAISO held a stakeholder call on December 18, 2018 to provide an in-depth review of the revisions proposed at that time to the generation deliverability assessment methodology. A redlined version of the On-Peak Deliverability Methodology documentation was included in Appendix B of the Issue Paper. The deliverability assessment revisions proposed at that time were to perform assessments under two distinct system conditions: the highest system need scenario and the secondary system need scenario. The highest system need scenario represents when the capacity shortage is most likely to occur. In this scenario, the system reaches peak sales with low solar output. The highest system need hours are hours ending 18 to 22 in the summer months with an unloaded capacity margin less than 6% in the CAISO annual summer assessment or identified as a loss of load hour in the CPUC ELCC study for wind and solar resources.

The secondary system need scenario represents when the capacity shortage risk will increase if the intermittent generation is not deliverable while producing at a significant output level. In this scenario, the system load is modeled to represent the peak consumption level and solar output is modeled at a significantly high output. The secondary system need hours are hours ending 15 to 17 in the summer months with an unloaded capacity margin less than 6% in the CAISO annual summer assessment or identified as a loss of load hour in the CPUC ELCC study for wind and solar resources.

Stakeholder Input

Stakeholders provided the following comments regarding concerns about the revisions to the deliverability methodology proposed in 2018. AWEA-California believes the increased curtailment risk to all generators which would result from implementation of the Generation Deliverability Assessment Methodology that was discussed during the end of 2018 warrants additional exploration of various options. Clearway Energy, EDF-Renewables (EDF-R), and GSCE raised concerns about revising the Deliverability Assessment methodology without additional changes to keep curtailment at reasonable levels, as the current deliverability methodology has done to date. The likelihood that new generation projects will pay for upgrades to alleviate resulting increased curtailment that they trigger is a strong incentive for developers to build/invest in California renewables, and for Load-Serving Entities (including

IOUs, municipalities, CCAs, ESPs, etc.) to buy at the POI. This protection mitigates risks and therefore helps offset high costs and other hurdles to developing in California.

GSCE also states that the CAISO discusses the possibility that its transmission planning process (TPP) could be relied upon for solutions to the curtailment caused by the shift in deliverability methodology. However, if the consequences of increased curtailment are not managed up front, developers may experience years of severe curtailment before a transmission solution is developed.

CAISO Response

The majority of stakeholders raised concerns with increased curtailment that would result from the revisions in the deliverability methodology focused on addressing resource adequacy needs. Most of the concerns were around renewable curtailment risks during system conditions when resource adequacy was not the primary concern. There were other concerns that were also raised and those concerns will be discussed below in this Straw Proposal. The CAISO continues to recommend the revisions to the deliverability methodology that were proposed with an additional assessment to address excessive curtailment risks.

4.3 Addressing the Increased Risk of Renewable Generation Curtailment

The CAISO acknowledged in its December 18, 2018 presentation to stakeholders that the objective of the on-peak deliverability assessment methodology has been to ensure that resources are deliverable during times of elevated need. The objective has *not* been to ensure that resources can be delivered during other conditions when supply shortfalls are unlikely (*e.g.,* in the middle of a spring day when there is low demand and high supply). Deliverability should not be confused with firm transmission service. Supply resources in the CAISO are subject to security-constrained economic dispatch, which evaluates congestion. The proposed revisions to the CAISO's deliverability assessment would continue to meet the purpose of deliverability, and would be expected to result in identifying fewer transmission delivery network upgrades. The latter is a key goal because ratepayers ultimately reimburse generators for delivery network upgrades through the CAISO's transmission access charge. That said, the CAISO recognizes that with a reduced amount of network upgrades, there would be an expectation that deliverability-driven transmission costs would decrease; however renewable generation curtailments could increase which would ultimately directly or indirectly increase costs for consumers to some extent.

The CAISO initially proposed to address this increase in curtailments by identifying needed policy and economic driven transmission upgrades in the TPP using existing mechansims. However, stakeholder comments clearly expressed a desire for the interconnection study process to also examine whether excessive curtailment risks are identified and can be mitigated on a timely basis. One concern of relying on the TPP is that delivery network upgrades needed for specific generation interconnection projects may not be approved until there was a high degree of certainty that the generation project would proceed. Essentially, the generation project would need to already have a power purchase contract and be

permitted for construction (or already constructed) before its delivery related transmission costs may be identified in the TPP. Generators in the CPUC portfolio are generic resources in a general area can only drive large area network upgrades. These generic resources cannot drive local delivery network upgrades because their precise location is not known.

Accordingly, the CAISO emphasized two specific questions. The first question asked whether additional studies should be added to the interconnection study process to meet the objective of avoiding excessive curtailment. The second question asked that if such studies are performed in the interconnection study process, whether the identified delivery network upgrades should be required to be funded (on a refundable basis? A non-refundable basis? or both?) by the generator owner for its generation project to obtain FCDS.

Stakeholder Inputs

The majority of stakeholders preliminarily responded that such studies should be included in the interconnection study process, and that the upgrades should not be required to obtain Full Capacity Deliverability Status (FCDS).

GSCE states that they are very concerned about the curtailment impacts on renewable developers that have already invested significant sums in upgrades for deliverability. In addition, they state that all interconnecting projects, whether they request FCDS or Energy Only, should be evaluated for their potential to be curtailed or cause the curtailment of other resources. The latter could occur, for example, where Energy Only generators interconnect near deliverable generators with limited transmission capacity. Clearway and EDF-R support the CAISO's ideas about requiring new generation projects seeking deliverability to fund upgrades to relieve curtailment they cause, *i.e*., to preserve peak-production deliverability of the area. GSCE states that generators retaining the obligation to fund upgrades to mitigate for curtailment include the value of queue management and maintaining the equity between new and earlier interconnection customers where earlier customers financed significant upgrades to the transmission grid.[1] They went on to state that since transmission upgrades provide for general grid reliability, the cost reimbursements are justified. IEP states that resources must pay for Network System Upgrades (subject to refund) to ensure that resources already on the system are not harmed by the interconnection of the new resource, and that this approach helps provide a measure of regulatory/commercial certainty to infrastructure investment and, as a result, lowers the cost of that investment. They went on to state that the principle that existing resources should be held harmless for future changes in the Deliverability Assessment Methodology to the extent feasible and practical ought to be applied in this initiative. PG&E believes that additional studies do need to be undertaken, with the objective to quantify the trade-offs of potential network upgrades to accommodate additional deliverability from new resources, versus the additional curtailment created by new resources interconnecting without additional upgrades. They also believe that resources should have appropriate incentives to identify

[1] Delivery network upgrades are most commonly financed by interconnection customers but reimbursed by the Participating Transmission Owner within five years of commercial operation. The transmission owner then includes those costs in its rate base to be recovered by ratepayers through transmission access charges.

locations for interconnection with existing transmission capacity, so a repayment cap should be considered for transmission upgrades that could be essential to relieving curtailment and identified within the interconnection process. The CPUC staff stated that they agree that it is important for the CAISO to study and identify expected magnitude and mitigation for curtailment as part of the interconnection process, so the Secondary System Need scenario is important. They went on to state that if there are some minor upgrades that can mitigate curtailment, it would be good to identify those upgrades. The CPUC staff does not agree that the generator's investment in deliverability upgrades identified to mitigate curtailment should be required to attain FCDS. The CPUC staff also states that there will certainly be upgrades to mitigate curtailment that will not be cost effective and thus should be considered optional. AWEA-California states that to provide the most benefits to ratepayers, cost-effective transmission solutions to mitigate excessive curtailment should be analyzed by the CAISO through either the interconnection studies or the TPP. EDPR NA supports the CAISO providing additional studies to provide information to generators on potential curtailment. EDPR NA believes, however, that the CAISO should explore whether such studies can be performed on a regular basis as part of the Transmission Planning Process. EDPR NA disagrees that network upgrades that relieve that curtailment as identified in additional studies should automatically become a cost obligation for obtaining FCDS. First Solar states that since the transmission infrastructure development is supporting compliance with state policy goals and supporting the growth of a transmission grid capable of incorporating greater amounts of renewable resources without excessive curtailment these upgrades would be funded the same way they are today – by the interconnection customer and reimbursed once the interconnection customer is operational.

A couple of stakeholders did not think that additional studies should be added to the interconnection study process to meet the objective of avoiding excessive curtailment. BAMx stated that there is no need for additional studies to be added to the interconnection study process to meet the objective of avoiding excessive curtailment. BAMx states that should the CAISO choose to perform additional studies to assess excessive curtailments (or "curtailment" studies) in the interconnection study process, any identified delivery network upgrades (DNU) should be funded by the generator owner (without repayment) for its generation project to obtain Full Capacity Delivery Status (FCDS). CalWEA stated that CAISO should avoid addressing curtailment risk as part of the generation interconnection process because it would make an already complex process even more complex and potentially further delay the implementation of its reformed deliverability assessment methodology.

CAISO Response

The CAISO recommends that an additional study be included in the interconnection study process as a standard feature to address curtailment of renewable resources caused by transmission constraints, but the study should focus on system conditions when renewable curtailment would not occur due to oversupply of resources. In addition, the upgrades identified as needed in the study should not be required for the resource to obtain FCDS.

The CAISO considered several options to address the curtailment concern as described below. All the options involve revising the existing off-peak deliverability assessment methodology.

Option 1: Enhance the off-peak deliverability assessment

The option would rely on the interconnection reliability study and deliverability studies to identify curtailment issues by updating study assumptions for the off-peak deliverability assessment such that the results provide a meaningful indication of curtailment due to transmission constraints. However, the off-peak deliverability study upgrades identifed would be for information only. This option would rely on the economic and policy studies in TPP for the actual development of upgrades to address renewable curtailment. The interconnection customers could also pursue merchant transmission upgrades based on the information from the off-peak deliverability assessment.

This option would require minimal tariff changes and could be implemented with the least amount of effort relative to the other options. It enhances the current process by providing better information regarding potential curtailment. However, because of free-rider concerns, the interconnection customers are unlikely to have sufficient incentive to pursue merchant transmission upgrades.

Option 2: Mandatory funding of off-peak transmission upgrades within the current DNU framework

Another option is to require the network upgrades identified in the off-peak deliverability assessment to obtain FCDS. This option includes the following elements:

a. Revise the off-peak deliverability methodology and include solar as a resource that primarily produces during the off-peak period.
b. Identified transmission upgrades would categorized as LDNUs or ADNUs.
c. LDNUs would be mandatory for new generators to achieve FCDS.
d. ADNUs would be optional, and the off-peak area constraints would limit TPD for allocation.

This option would help ease the concerns that new interconnections cause curtailment for the existing generators. However, given the reduced capacity value of solar resources, there may not be sufficient incentive for new solar resource interconnections to fund the upgrades, so this could result in a considerable amount of generation selecting energy only deliverability status (EO). For generators that select EO, the upgrades would not be built and that potential curtailment would not get relieved.

Option 3: Optional to fund off-peak transmission upgrades under a new framework

Economic dispatch does not distinguish among generators' deliverability statuses. All other factors being equal, the lowest bid will be dispatched even if it is an EO resource bidding against a resource with FCDS. Because curtailment is not impacted by generators' deliverability status, it could be better to have a new framework that requires the network

upgrades being funded by the interconnection customers for their interconnection requests regardless the deliverability status. This option includes the following elements:

a. Update the off-peak deliverability methodology assumptions and include solar as a resource that primarily produces during the off-peak period.
b. Identified upgrades would be optional for the interconnection customers to fund and be refunded with CRRs.
c. The upgrade costs funded by the interconnection customer would be capped.
d. Require interconnection financial security posting for the upgrades if the interconnection customer elects to fund the upgrades.
e. Elected upgrades could be identified, upsized, or reconfigured in the TPP, and the cost responsibility would be removed from the interconnection customers.

With this option the off-peak deliverability assessment would remain unbundled from the on-peak assessment for resource adequacy purposes. It would provide an opportunity for all interconnection customers to proactively manage their curtailment risk. The cost cap would provide cost certainty to the interconnection customers. By electing to fund the upgrades, the interconnection customers would attract more interconnection requests that utilizing the upgrades, which improves the chances that such upgrades would be identified, upsized, or reconfigured in the TPP. This could be an incentive for the interconnection customers to fund such upgrades. However, based on past experience, the CAISO would not expect generators to fund any upgrades based on expected CRR revenues alone.

Option 4: Optional off-peak local network upgrades (OLNU) with reimbursement cap

To balance between the generators' choice and the optimal system need, Option 4 is similar to Option 3, but it limits the generators' choice of upgrades they would fund to local transmission upgrades. This option would also provide a certain level of reimbursement for the cost of the upgrades. This option includes the following elements:

a. Update the off-peak deliverability methodology assumptions and include solar as a resource that primarily produces during the off-peak period.
b. Identify local and area off-peak deliverability constraints.
c. Area contraints are for information only – provide conceptual upgrades and deliverable amount without upgrades.
d. Upgrades to mitigate local constraints are optional for the IC to fund.
e. The local upgrades belong to their own cost category, not under the current cost responsibility and maximum cost responsibility for LDNUs and RNUs.
f. Set a reimbursement cap for the upgrades, the remainder is refunded with CRR.
g. Require interconnection financial security posting for the upgrades if the interconnection customer elects to fund the local upgrades.
f. The upgrade costs funded by the interconnection customer would be capped.
h. Elected upgrades could be identified, upsized or reconfigured in the TPP and the cost responsibility would be removed from the interconnection customers.

This option provides similar benefits as Option 3. The difference is that approval of area upgrades is always through comprehensive evaluation in TPP. The interconnection customers could drive upgrades to relieve local congestion.

Option 5: Optional off-peak deliverability status service with mandatory local off-peak transmission upgrades

Option 5 introduces a new concept to the CAISO's markets: giving curtailment/dispatch priority based on deliverability statuses. For example, with two resources self-scheduling in the market, an interconnection customer selecting "Off-peak Deliverability Status" would be curtailed after a generator that does not have that status.

This option includes the following elements:

a. Update the off-peak deliverability methodology assumptions and include solar as a resource that primarily produces during the off-peak period.
b. Resources that primarily produces during the off-peak period would be eligible to select Off-Peak Deliverability Status (OPDS).
c. Identify local and area off-peak deliverability constraints.
d. Area constraints are for information only – provide conceptual upgrades and deliverable amount without upgrades.
e. Upgrades to mitigate local constraints are mandatory for the ICs that request OPDS to fund.
f. The local upgrades belong to their own cost category, not under the current cost responsibility and maximum cost responsibility for LDNUs and RNUs.
g. The upgrade costs would be fully reimbursed.
h. Require interconnection financial security posting for the upgrades.
i. The upgrade costs funded by the interconnection customer would be capped.
j. The upgrades could be identified, upsized or reconfigured in the TPP and the cost responsibility would be removed from the interconnection customers.
k. ICs that select OPDS would receive curtailment/pricing priority.
l. Existing FCDS and PDS generators that primarily produces during the off-peak period would receive curtailment/pricing priority

This option would provide an option for ICs to have a similar level of curtailment risk as the current deliverability methodology provides. It also provides a commensurate benefit for ICs that elect to fund upgrades to obtain OPDS to have some protection against curtailment over other self-scheduling resources.

4.4 Solar and Wind Output Assumptions

Many stakeholders continued to raise concerns that the ELCC-based NQC values are higher in some cases than the study assumptions in the revisions to the on-peak deliverability methodology proposed in 2018.

Stakeholder Inputs

AWEA states that CAISO should consider dispatching wind and solar resources at the higher of the currently applicable QC figures and the level that would otherwise apply in the deliverability methodology. BAMx recommends that the CAISO align the solar and wind output assumptions with the ELCC based QC values. EDF-R suggests that the CAISO dispatch projects in deliverability studies at the higher of the current applicable QC and the otherwise applicable output level for the new adopted methodology. CPUC staff suggest that the Secondary System Need scenario identify and quantify curtailment or non-deliverability that a generator faces, and then compare the deliverable level to ELCC percentages.

CAISO Response

The CAISO has reviewed the revised Deliverability Assessment methodology's solar and wind output assumptions proposed in 2018, and notes that the maximum solar and wind output assumptions in both the HSN and SSN assessments exceed the average ELCC values for 2018 during June through September, except for the SDG&E area. The CAISO proposes to adjust the SSN Solar output assumption for the SDG&E area to 40.2 %, which equals the average ELCC value for Solar for June through September.

4.5 Hybrid Solar-Storage Facilities

Stakeholder Inputs

BayWa asked the CAISO to provide details on the hybrid technology with storage facility.

CAISO Response

The CAISO clarifies modeling of hybrid technology in the deliverability assessment under different scenarios in Section 5 of this paper.

4.6 Deliverability Transfer

Stakeholder Inputs

AWEA-California states that if deliverability transfers are not addressed early on in this initiative, it is possible that there will be a rush to transfer deliverability in an effort to initiate the transfers under the current methodology (which would allow for more transfers for many resources than the new methodology will allow). They go on to say that CAISO should try to avoid this rush by outlining the impacts of deliverability transfers early in this stakeholder initiative, and that CAISO should consider a process that would provide generators an opportunity to indicate a deliverability transfer is being considered. And finally they say that if those submissions are made, CAISO might provide a length of time for deliverability transfers to occur with deliverability transfers able to occur up to the max deliverability output that was analyzed under the OLD methodology.

EDF-R and First Solar also raise the "gold rush" concern and believes that deliverability transfer should be within the scope of this initiative. They raise the concern that if the new methodology lowers the amount of available deliverability transfer, then this is not a reasonable outcome if the project funded upgrades.

CAISO Response

As stated in the Issue Paper regarding the transfer of deliverability, once the revisions to the methodology are finalized, then the details on transfers of deliverability can be addressed. Generators rushing to transfer their deliverability in the interim is not expected to be a logistical issue. The CAISO outlined current deliverability transfer methods in the most recent Interconnection Process Enhancements initiative.[2]

4.7 Timeline to Implement the Proposal

Almost all stakeholders recommended that the revisions to the deliverability assessment methodology be implemented as soon as possible.

Stakeholder Inputs

EDPR NA states that there are important benefits to California that would come from a timely change in the CAISO's methodology, and the use of an outdated methodology in CAISO's TPD allocation will reduce the number of projects that can obtain Full Capacity status at a critical juncture. AWEA-California supports implementation of the new deliverability methodology as soon as practicable, while also working to develop solutions to the associated increased curtailment risk. BAMx encouraged the CAISO to implement the proposed methodology without any further delay but to make a commitment to refine it further at a future date. CalWEA states that CAISO should immediately implement its reformed deliverability assessment methodology, as part of Phase 2 of Cluster 11 and Phase 1 of Cluster 12 interconnection studies and any TPP study that it undertakes in response to the CPUC's IRP process.

However, GSCE believes this initiative should proceed cautiously because there are significant negative consequences that could result from the CAISO's proposed change in its deliverability assessment methodology.

CAISO Response

The CAISO recommends that the revisions to the deliverability assessment methodology with the enhancements described later in this Straw Proposal should be implemented as soon as possible. However, as GSCE points out, the CAISO needs to proceed cautiously to ensure that it addresses stakeholder concerns with the revisions proposed in 2018, and the enhancements needed to address stakeholder concerns will require a change to the CAISO Tariff. With stakeholder support the CAISO should be able to revise the Tariff and have

[2] http://www.caiso.com/informed/Pages/StakeholderProcesses/InterconnectionProcessEnhancements.aspx.

those changes effective in time to implement the revised deliverability assessment methodology for the 2020 reassessment. Accordingly, the CAISO hopes to take this proposal to the September Board of Governors meeting.

5 Straw Proposal to Revise Deliverability Assessment Methodology

The on-peak deliverability assessment will be a test under multiple system conditions: the highest system need scenario, the secondary system need scenario, and non-summer peak scenario.

The highest system need scenario and the secondary system need scenario assessments follow the current deliverability assessment procedure. The dispatch assumptions align with the particular load condition being studied. The two scenarios play a different role in determining the required delivery network upgrades.

The off peak (*i.e.*, non-summer peak) scenario is a supplemental study to reduce the risk of excessive renewable curtailment due to transmission constraints. The transmission upgrades identified in the off peak scenario are in general not for resource adequacy purposes. This straw proposal recommends inexpensive upgrades for local curtailment being assigned to generation interconnection projects, but relying on transmission planning process to comprehensively address substantial renewable curtailment mitigations.

5.1 Highest System Need Scenario

The highest system need (HSN) scenario represents when the capacity shortage is most likely to occur. In this scenario, the system reaches peak sale with low solar output. The highest system need hours are hours ending 18 to 22 in the summer months with an unloaded capacity margin less than 6% in the CAISO annual summer assessment or identified as loss of load hour in the CPUC ELCC study for wind and solar resources.

The CEC 1-in-5 peak sale forecast for each planning area is distributed to all the load buses in study.

The net scheduled imports at all branch groups as determined in the latest annual Maximum Import Capability (MIC) assessment set the imports in the study. Approved MIC expansions, if not yet implemented, are added to the import levels.

The study amount for each generator, the maximum output tested in the deliverability assessment, depends on the technology, the installed capacity and the Qualitying Capacity.

The intermittent resources are modeled based on the output profiles during the highest system need hours. A 20% exceedance production level for wind and solar resources during these hours sets the study amount tested in the deliverability assessment. The CAISO will review the latest available CPUC ELCC study data and CAISO annual summer assessment data to annually update the modeling assumptions, as needed.

The study amount for the non-intermittent resources are set to the highest summer month Qualifying Capacity in the last three years. For proposed new non-intermittent generators that do not have Qualifying Capacity value, the study amount is the capacity requesting full deliverability. For energy storage generation, the study amount is set to the 4-hour discharging capacity limited by the requested maximum output from the generator. For hybrid projects, the study amount for each technology is first calculated separately as above. Then the total study amount among all technologies is limited by the requested maximum output of the generation project.

Table 1: Modeling Assumptions for Highest System Need Scenario

Selected Hours	HE18 ~ 22 in summer month and (loss of load event in ELCC simulation by CPUC or UCM < 6% in CAISO summer assessment)
Load	1-in-5 peak sale forecast by CEC
Non-Intermittent Generators	Study amount set to highest summer month Qualifying Capacity in last three years
Intermittent Generators	Study amount set to 20% exceedance level during the selected hours
Import	MIC data with expansion approved in TPP

The deliverability assessment then follows the steps in the current methodology. Deliverability constraints are identified and delivery network upgrades are identified for each constraint. The delivery network upgrades are categorized as either LDNUs or ADNUs following the current study process.

5.2 Secondary System Need Scenario

The secondary system need (SSN) scenario represents when the capacity shortage risk will increase if the intermittent generation while producing at a significant output level is not deliverable. In this scenario, the system load is modeled to represent the peak consumption level and solar output is modeled at a significantly high output. The secondary system need hours are hours ending 15 to 17 in the summer months with an unloaded capacity margin less than 6% in the CAISO annual summer assessment or identified as loss of load hour in the CPUC ELCC study for wind and solar resources.

The hour with the highest total net imports among all secondary system need hours from the latest MIC assessment data is selected. Net scheduled imports for the hour set the imports in the study. Approved MIC expansions, if not yet implemented, are added to the import levels.

The intermittent resources are modeled based on the output profiles during the secondary system need hours. 50% exceedance production level for wind and solar resources during

the hours sets the study amount tested in the deliverability assessment. The CAISO will review the latest available CPUC ELCC study data and CAISO annual summer assessment data to annually update the modeling assumptions, as needed.

The study amount for the non-intermittent resources are set to the highest summer month Qualifying Capacity in the last three years. For proposed new non-intermittent generators that do not have Qualifying Capacity value, the study amount is the capacity requesting full deliverability. For energy storage generation, the Pmax is set to the 4-hour discharging capacity limited by the requested maximum output from the generator. For hybrid projects, the study amount for each technology is first calculated separately as above. Then the total study amount among all technologies is limited by the requested maximum output of the generation project.

Table 2: Modeling Assumptions for Secondary System Need Scenario

Select Hours	HE15 ~ 17 in summer month and (loss of load event in ELCC simulation by CPUC or UCM < 6% in CAISO summer assessment)
Load	1-in-5 peak sale forecast by CEC adjusted to peak consumption hour
Non-Intermittent Generators	Study amount set to highest summer month Qualifying Capacity in last three years
Intermittent Generators	Study amount set to 50% exceedance level during the selected hours, but no lower than the average QC ELCC factor during the summer months
Import	Highest import schedules for the selected hours

The deliverability assessment then generally follows the steps in the current methodology. As the load is lower, it may not be feasible to dispatch all existing generators at 80% ~ 92% of the Pmax. The initial dispatch may be lowered to less than 80%, but not lower than the LCR requirement in each LCA.

5.3 Delivery Network Upgrades – Use of HSN and SSN Scenarios

Network upgrades are identified to mitigate all the deliverability constraints from both the primary and the secondary system need scenarios.

In the generation interconnection process,

- The highest system need scenario represents when a capacity shortage is most likely to occur. As a result, if the addition of a resource will cause a deliverability deficiency determined based on a deliverability test under the highest system need scenario, then the constraint will be classified as either a Local Deliverability Constraint or an Area Deliverability Constraint.

- The secondary system need scenario represents when the capacity shortage risk will increase if the intermittent generation while producing at a significant output level is not deliverable. If the addition of a resource will cause a deliverability deficiency determined based on a deliverability test under the secondary system need scenario, and is not identified in the highest system need scenario, then the constraint can be classified as an Area Deliverability Constraint following the classification guidelines in the BPM for the Generator Interconnection and Deliverability Allocation Procedures.

In the transmission planning process,

- Transmission upgrades identified under the highest system need scenario are approved as policy driven upgrades.
- Transmission upgrades identified under the secondary system need scenario need additional economic or reliability justification to be approved as policy driven or economic upgrades. The transmission planning process could make a determination that no upgrades are needed for the secondary system need deliverability constraint. If the transmission planning process decides not to pursue upgrades to support the deliverability test in the secondary system need scenario, generation up to the amount assessed for the renewable portfolio behind the associated deliverability constraints are deemed deliverable in the Transmission Plan Deliverability allocation and annual NQC determination.

5.4 Off-Peak Deliverability Assessment

Once the precise location and amounts of future resources are known, the most robust approach to approve transmission upgrades to deliver renewable energy reliably and economically is through the transmission planning process framework of reliability, economic and policy upgrades. However, there is a concern with the TPP's ability to identify the upgrades timely enough for generation development, especially those depending on the exact point of interconnection of the future generations. Therefore, a supplemental study that focuses on the non-RA renewable energy delivery could inform generators of their curtailment risk and how to reduce such risk at the early development stage. The generators would be given an opportunity to fund network upgrades. To enable this, the CAISO proposes revisions to the off-peak deliverability assessment around the following principles:

1. Identify transmission bottlenecks that would cause excessive renewable curtailment.
2. Identify transmission upgrades for local constraints that tend to be less expensive. The need for such upgrades are highly dependent on the development of generation in a small localized area. The generation behind the constraint is more likely to produce a high simultaneous output when there is no system-wide over-supply.
3. It is prudent to rely on the TPP framework to approve transmission upgrades for area constraints that tend to be expensive. For area constraints, the general placement of new renewable generation in the portfolio is sufficient to identify the need, and there is higher chance that the transmission induced curtailment is occurring simultaneously with system-wide over-supply.

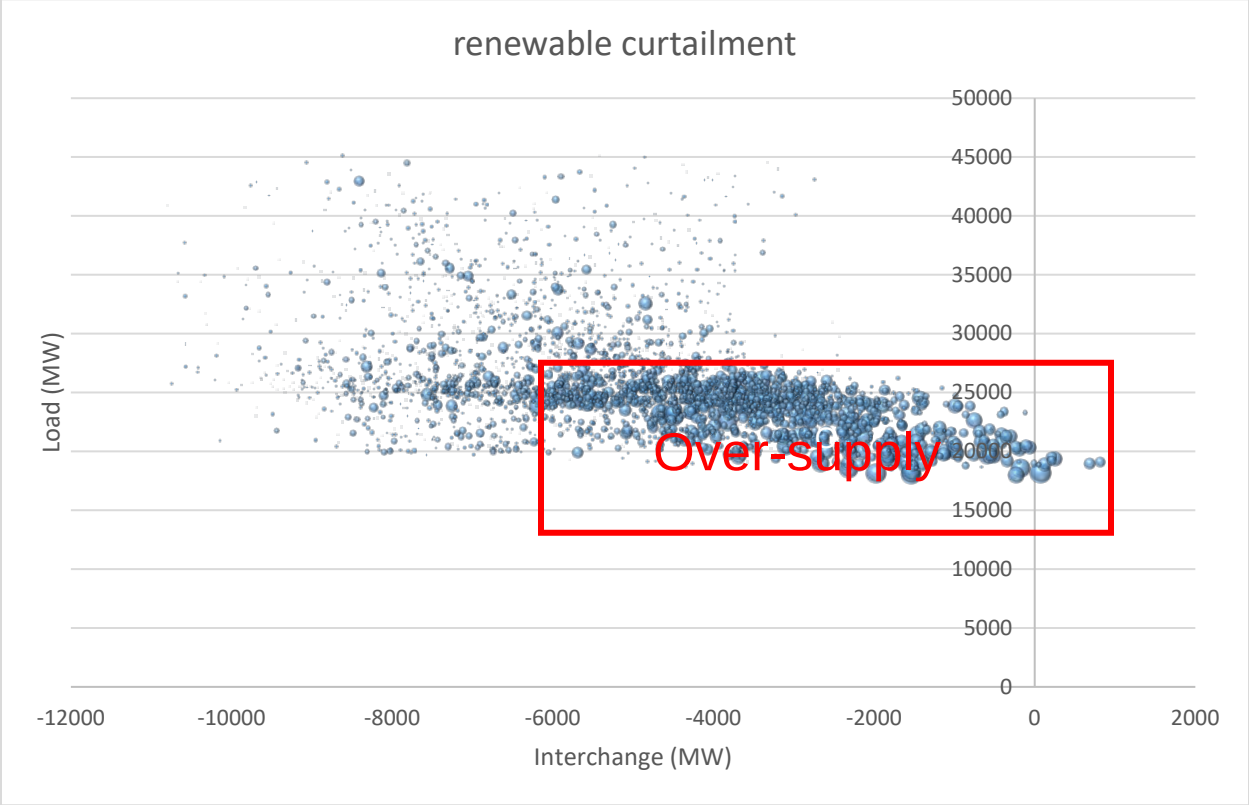
4. The curtailment risk is regardless of the generator's deliverability status, so this study should consider both full capacity and energy only generators.

Details of the CAISO proposal are discussed below.

General System Conditions for the Off-Peak Deliverability Assessment

As renewable penetration increases, curtailments are expected to be more severe under lighter load conditions. Therefore, the off-peak condition would be studied to supplement the on-peak-deliverability assessment. The objective of the off-peak deliverability assessment is to identify transmission upgrades needed to relieve excessive renewable curtailment caused by transmission constraints. The general system study conditions should capture a reasonable scenario of the load, generation, and imports that stress the transmission system, but not coinciding with an over-supply situation. The renewable curtailment data from 2018 was examined to establish this general system condition. Figure 2 shows an hourly renewable curtailment scatter plot with assocated load and import levels. The size of the bubbles in the figure are proportional to the MW being curtailed. The curtailments in the right lower corner of the scatter plot are most likely to be due to system-wide over-supply. The general system conditions to assess the off-peak transmission constraints are selected just outside the top left corner of the box in Figure 2 to stress the transmission system. The load is 55% to 60% of the summer peak load and the import is about 6000 MW.

Figure 2: Renewable Curtailment



The production of wind and solar resources under the selected system conditions varies widely. The production duration curves for solar and wind were examined. The production level under which 90% of the annual energy is produced set the outputs to be tested in the off-peak deliverability assessment. As seen in Figure 3 and Figure 4, the 90% energy levels are 68% of installed capacity for solar and 44% for wind.

Figure 3: Normalized CAISO Total Solar Output Duration Curve

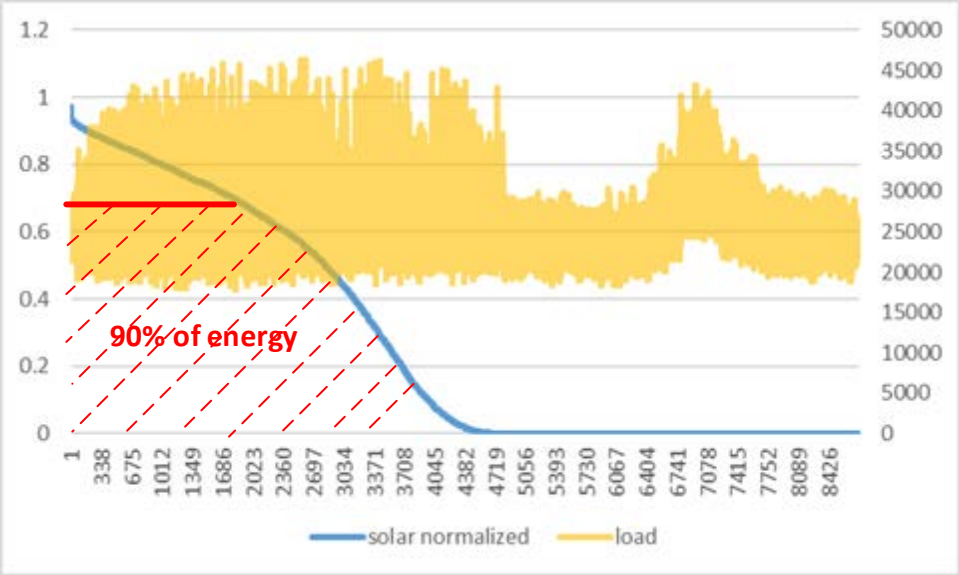
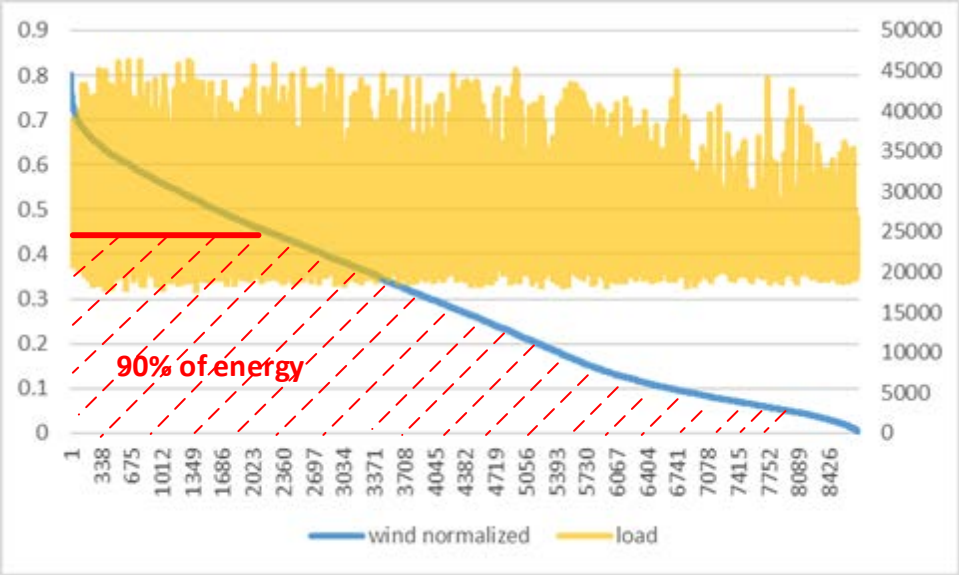


Figure 4: Normalized CAISO Total Wind Output Duration Curve



The dispatch of the remaining generation fleet is set by examining historical production associated with the selected renewable production levels. The hydro dispatch is about 30%

of the installed capacity and the thermal dispatch is about 15%. All energy storage facilities are assumed offline.

The dispatch assumptions discussed above apply to both full capacity and energy-only resources. However, with the large amount generation in the interconnection study queue, it is impossible to balance load and resources under such conditions with all queued generation dispatched. The dispatch assumptions are applied to all existing generators first, then some future generators if needed to balance laod and resources. This establishes a system-wide dispatch base case that is the starting case for developing each of the study area base cases that the off-peak deliverability assessments are based on. Table 3 summarizes the generation dispatch assumptions.

Table 3: CAISO System-Wide Generator Dispatch Assumptions

	Dispatch Level
wind	44%
solar	68%
Battery Storage	0
hydro	30%
thermal	15%

The off-peak deliverability assessment models all the approved transmission upgrades, as well as RNUs and LDNUs required under the on-peak deliverability assessment.

Off-Peak Deliverability Assessment Procedure

The off-peak deliverability assessment is performed for each study area separately. The study areas in general are the same as the reliability assessment areas in the generation interconnection studies. However, to avoid excessive generation being dispatch in one study area, one reliability assessment area may be broken into several smaller gen-pockets that separate wind/solar areas and align with TPP study areas. Below is the preliminary list of the study areas –

- PG&E north
- PG&E Fresno
- PG&E Kern
- SCE Northern
- SCE North of Lugo
- SCE/VEA/GWL East of Pisgah
- SCE/DCRT Eastern
- SDGE Inland
- SDGE East

Study area base cases are created from the system-wide dispatch base case. All generators in the study area, existing or new, are dispatched to a consistent output level. In order to capture local curtailment, the renewable dispatch is increased to the 90% energy level for the study area, which is higher than the system 90% energy level. The study area 90% energy level was determined from representing individual plants in different areas.

- If the renewables inside the study area are predominantly wind resources (more than 70% of total study area capacity), increase wind resource dispatch as shown in Table 4. All the solar resources in the wind pocket are dispatched at the system-wide level of 68%. If not a wind pocket, dispatch assumptions in Table 5 are used.

Table 4: Solar and Wind Dispatch Assumptions in Wind Area

	Wind Dispatch Level	Solar Dispatch Level
SDG&E	69%	68%
SCE	64%	
PG&E	63%	

Table 5: Solar and Wind Dispatch Assumptions in Solar Area

	Solar Dispatch Level	Wind Dispatch Level
SDG&E	79%	44%
SCE	77%	
PG&E	79%	

As the generation dispatch increases inside the study area, the following could be done to balance the load and resources:

- Reduce new generation outside the study area with a limitation of Path 26 4000 MW north to south or 3000 MW south to north.
- Reduce thermal generation inside the study area.
- Reduce import.
- Reduce thermal generation outside the study area.

A contingency analysis is performed for normal conditions and selected contingencies:

- Normal conditions (P0).
- Single contingency of transmission circuit (P1.2), transformer (P1.3), single pole of DC lines (P1.5) and two poles of PDCI if impacting the study area.
- Multiple contingency of two adjacent circuits on common structure (P7.1) and loss of a bipolar DC line (P7.2).
- Two adjacent transmission circuit according to WECC's Project Coordination, Path Rating and Progress Report Processes.

For overloads identified under such dispatch, resources that can be re-dispatched to relieve the overloads are analyzed first:

- Existing energy storage resources are dispatched to full four hour charging capacity to relieve the overload.
- Thermal generators contributing to the overloads are turned off.
- Imports contributing to the overloads are reduced to the level required to support out-of-state renewables in the RPS portfolios.

The remaining overloads after the re-dispatch will be mitigated by the identification of transmission upgrades. First, the overloads are identified as local constraints or area constraints. The CAISO will apply the same local vs. area constraint classification methodology as in the on-peak deliverability assessment. Then, the transmission upgrades to mitigate local constraints are labeled as off-peak local network upgrades and the transmission upgrades to mitigate area constraints are labeled as off-peak area network upgrades.

Off-Peak Network Upgrades

As the off-peak deliverability assessment is performed for generators regardless of their on-peak deliverability status to identify transmission contraints impacting renewable production, a new upgrade framework is needed to separate them from the Delivery Network Upgrades associated with the Full Capacity Deliverability Status. The CAISO views Option 4 and 5 as preferred options—as laid out in Section 3 of this paper—and will further refine and finalize the details of the final proposal after receiving stakeholder's comments.

Off-Peak Local Network Upgrades

The interconnection customers for wind and solar resources are provided an opportunity to fund off-peak local network upgrades in the generation interconnection process. The off-peak local network upgrades belong to a separate cost category from the Reliability Network Upgrades and Delivery Network Upgrades. Therefore, inclusion of the off-peak upgrades would not impact the cost responsibility and maximum cost responsibility for RNUs and DNUs.

- Option 4: optional off-peak local network upgrades (OLNU) with reimbursement cap

Off-peak upgrades are assigned to the interconnection requests in the study cluster that have 5% or more contribution to the transmission constaint. There is no cost allocation among the interconnection requests in the same cluster in Phase I interconnection study. Each interconnection request is assigned the full cost of the off-peak local network upgrades.The IC elects whether to fund off-peak local network upgrades after receiving the Phase I interconnection study report. The need for the off-peak upgrades are re-evaluated in Phase II and the cost is allocated to the contributing interconnection requests that have elected to fund the upgrades. The off-peak upgrade cost is capped by the lower of the full cost of network upgrades between the Phase I and the Phase II study. The off-peak upgrades may be updated in the annual reassessment with cost reallocation, but subject to the cost cap. The off-peak network upgrades are included in the overall network upgrade cost calculation for the interconnection financial security posting.

The CAISO recommends that the off-peak upgrades costs assigned to the interconnection customers are reimburseable with a reimbursement limit. The interconnection customer would receive Merchant Transmission CRRs for assigned off-peak upgrade costs beyond the reimbursement limit.

- Option 5: optional off-peak deliverability status service with mandatory local off-peak transmission upgrades

The interconnection customer for wind or solar generators selects off-peak deliverability status (OPDS) when submitting the interconnection request. The off-peak upgrades are only assigned to the interconnection requests in the study cluster that have 5% or more contribution to the transmission constaint and select OPDS. The cost is allocated among these interconnection requests in proportion to the flow impacts on the upgrade. The off-peak upgrade cost is capped by the lower of the allocated cost of network upgrades between the Phase I and the Phase II study. The off-peak upgrades may be updated in the annual reassessment with cost reallocation, but subject to the cost cap. The off-peak network upgrades are included in the overall network upgrade cost calculation for the interconnection financial security posting.

The CAISO recommends that the off-peak upgrades costs assigned to the interconnection customers are reimburseable.

Generating facilities that select the OPDS option will have a higher scheduling priority in the market than generating facilitites that do not have the OPDS option once it is in operation. The higher scheduling priority can be achieved in the market by setting the OPDS self schedule with a higher penalty price (more negative price) in the market clearing process, known as the scheduling run, than the penalty prices assigned to other resources that either do not select or are not eligible for OPDS condition.[3] The penalty prices allow the market clearing process to assign the priority among self schedules in a given sequence such that when the market curtails self schedules (*i.e.*, price takers), the resources with lower priorities will be curtailed first. A curtailment is a market schedule or dispatch below the self schedule level submitted by the generating resource. When supply needs to be dispatched decrementally, the market relies on submitted bids, starting from the most expensive to the cheapest, with self schedules placed at the lower part of the supply stack. When sufficient economical bids are available in the market, there may be no need to curtail any self schedules. However, under tight system conditions, such as local transmission congestion, the market will still need to curtail self schedules once all economical bids have been exhausted. Under such tight conditions, the OPDS condition will only provide a higher priority to curtail with respect to other self schedules. Therefore, this OPDS condition can only ensure a relative priority in the sequencing of curtailing self schedules among all types of self schedules and does not guarantee the OPDS self scheudles will not be curtailed. Like FCDS, OPDS should not be confused with firm transmission service or precedence over

[3] The current penalty price parameters can be found in the CAISO's Market Operations BPM and section 6.6.5. https://bpmcm.caiso.com/BPM%20Document%20Library/Market%20Operations/BPM_for_Market%20Operations_V60_clean.doc.

market results. Bids and self schedules of OPDS resources will still be subject to security-constrained economic dispatch, and may still be subject to curtailment.

If the off-peak upgrades are identified, upsized or reconfigured in a subsequent TPP cycle, the network upgrade requirement and cost allocation will be removed from the interconnect customers' responsibility.

Off-Peak Area Network Upgrades

Off-peak area network upgrades are identified for information purpose only, same as the current off-peak deliverability assessment. The estimated scope and cost will be provided. In addition, information will be provided on how much renewable generation need to be curtailed in order to mitigate the remaining overloads after the re-dispatch described above without the area network upgrades.

6 Next Steps

In this straw proposal the CAISO has summarized stakeholder's comments and proposed revisions to the off-peak deliverability assessment to address stakeholders' concern about increased levels of curtailments. The CAISO will hold the second stakeholder meeting on August 5, 2019 to review this straw proposal and solicit input for the final proposal.