Deliverability Assessment Methodology

Issue Paper

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Infrastructure and Operations Planning

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1 Summary of Issues

The California Independent System Operator (ISO) uses the deliverability assessment methodology to ensure that the transmission system can deliver resource adequacy (RA) capacity to meet load during stressed system conditions. These RA resources first have to meet basic interconnection requirements to be reliably interconnected. Given the backlog of outstanding interconnection requests in the ISO interconnection queue, and the unprecedented volume of new requests in Clusters 14 and 15, the ISO is pursuing refinements to the interconnection process in the Interconnection Process Enhancements Initiative, and will explore changes to the deliverability assessment methodology in this initiative. The ISO will also address some related issues in the RA Initiative. The ISO's goal is to move through the interconnection, deliverability, and RA initiatives in a coordinated manner to streamline processes and studies for more accelerated deployment of generation resources to reliably serve load.

This Issue Paper reflects the ISO's commitment to the new more synchronized process outlined in the Memorandum of Understanding (MOU) between the California Public Utilities Commission (CPUC), California Energy Commission (CEC) and ISO, which commits the entities to improved streamlining and coordination of resource and transmission planning, interconnection, and power procurement.[1]

The ISO understands the importance of Transmission Planning Deliverability (TPD) capacity for developers and offtakers. This paper explores the following issues that have been raised in stakeholder comments in response to the ISO's Update Paper[2], to generate discussion of potential solutions to improve the deliverability assessment methodology.

System Deliverability Issues

- **Study of High System Need (HSN) and Secondary System Need (SSN):** In response to comments on the Issue Paper, the ISO will explore the necessity of studying more than one stressed system condition, and whether opportunities exist to allocate deliverability up to the portfolio volumes studied. We will also explore this topic in the ISO's RA initiative, in light of recent changes in the CPUC RA program to move

[1] http://www.caiso.com/Documents/ISO-CEC-and-CPUC-Memorandum-of-Understanding-Dec-2022.pdf
[2] Deliverability Challenges: An ISO Update. December 12, 2022. Update-Paper-Generation-Deliverability-Methodology-Review-Dec132022.pdf (caiso.com)

toward a 24-hour Slice-of-Day approach to RA. The ISO does have outstanding concerns with the potential for increased operational complexity and congestion and implications to the Transmission Planning Process (TPP) that could result from changes to the study framework, which will need to be considered in exploring this issue.

- **Study of n-2 contingencies:** The ISO is required by NERC to study n-2 contingencies on double-circuit towers, as are other ISOs such as MISO and PJM. Therefore, the ISO does not intend to change this practice. Further, the ISO is concerned that discontinuation of the n-2 contingency studies would lead to sub-optimal results that would need to be addressed and resolved – albeit less effectively and less timely - in the Transmission Planning Process (TPP).
    - *Alternative proposal:* To continue to comply with NERC requirements and avoid additional delays associated with the time required to mitigate n-2 contingencies, the ISO will explore a risk based approach and resulting policy changes to provide some form of interim deliverability while waiting for the related n-2 deliverability upgrades to be completed. This award could only be considered in cases where reliability concerns do not exist.
- **Delayed deliverability upgrades:** The ISO understands the disruptions resulting from delayed PTO timelines for deliverability upgrades, and will explore the provision of some form of interim deliverability to projects affected by delayed network upgrades through a risk based approach.
- **Diablo Canyon study considerations:** Stakeholders suggested removing Diablo Canyon from studies after 2025. The ISO is open to discussing the best way to study Diablo Canyon, but notes that its studies do not currently consider Diablo Canyon addressing transmission grid needs beyond 2025. The ISO also notes PG&E will retain the Large Generator Interconnection Agreement (LGIA) until retirement and repowering rights for up to three years after the plant's retirement. The impact of this suggestion is unclear, so the ISO suggests additional stakeholder discussion on this topic.

Local deliverability issues

- **Local Capacity Area (LCA) testing:** Stakeholders suggested that local capacity resources shouldn't be required to provide system capacity, which would effectively split local and system RA into two separate and discrete products. The ISO suggests that this issue requires a larger policy discussion due to its inherent impact on local and system resource adequacy procurement requirements, and intends to address it in the ISO's RA Initiative rather than this Initiative.

Additional stakeholder comments

Other stakeholder comments addressed changes to the ISO's simultaneous dispatch requirement and the use of ELCC-derived QC values instead of the ISO's percent exceedance based values. The ISO does not intend to implement changes in these areas for reasons described below.

- **Simultaneous dispatch:** Some stakeholders have commented that it is not realistic to study all generation in an area simultaneously dispatched at the level they could realistically be called upon in stressed system conditions. The ISO is not exploring changes to the simultaneous dispatch requirement. Actual operating experience supports the simultaneous dispatch assumption during resource shortage conditions. Such changes to the premise and purpose of the studies would undermine the RA program and compromise the ISO's current ability to ensure that it could serve load in stressed system conditions.
- **Dispatch levels:** Some stakeholders have stated that it is inappropriate to study intermittent resources with an output that is different than their QC levels. The methodology studies intermittent resources at exceedance-based output levels that are reasonably expected during resource shortage conditions. The exceedance-based levels can be lower or higher than the NQC, depending on the resource type. The ISO will continue to use exceedance-based values in the deliverability studies and will continue to review and update those values as circumstances change.

2 Introduction

This issue paper launches a process to assess the ISO's deliverability assessment methodology, an assessment conducted on generation seeking to provide RA capacity, which is capacity that can be reasonably relied upon in times of system stress to serve customer demand.

The need for additional generation of electricity over the next 10 years, including the need for out-of-state resources, has escalated rapidly in California as it continues transitioning to the carbon-free electrical grid required by Senate Bill 100 that was signed into law in 2018. To help ensure we have the transmission and generation interconnections in place to achieve this transition reliably and cost-effectively, the ISO has been coordinating with the state's primary energy planning and regulatory entities to adopt a much more strategic and proactive approach to resource, procurement, transmission planning and interconnections overall. The more proactive and coordinated strategic direction reflected in this year's transmission plan is set forth in a joint Memorandum of Understanding ("MOU") signed by the ISO, the California Public Utilities Commission ("CPUC") and California Energy Commission ("CEC") in December 2022, that tightens the linkages between these key processes. The MOU emphasizes the continued role of the state agencies to provide resource forecasts - in the form of portfolios of resource quantities and locations - for planning purposes.

In response to the acceleration in resource procurement by load-serving entities, the ISO has been receiving hundreds of interconnection requests a year from potential resource developers, many of which are located in areas that are not a priority in the state's resource planning. With the ISO's interconnection application queue inundated with applications, current processes need to be re-imagined to ensure resource procurement and queuing are effectively shaped and informed to take advantage of transmission and interconnection capacity that exists or is already planned and under development, and to align with the transmission upgrades necessary for longer-term resource development.

The ISO launched a review of its current interconnection processes, the 2023 Interconnection Process Enhancements (IPE) initiative.[3] Track 1 of IPE was adopted by the ISO Board of Governors on May 18, 2023, and Track 2 of the IPE Initiative will tackle additional transformational reforms to the interconnection queuing process that will leverage the improved coordinated planning resulting from the MOU and help further break down barriers to efficient and timely resource development.

Other activities are also proceeding in parallel, focused on streamlining processes and overcoming barriers to timely resource development. These include transmission project tracking and reporting through the joint CPUC/ISO Transmission Development Forum, working with individual resource developers through the TED Task Force led by the CPUC and GO-Biz in the Office of the Governor.

In addition, the concerns have grown with the pace of development of transmission upgrades or enhancements to enable resources to achieve deliverability status and provide capacity into the state's RA program and have elevated, especially when delays to transmission upgrade schedules have occurred or new requirements impacting schedules have been identified late in the process.

This also led to questions and speculation about the technical requirements the ISO assesses in awarding deliverability status to generators, including whether the requirements could be lessened to award more deliverability status with the current transmission system and if they could require fewer upgrades or mitigations to make additional generation deliverable. As stated earlier in this paper, he ISO's deliverability assessment methodology is an assessment conducted on generation seeking to provide RA capacity – capacity that can be reasonably relied upon in times of system stress to serve customer demand. The ISO developed its initial on-peak deliverability study methodology for RA purposes in 2004 and it was then generally adopted in the CPUC's RA proceeding that same year. Since then, the methodology has been modified to address evolving circumstances, and a comprehensive

[3] California ISO - Interconnection process enhancements 2023 (caiso.com)

stakeholder process was conducted in 2019 and 2020. Also, in June 2022, storage dispatch assumptions were adjusted to reflect the evolving nature of the generation fleet. The need for adequate transmission to support the simultaneous access to RA is a basic tenant of the RA program, and this has been substantiated during extreme stressed conditions in each of the last three years – August 13 and 14 in 2020, July 9 in 2021, and September 6, 2022[4].

The ISO posted a December 2022 paper[5] providing an update on deliverability issues that responded to industry concerns about access to deliverability for resources seeking to compete in load-serving entity procurement processes and to explore root causes of the concerns and set out a preliminary path forward the ISO is considering. In response to that paper, stakeholders provided comments that are summarized and discussed in this Issue Paper.

3 Stakeholder Process

The ISO issued the December 12, 2022 Update Paper to initiate a review of the methodology to ensure that the deliverability requirements strike the appropriate balance between reliability and cost containment, and that the reliability requirements are not unduly burdensome. While the ISO had not found that the specific concerns raised at that time to the ISO substantiated material issues with the existing methodology itself, the ISO agreed this is a critical issue to the ISO and industry, and worth ensuring that all options have been considered. The ISO collected comments on the update to better understand stakeholder concerns and shape this issue paper. As well as comments about the methodology itself, a large number dealt with other aspects of the ISO's interconnection process and the management of deliverability network upgrades.

The purpose of this issue paper is to summarize and discuss the stakeholder input provided in response to the update paper, and map out a path forward. This paper also identifies preliminarily the interconnection process issues, and the management of deliverability network upgrades, that need to be considered more collectively with the interconnection process enhancements process now also underway.

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[4] From August 31 through September 9, 2022, California and much of the Western United States experienced record-setting heat resulting in all-time high demand for electricity across the region (September 2022 heat wave). The prolonged heat event precipitated an unprecedented number of calls for consumer conservation. This included 10 consecutive days of voluntary Flex Alerts and new state programs that provided non-market resources to address extreme events culminating on September 6, the only day when the ISO system reached its highest emergency alert level.

[5] https://stakeholdercenter.caiso.com/StakeholderInitiatives/Generator-deliverability-challenges

After publication of the issue paper, the ISO will hold a stakeholder call and, after reviewing comments, will develop a more comprehensive stakeholder process for additional papers, stakeholder calls or workshops as necessary.

4 The Role of Deliverability in Resource Adequacy

A generating resource must pass the CAISO's deliverability test under system summer peak load conditions for its Qualifying Capacity (QC) as determined by the CPUC. The amount that meets the test requirements, which may be less than the full Qualifying Capacity initially assigned by the CPUC, is the Net Qualifying Capacity (NQC) that can be counted to meet RA requirements. The generating resource passes the deliverability test if it is able to deliver its output to system load under these conditions.

The methodology for this on-peak deliverability assessment has been applied in the ISO generation interconnection studies and transmission planning studies. In addition to delivery network upgrades identified in generator interconnection studies, a number of policy driven transmission upgrades were identified and approved to support deliverability of the State's Integrated Resource Plan resource portfolios through the transmission planning process. In other words, the ISO transmission planning process approved those upgrades necessary for the system fleet to be able to deliver its output to meet system demand during peak load conditions, with the studies conducted in accordance with the methodology.

5 Deliverability Assessment Methodology

5.1 The On-Peak Deliverability Assessment Methodology[6]

As noted earlier, the CAISO's on-peak deliverability study methodology for RA purposes was discussed extensively in the CPUC's RA Proceeding in 2004, and was generally adopted in that proceeding. It was also accepted by FERC as a reasonable implementation of Large Generator Interconnection Procedures (LGIP) Section 3.3.3, during the FERC Order 2003 compliance filing process. A generator deliverability test is applied to ensure that capacity is not "bottled" from a RA perspective. This would require that each electrical area be able

[6] http://www.caiso.com/Documents/On-PeakDeliverabilityAssessmentMethodology.pdf

to accommodate the full output of all of its expected available capacity resources and export, whatever power is not consumed by local loads during periods of peak system load.[7]

From the perspective of individual generator resources, deliverability ensures that under normal transmission system conditions, if capacity resources are available and called on, their ability to provide energy to the system at peak load will not be limited by the dispatch of other capacity resources in the vicinity. This test does not guarantee that a given resource will be dispatched to produce energy at any given system load condition. The ISO does not offer "firm" network or point-to-point transmission service. Rather, the test's purpose is to demonstrate that the available generation capacity in any electrical area can be run and delivered simultaneously, at peak load, and that the excess energy above load in that electrical area can be exported to the remainder of the Balancing Authority Area.[8] In short, the test verifies that bottled capacity conditions will not exist at peak load, limiting the availability and usefulness of RA capacity resources for meeting RA requirements. In actual operating conditions, energy-only resources may displace RA resources in the market's economic dispatch that serves load.

The electrical regions from which generation must be deliverable range from individual buses to all of the generation in the vicinity of the generator under study. The premise of the test is that all available capacity in the vicinity of the generator under study is required, hence the remainder of the system is experiencing a significant reduction in available capacity. However, since localized transmission capacity deficiencies should be tested when evaluating deliverability from the load perspective, the dispatch pattern in the remainder of the system is appropriately distributed. Failure of the generator deliverability test when evaluating a new resource in the generator interconnection study impacts the ability of the resource to be included in meeting RA needs. If the addition of the resource will cause a deliverability deficiency, then the resource should not be fully counted towards RA reserve requirements until transmission system upgrades are completed to correct the deficiency.

In summary, the goal of the On-Peak Generator Deliverability Study Methodology is to determine if the aggregate of available generation output in a given area can be simultaneously transferred to the remainder of the ISO Balancing Authority Area during resource shortage conditions. Any generators requesting Full or Partial Capacity

[7] Export capabilities at lower load levels can affect the economics of both the system and area generation, but generally they do not affect RA. Therefore, export capabilities at lower system load levels are not assessed in this deliverability test procedure.

[8] Subject to contingency testing.

Deliverability Status[9] in their interconnection request to the ISO-Controlled Grid will be analyzed for "deliverability" to identify the Delivery Network Upgrades (DNU) necessary to obtain this status.

The ISO deliverability test methodology is designed to ensure that facility enhancements and cost responsibilities can be identified in a fair and nondiscriminatory fashion.

The test methodology studies two scenarios: one is the highest system need (HSN) scenario and the other is known as the secondary system need (SSN) under higher gross load conditions when solar is dropping off. The HSN scenario is tested for all generating resources in the study. The load, generation dispatch and imports are corresponding to when the system RA need is the highest during the year based on pre-selected profiles. The highest system need in the past has been the peak gross consumption condition, but that has transitioned to the peak sale condition with the behind-the-meter distributed generation (DG) growth. The study is therefore supplemented by the SSN scenario, which focuses on the transition period when the gross load is still high and the solar production is dropping off. During this condition, a resource shortage is less likely but could still occur.

Overview of the Deliverability Analysis Testing Process

The previous section describes the general approach for the deliverability methodology. This section builds on the concepts already introduced and describes additional concepts that need to be comprehended to understand the ISO deliverability methodology. At a high level, the test procedure can be thought of as the following three steps.

1. The ISO builds the initial power flow base case, dispatching all existing generation, and new generation to balance loads and resources.
2. The ISO uses a commercially available software tool to perform generation sensitivity analysis to identify potentially limited generation pockets. At the most granular level, the sensitivity analysis identifies the exact generation facilities that have the highest flow impact on a particular transmission facility with all other facilities in-service and during forced outages of other facilities.
3. For each potentially limiting generation pocket identified in step 2, the ISO increases a subset of the generation with the highest flow impact on that facility to assess the potential for it to be overloaded under stressed system conditions.

[9] Full Capacity Deliverability Status ("FCDS") means that the generator is requesting that its entire output be deliverable. Partial means something less than its entire output. Generating units comprising a single generating facility/interconnection customer/generator interconnection agreement may have separate meters and resource IDs such that the individual generating units may be FCDS even if the entire facility at the point of interconnection is not deliverable.

All ISO-controlled facilities are analyzed to determine if they are limiting the deliverability of generation within the ISO deliverability methodology parameters.

Initial Base Case Dispatch

As described above, generation is dispatched in the initial base case at close to maximum dependable capacity. The selected percentage dispatch below maximum capacity considers the average forced outage rates of the generators, spinning reserve, and unexpected retirement of generation capacity across the system. For the cluster studies, the ISO has been dispatching all generation at 80% of maximum dependable capacity. Because we are modeling a resource shortage scenario, it is assumed that all available generation is being dispatched, and due to the shortage condition, the incremental dispatch cost of generation is not affecting the dispatch.

For the cluster studies, the amount of generation in the interconnection queue far exceeds the amount needed to achieve a load and resource balance. Therefore, the queued generation is organized into geographic areas, and five to ten base cases are built with each case designed to focus on a particular geographic area. Then the queued generation in these areas is dispatched similar to the existing generation (e.g. 80% of dependable capacity).

Identification of Generation Pockets Associated with Individual Transmission Facility Constraints

As described above, each transmission line and transformer is analyzed individually, starting from the initial base case dispatch. A study group is established for each line and transformer that includes all generation with a 5% distribution factor or greater on the particular line or transformer. The 5% distribution factor threshold is also used by PJM and MISO in their deliverability analysis methodologies. For each analyzed facility, an electrical circle is drawn which includes all units that have a 5% or greater distribution factor (DFAX) on the facility being analyzed. The 5% Circle can also be referred to as the study group for the particular facility being analyzed. Capacity generation dispatch inside the study group is increased to determine the loading on the line or transformer under stressed system conditions. Generation outside the study group is proportionally decreased to maintain the balance between loads and resources. This process is intended to test the ability of available resources inside the study group to be dispatched at full output when various resources across the ISO system are unavailable during a resource shortage condition.

Dispatch of Generators in the Study Group

The outputs of capacity units in the 5% Circle study group are increased starting with units with the largest impact on the transmission facility. The number of units to be increased within a group is limited to an amount of generation that can be reasonably expected to be simultaneously available, and the likelihood of all of the units within a group being available at the same time becomes smaller as the number of units in the group increases. The objective of the ISO deliverability methodology is to ensure that roughly 80% of the time, the transmission system will not constrain the output of generation in a study group during a resource shortage condition. The cumulative availability of 20 units with a 7.5% forced outage rate would be 21%. Therefore, no more than 20 units are increased to their maximum output within a study group. All remaining generation within the ISO balancing area is proportionally displaced, to maintain a load and resource balance. The amount of generation increased also needs to be limited because decreasing the remaining generation can cause problems that are more closely related to a generation deficiency in a load pocket rather than a generation pocket deliverability problem. Therefore, no more than a 1500 MW increment of generation is increased within a study group.

For groups where the 20 units with the highest impact on the facility can be increased more than 1500 MW, the impact of the remaining amount of generation to be increased will be considered using a Facility Loading Adder. The Facility Loading Adder is calculated by taking the remaining MW amount available from the 20 units with the highest impact times the DFAX for each unit. An equivalent MW amount of generation with negative DFAXs times the DFAX for each unit will also be included in the Facility Loading Adder, up to 20 units. Negative Facility Loading Adders are set to zero.

Import Assumptions

California has been for some time, is now, and will likely remain, dependent on imports to satisfy its energy and resource requirements. Therefore, it is likely that as part of fulfilling their obligation to procure sufficient resources (reserves) in the forward market to serve their respective loads, LSEs will contract with out-of-state resources. This is appropriate and necessary.

The ability to rely on imports to satisfy reserve requirements is dependent on the deliverability of such out-of-state resources from ISO balancing area intertie points with neighboring systems to the aggregate of ISO load. While the existing system may be able to satisfy the procurement plans of any one LSE, it likely will not be able to transmit the sum of LSEs' needs. Each LSE may well plan to rely on the same potentially constrained transmission paths to deliver its out-of-state resources. Therefore, the transmission system should be checked to make sure that simultaneous imports can be accommodated.

When relying on imports to serve load, each LSE should be required to ensure that it has assessed deliverability of such resources from the tie point to load on the ISO's system. The deliverability studies provide this assessment.

Transmission constraints can impact the simultaneous deliverability of imports and internal generation. As a result, the interaction between deliverability of imports and the deliverability of generation needs to be examined. The ISO generation deliverability assessment includes, as an input assumption, the amount of imports and existing transmission contract-related encumbrances, or usage of historical long-term firm transmission rights assigned to specific entities electrically flowing over the ISO-Controlled Grid.

Whatever import capacity is available to LSEs for RA planning purposes is also the basis for the import assumptions in the internal generation deliverability analysis. Historical import information and existing transmission contract information are both used as the basis for determining the amount of import levels to be allocated to LSEs. The ISO assumes that the entities that have contracted for the transmission capacity are already relying on this import capability in their resource plans, so this transmission is not reallocated.

Generation Capacity Study Assumptions

Existing generation dependable capacity is modeled in the deliverability study base cases according to their Net Qualifying Capacity (NQC) posted on the ISO website. The NQC is determined based on a methodology that generally sets the dependable capability of a generator close to its nameplate capability. However, for intermittent generation the NQC is based on its equivalent load-carrying capacity which is based on a stochastic analysis of the intermittent generation production during resource shortage conditions. The CPUC RA counting of resources will change soon to look at 24 different "slice-of-day" values. The underlying objective is to count the equivalent value of the resources during resource shortage conditions. For deliverability study purposes, the ISO deliverability methodology currently studies two different equivalent values for intermittent resources: the HSN value and the SSN value. The HSN and the SSN study scenarios are described above and the current study values are shown in Table 1. For example, in the HSN study, a 100 MW solar resource in the Southern California Edison service territory would be studied at a value of 10.6 MW or less. That 100 MW resource would be modeled at 80% of 10.6 MW or 8.48 MW in the starting base case and may be turned up to a maximum of 10.6 MW in the HSN study.

Table 1: Maximum resource output tested in the deliverability assessment

Area	HSN			SSN		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	3.0%	10.6%	10.0%	40.2%	42.7%	55.6%
Wind	33.7%	55.7%	66.5%	11.2%	20.8%	16.3%
New Mexico Wind	67%			35%		
Wyoming Wind	67%			35%		
Diablo OSW	100%			37%		
Morro Bay OSW	100%			49%		
Humboldt Bay OSW	100%			53%		
Energy Storage	100% or 4-hour equivalent if duration is < 4-hour			50% or 4-hour equivalent if duration is < 4-hour		
Non-Intermittent resources	NQC or 100%					

The highest system need scenario represents when a capacity shortage is most likely to occur. In this scenario, the load is modeled at the peak sales amount with low solar output. The highest system need hours are hours ending 19 to 22 in the summer months with an unloaded capacity margin of 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 HSN study value is set to the 20% exceedance level during the selected hours. The secondary system need hours are hours ending 15 to 18 in the summer months with an unloaded capacity margin less than 6% in the CAISO annual summer assessment or similar assessments in the long-term planning horizon. The SSN study values are set to the 50% exceedance level during the selected hours.

5.2 On-Peak Deliverability Methodology Issues Summary

In this section, stakeholder comments on the December 12, 2022 Update Paper have been summarized, with ISO responses provided. The detailed comments are posted on the ISO website on the initiative page for this topic[10].

5.2.1 Comparison of CAISO, PJM and MISO deliverability studies

Stakeholders have expressed concerns regarding a few key study parameters included in the CAISO's On-Peak generator deliverability methodology and have raised concerns that the CAISO's practices are more conservative than other entities such as PJM and MISO. The ISO reviewed PJM's and MISO's business practice manuals and compared several key parameters as shown in the table below. Stakeholder concerns were that transmission upgrades identified as needed or the constraints on deliverability due to the study parameters used by the CAISO were more onerous than PJM's and MISO's. After researching these claims, and summarizing the deliverability methodologies in Table 2, the CAISO has concluded that MISO's and PJM's practices are reasonably comparable to the CAISO's.

The reliability impacts of generation projects seeking to interconnect must be assessed in addition to a deliverability assessment, and transmission upgrades identified as needed in either study are required for the generation project to be interconnected and counted for RA. Therefore, the study parameters of both the reliability assessments and the deliverability assessments must be compared to attain a complete comparison. In addition, PJM has a common mode analysis that is also performed as part of its deliverability study as described in its Manual 14b, Attachment 3, section C.3. Taking this into account as shown Table 2, the PJM and MISO study procedures are reasonably similar to the CAISO's. Both PJM and MISO require that P7 contingencies be studied and mitigated with transmission upgrades, and the number of generators at full output in the generation pocket is similar to the CAISO methodology.

[10] https://stakeholdercenter.caiso.com/Comments/AllComments/4c7edbc6-5c17-4c7d-8e9a-fe31a4a557ad

Table 2: Comparison of PJM, MISO and CAISO reliability and deliverability study methodologies

	PJM	MISO	CAISO
Reliability Study			
Contingencies	See Deliverability Study below	All TPL-001-5 (N-1 and N-2)	All TPL-001-5 (N-1 and N-2)
Dispatch wind and solar	See Deliverability Study below (a light load analysis is also required)	100%	100%
Mitigation for thermal overloads	Transmission upgrades	Transmission upgrades	Congestion management
DFAX criteria	See Deliverability Study below	5%	N/A
Deliverability Study			
Contingencies	N-1 and common mode (N-2)	N-1 but have to mitigate for N-2 in the reliability study (see above)	N-1, P7(N-2) (do not have to build transmission upgrades for N-2 in the reliability study)
Load	Summer peak	Summer peak	Summer peak
Wind and solar output	Wind at 13% to 20%	Wind: Historical output during top 8 peak load hours over 3 years Solar: historical average output for hours 15, 16, and 17	20% exceeded level during Hours 19 - 22 in summer months and (loss of load event in ELCC simulation by CPUC or UCM < 6% in CAISO summer assessment)
DFAX criteria	5%/10% N-1/Common mode	5% or greater	5% or flow impact above 5%
# of units at max output	Approximately 20 depending on forced outage rate. Common mode is less than 20 depending on forced outage rate	30	Up to 20 but capped by 1500 MW incremental increase
Loading Adder	Based on contribution from off-line generators beyond the approximately 20 in the 80/20 list	Based on contribution from units 31 through unlimited	Based on units within top 20 but beyond the 1500 MW incremental cap
Energy only unit dispatch	EO included in common mode analysis	EO with transmission service are dispatched	EO are off

Sources:

- PJM Manuals 14A and 14B
- MISO Generation Interconnection BPM-015-r23

5.2.2 N-2 contingencies

NERC Reliability Standard FAC 002, Facility Interconnection Studies is an applicable reliability standard for generation interconnection studies. It requires steady-state, short-circuit, and dynamics studies as necessary to evaluate system performance under both normal and contingency conditions in accordance with Reliability Standard TPL-001. NERC Reliability Standard TPL 001 requires common mode n-2 contingency analysis. The GIDAP tariff language requires a reliability study which consists of steady-state, short-circuit, and dynamics studies and deliverability studies which consist of a steady state study of a comprehensive variety of severely stressed conditions. Mitigation plans are identified for reliability concerns found in the dynamics and short circuit study. Mitigation plans are also identified for steady state concerns. The reliability studies tend to be an assessment of the maximum output of the generation in the interconnection study and are almost always studying more stressed system conditions than the deliverability studies. N-1 contingency overloads identified in the reliability studies, that are more severe than the deliverability study results, are addressed by congestion management. N-2 contingency overloads in the reliability studies are also almost always more severe than in the deliverability studies. However, congestion management is not a feasible mitigation for n-2 contingencies because there are limits to the ability of the market to manage all n-2 contingencies simultaneously and as a result, they can only be considered during real-time operation selectively during periods of elevated risk of the n-2 outage occurring. Protecting for an n-2 contingency through this vehicle is therefore not acceptable if the consequences of the n-2 contingency are too severe. Also, excessive reductions of output on a sustained basis to manage the risk of an n-2 contingency contradict the premise that the resources should be available to serve load. Therefore, remedial action schemes (RAS) or system upgrades are needed to mitigate n-2 contingencies. As described above, the deliverability study assumptions are designed to be plausible and reasonable. On the other hand, the dispatch of resources in the reliability studies are considered to be worst case. RAS will be utilized to mitigate n-2 constraints identified in both the reliability and the deliverability studies. If RAS is not sufficient then system upgrades are identified as needed in the planning horizon based on the deliverability study.

Several stakeholders raised concerns about including n-2 contingencies in the analysis.

CalWEA suggested that MISO and PJM did not consider n-2 contingencies in their analyses as part of the requirement for obtaining deliverability. This is not the case; the consideration of n-2 contingencies by both MISO and PJM is discussed above.

AES Clean Energy stated that it understood that NERC Standard TPL-001 dictates the study of n-2 contingencies, but then made the point that besides a few select paths, the ISO doesn't monitor and redispatch for n-2 contingencies in real-time operations in its security-controlled dispatch. Therefore, AES Clean Energy believes that the deliverability methodology should only consider n-2 contingencies the way they are considered in real-time operations.

The ISO agrees that NERC requires the analysis of n-2 contingencies in the planning horizon, and does not generally require the analysis of n-2 contingencies in real-time operations. One reason for this difference is that by designing the system to withstand n-2 contingencies in the planning horizon, when these contingencies occur in the operating horizon they are manageable. If these contingencies are not mitigated in the planning horizon, then they become unmanageable in the operating horizon – there are no options available to system operators.

AES Clean Energy believes that the ISO can meet its requirement to conduct n-2 contingency studies, but then apply those results with nuance. AES stated that ISO can apply a probability assessment to the outcomes and appropriately calibrate, tier, or apply remedial strategies up until a point of operationally relevant reliability.

The ISO response is that the mandatory NERC planning standards do not allow a probabilistic planning approach when considering which contingencies to assess and mitigate. However, it is also worth noting that for the majority of n-2 constraints that have been identified, relatively low-cost RAS are utilized to drop generation immediately following an n-2 contingency.

BAMx proposed that the ISO only apply the higher level contingencies, such as n-2 and extreme events at the end of the process when assessing the aggregate ability to meet the TPL-001 standards. That is, for the GIDAP and TPP deliverability assessments of specific generation pockets only apply n-1 contingencies, and then determine in the TPP reliability assessment whether there are any resultant TPL standard violations (including n-2) that cannot be adequately mitigated.

The ISO response is that it is not clear how BAMx envisions these higher level contingency, TPL standard violations would be mitigated other than by curtailing generation. If the generation is curtailed, how can it serve load?

The ISO does see a possible mitigation to the concern that the mitigations for n-2 contingencies are delaying access to deliverability, and creating a barrier to timely resource development. As stated above, if RAS is not sufficient to mitigate an n-2 contingency, then system upgrades are identified as needed in the planning horizon based on the deliverability study. Once a transmission upgrade project is under development, the RAS guidelines in the ISO Planning Standards can be potentially relaxed until that upgrade is energized.[11] Therefore, generation interconnection customers may not have to wait for that transmission project to be constructed before they can obtain deliverability status needed to count for RA. In addition, if generation projects are under development and expected to come online within the operating horizon, but the transmission upgrade (including RAS) is delayed, then the n-2 contingency requirement could be relaxed until the transmission upgrade is energized providing reliability can be maintained. However, until the transmission upgrade project is in service, generators requiring that project to achieve Full Capacity Deliverability Status (FCDS) would have interim deliverability status (IDS). Alternatively, IDS could be provided as long as the planned mitigation is under development, and as long as any operational reliability concerns are addressed. Proactively addressing the n-2 operational reliability concerns may require enhancements to the reliability studies that are performed in GIDAP.

5.2.3 Simultaneous dispatch of generation

The ISO described how generators are dispatched in the deliverability study in the discussion above under the headings of Dispatch of Generators in the Study Group and Generation Capacity Study Assumptions.

BAMx stated that the assumptions about the level of generation for FCDS resources during both the High System Need (HSN) and Secondary System Need (SSN) periods should realistically represent their expected levels of operation and should not necessarily assume simultaneous operation at their "qualifying capacity" level, as assumed in the ISO's deliverability assessment methodology.

The ISO response is that during a resource shortage condition, all available resources will be needed simultaneously to serve all of the firm load. The most recent events of September 6, 2022 and the other heatwave days in 2021, and 2020 mentioned above have reinforced the need for RA resources to be capable of simultaneously providing needed capacity under stressed system conditions. The objective of the deliverability methodology is to study exactly those conditions as much as practicable. In the methodology, a limited subset of the generation in a particular generation pocket is assumed to be available and is modeled up to its assumed availability amount. The remaining generation capacity behind the

[11] See ISO G-RAS4, http://www.caiso.com/Documents/ISO-Planning-Standards-Effective-Feb22023.pdf

constraint is assumed to be de-rated or not available, and is not assumed to be simultaneously operating. In addition, energy only units behind the constraint are not assumed to be simultaneously operating.

5.2.4 Network upgrades exceeding actual local load needs

Section 6.1.1.3 in the GIDAP Business Practice Manual[12] and Section 6.3.2.1.1 of the GIDAP tariff language[13] describe that transmission constraints identified in the On-Peak deliverability study are classified as Area Deliverability Constraints and Local Deliverability Constraints. In that framework, constraints with large amounts of generation behind them that trigger large, high-cost network upgrades are classified as Area Constraints, and corresponding Area Delivery Network Upgrades (ADNU) are identified. This framework is designed to avoid the identification of excessive delivery network upgrades that would be considered required and allocated among all the interconnection customers in the area in that application window despite only being needed for generation amounts far beyond the expected amount of generation development in the ISO's long-term transmission planning process based on state agency input. Interconnection customers are given a choice and can select either Option (A) or Option (B) in moving forward in the ISO's interconnection process. Customers that select Option (A) are not responsible for funding upgrades to mitigate Area Deliverability Constraints, but instead compete with other generators to obtain a deliverability allocation of available deliverability based on the transmission system already planned to meet expected generation development levels. Customers that select Option (B) are responsible for funding the upgrades needed to mitigate Area Deliverability Constraints.

AES Clean Energy stated that the studied deliverability capacity often exceeds the local load within the study area, and often results in inaccurate network upgrades requirements since not all studied capacity will interconnect and serve load within the study region. The ISO, AES said, should consider an alternate methodology to ensure that the studied deliverability capacity doesn't exceed load within the study area to provide more accurate network upgrade results.

The ISO response is that this concern is addressed with the Area and Local deliverability constraint framework in GIDAP where constraints with large amounts of generation behind

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12 https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Generator%20Interconnection%20and%20Deliverability%20Allocation%20Procedures

13 http://www.caiso.com/Documents/AppendixDD-GeneratorInterconnectionDeliverabilityAllocationProcedures-asof-Feb11-2023.pdf

them that trigger large, high-cost network upgrades are classified as Area Constraints, and corresponding ADNUs are identified. Then, a $/MW cost indicator is provided to the interconnection customers (ICs), so they can decide to choose either Option (A) or Option (B). ADNU costs are not assigned to ICs that select Option (A). For customers that select Option (B), a transmission upgrade is identified based on the limited amount of MWs of ICs that select Option (B). With that framework, the assigned Delivery Network Upgrades for Option (A) customers are not based on studying amounts of generation that exceed actual load needs. The ISO notes that this methodology has been effective in the past; however, the excessive level of applications in some areas has created challenges even with the checks and balances in place; this is being explored in the Interconnection Process Enhancements 2023 initiative.

5.2.5 The Windhub constraint

TPL-001-5 requires the evaluation of the loss of a single transmission circuit followed by the loss of another single transmission circuit prior to system adjustments. It also requires the evaluation of the loss of a switching station (one voltage level). Events like these that are expected to produce the most severe system impacts are required to be analyzed. The purpose of this analysis is to identify system performance where cascading occurs, and to evaluate mitigation measures. The most prudent mitigation measure is to proactively design the grid so that it does not have substation and transmission line connectivity configurations and connected generation or load amounts that make it vulnerable to these events being more likely to occur. Windhub has been identified as a location that is expected to produce the most severe system impacts during the events described above, when the amount of generation exported from Windhub is excessive.

BAMx states that the impact of overlapping transmission outages should be evaluated in the overall Loss of Load Expectation (LOLE) studies and, if necessary, the Planning Reserve Margin requirements may need to be increased. This should be done at the system level, rather than imposing it on individual resources seeking FCDS as part of the deliverability assessment methodology. BAMx argues that this approach will balance the concerns about having sufficient RA resources to simultaneously provide needed capacity under stressed system conditions against the cost-effectiveness and timeliness of network upgrades.

The ISO response is that BAMx appears to be suggesting that the ISO perform an LOLE analysis that includes both transmission and generation outages. This would require a stochastic analysis modeling generation and transmission outage rates along with including a full transmission network model. There are no tools available that are utilized in the industry to perform such an analysis on a large system like the ISO system. The ISO notes that the only overlapping outage that has been a constraint in the deliverability studies is the Windhub constraint. The Windhub constraint is problematic because the magnitude of generation loss can cause cascading outages across the ISO and WECC system. The ISO is not aware of any other generation source in the WECC with over 6000 MW of generation and only two transmission lines connected. The loss of one Windhub line results in exposing the entire ISO and surrounding areas to voltage collapse-driven cascading outages for loss of the second Windhub line in the Cluster 13 and Cluster 14 studies. This results in the need to immediately curtail up to 5000 MW of generation, or cascading outages if the second contingency occurs before the generation can be curtailed. An area deliverability constraint has been enforced to address this voltage collapse and loss of resource issue.

5.2.6 Excessive transmission upgrades

Through the identification of area and local deliverability constraints as described above, the ISO coordinates the development of transmission and generation by coordinating its generation interconnection and transmission planning processes, which are in turn coordinated with the CPUC's Integrated Resource Planning Process. In general, low-cost delivery network upgrades that are triggered by specific generation interconnection projects are developed through the generation interconnection process. High-cost delivery network upgrades that would be triggered by many generation interconnection request projects are developed through the transmission planning process, and the deliverability capability of the planned transmission grid is allocated through the generation interconnection process. Existing transmission capability information, potential transmission upgrade project cost and incremental capability information are provided to the CPUC, which it uses to optimize the long-term resource plan, considering the overall generation and transmission costs to ratepayers. The transmission system is then planned to ensure the deliverability of the FCDS resources in the long-term resource plan. The transmission upgrades identified as needed in the ISO transmission planning process are compared to the information originally provided to the CPUC to ensure that this is all reasonably aligned.

BAMx stated that expensive transmission upgrades have been deemed necessary by the ISO to make projects deliverable, and that the ISO should not sanction a transmission planning and generation interconnection and deliverability allocation process (GIDAP) whose underlying theme seems to be "deliverability at any cost." BAMx stated that the ISO has an obligation to ensure just and reasonable transmission rates and deliverability at any cost is not consistent with this obligation.

The ISO notes that Table 2 of the Executive Summary in the 2012-2013 Transmission Plan[14] provides a list of projects that were identified as needed to meet the 33% RPS goal that was in place at that time. The need for most of those projects was based on traditional transmission planning methods prior to the reliance on the ISO's deliverability methodology, and based on traditional planning methods it was not expected that the list of projects in Table 2 was anywhere near sufficient to meet the 33% RPS goal. However, using the ISO's deliverability methodology, the ISO demonstrated that it was sufficient. In addition, over the 10 years since, and until recently[15], there have been very few additional transmission upgrades identified as needed, based on the ISO's deliverability methodology, for meeting the generation deliverability requirements even as the RPS goal was raised to 50%, and as the portfolios began to exceed 50%.

5.2.7 Secondary System Need study

As described above, the deliverability assessment is performed under two distinct system conditions – the highest system need scenario (HSN) and the secondary system need scenario (SSN). With the growing complexity of the resource fleet and interdependence on various resource types on providing reliability across all hours, the CPUC has been driven to move from a single assessment hour to a 24 "slice of day" approach for RA purposes. The ISO had proactively moved from studying one system condition during the peak load hour to two study conditions—one for the net peak load hour (HSN) and one that focuses on the transition period when the gross load is still high and the solar production is dropping off (SSN). During this SSN condition, a resource shortage is less likely but could still occur. In the GIDAP, Delivery Network Upgrades can be identified as required under the HSN study condition, but they are not identified under the SSN study condition. The SSN is rarely binding, but if it is the need for an upgrade to mitigate the SSN area constraint is considered in the transmission planning process.

BAMx commented that it appreciated the ISO's review of the deliverability study dispatch assumptions in mid-2022, leading to a reduction in the dispatch assumptions for the storage study amount for the SSN study. However, BAMx indicated that the storage discharge may need to be further reduced based upon typical operation during the summer months at levels significantly lower than 80% of full capacity. If the expected storage discharging

[14] BoardApproved2012-2013TransmissionPlan.pdf (caiso.com)

[15] The 2021-2022 and 2022-2023 ISO transmission plans have seen an accelerated growth in the renewable portfolios and have looked out beyond the ten year planning horizon to 2035. After the previous nine years of very few policy projects identified as needed, the last two transmission planning cycles have identified a significant number of policy-driven projects in order to address the dramatically accelerated resource growth.

behavior is properly modeled, the SSN assessment should not identify more area delivery network upgrades (ADNU) than the High System Needs (HSN) assessment.

The ISO response is that the storage modeling assumptions in the SSN assessment are based on the recent historical storage discharging information provided by the ISO during the 2022 SSN study assumption update stakeholder process. Also, with the new assumptions, the SSN scenario is rarely more binding than the HSN scenario. In addition, the SSN does not trigger upgrades in the interconnection study, and the need to mitigate SSN constraints in the transmission planning process has to be carefully reviewed to ensure that an upgrade is warranted. If an SSN constraint is not mitigated in the TPP, that constraint will be relaxed in the interconnection study process up to the portfolio amount that was studied in the TPP. In other words, deliverability can be allocated up to the portfolio amount, and a transmission upgrade would not be required to mitigate the constraint.

In addition, the ISO notes that the SSN study assumptions are based on both historical data and resource production cost simulation data during resource shortage conditions during the SSN study hours.

Based on Nextera's review of the System Operating events in September, 2022, Nextera believes there is a need to further improve upon the dispatch assumptions as conforming to real-time events. During September, 2022 events, the average storage dispatch level during the SSN time window ranged from 10-46% of the peak storage output.

The ISO notes that because storage projects are fully controllable resources and not intermittent, the ISO has not used the average output over the entire SSN period of time to determine the dispatch level for storage. The highest need for resources during the SSN time window is clearly the later hours; since storage is controllable, those hours were the focus of the ISO's analysis.

As described above, currently two study conditions are analyzed and as generation fleet characteristics, the load profile, and RA requirements evolve, the ISO will need to consider analysis of additional system conditions for deliverability assessment purposes.

5.2.8 Transmission Planning Process versus Generation Interconnection Process

The generation interconnection and transmission planning processes are coordinated as described above. The decision to build most transmission delivery network upgrades is not made in the GIDAP, and deliverability is allocated only up to the capability of the transmission system currently planned.

The California Energy Storage Alliance (CESA) asked whether n-2 contingencies should be mitigated in the transmission planning process instead of in the generator interconnection process. BAMx provided a similar comment, suggesting that a Transmission Economic Analysis Methodology be used to determine when n-2 contingencies need an upgrade.

The ISO response is that it would be problematic to assess the interconnection and deliverability of generation in a way that intentionally leaves n-2 concerns to the transmission planning processes. In the planning and procurement of new resources, the full set of transmission upgrade costs need to be considered to minimize the costs to ratepayers. For example, if resource A is selected over resource B, and resource A is later found during the transmission planning process to trigger additional high-cost transmission upgrades due to n-2 contingencies, and no additional transmission upgrades would have been triggered by resource B, then the LSE that procured resource A likely ended up making a worse choice from ratepayers' perspective.

In general, waiting to mitigate transmission constraints in the transmission planning process instead of identifying them in the interconnection process can result in delaying the development of the transmission upgrades by several years. This can create operating and commercial challenges while the upgrades are being planned reactively, and dissatisfaction from earlier-connected resources that are impacted in the interim, leading to considerable interconnection customer dissatisfaction.

5.2.9 Deliverability of Co-located Energy Only Resources

The RA process allows an energy only resource that is co-located with a storage facility to count towards the slice of day charging sufficiency requirement.

Some stakeholders have asked about the ability of energy only resources being allowed to count towards the slice-of-day charging sufficiency requirement, and whether transmission constraints would affect the ability of the EO resources to provide this energy.

The ISO response is that this may need to be assessed. One possibility is to develop a bookend scenario that can be studied in the ISO transmission planning process. In this scenario, storage charging in non-Local Capacity Requirement (LCR) areas and co-located EO resources could be maximized.

5.2.10 Deliverability for Local Capacity Resources

As described in section 4.1, the goal of the On-Peak Generator Deliverability Study Methodology is to determine if the aggregate of available generation output in a given area can be simultaneously transferred to the remainder of the ISO Balancing Authority Area during resource shortage conditions. The same deliverability test is applied to generation in local capacity areas as is applied to generation outside of local capacity area. A generation pocket may include a basket of resources inside a local capacity area and immediately outside of the local capacity area that can all be constrained if more generation is added and results in overloading the transmission system exporting the excess generation from the area.

LSA states that the current ISO methodology assumes that: (1) All generation receiving “deliverability” must be deliverable to “the aggregate of load;” and (2) such generation located within an LCA can be designated as LCRs. The Update defends the current construct by noting that some have argued that LCRs need only be deliverable with their respective LCAs and then refutes that argument by saying that LCRs must be available to serve load outside their LCAs under some conditions.

LSA questions whether this issue is so black and white. LSA acknowledged the ISO’s statement that some LCRs may sometimes need to be available to serve load outside their LCAs but questioned whether all such LCRs must have that capability. LSA suggested that the ISO consider whether some portion of the LCR requirement could be satisfied by resources passing a test to be deliverable only to their LCAs.

The ISO responds that the construct of being deliverable to the “aggregate of load” is primarily intended to mean that deliverability is not point-to-point transmission service to a particular load, and the ISO deliverability methodology is not designed to provide point-to-point transmission service.

If a transmission-constrained generation pocket has some local load, but there is more generation than load, then the only way for a new generator to serve that local load is to turn down some of the existing local generation. In that example, the new generator may be deliverable to that local load, but now some of the existing generation in that local area is no longer deliverable to any load.

CalWEA’s comments appear to suggest that the ISO deliverability methodology requires the deliverability of LA Basin storage all the way into the SF Bay Area.

The ISO responds that this is not the case. The study methodology is designed to only identify transmission constraints on facilities that are serving to export the generator out of its local area.

Automatically assuming a resource in a local capacity area should be deliverable ignores that an existing resource immediately outside the LCA may have been awarded deliverability because of its proximity to the LCA, and that the existing resource would lose deliverability.

In addition, with excessively large amounts of generation in the queue, some LCAs may have a surplus of generation that exceeds the load in the LCA. The 2023 Interconnection Process Enhancements process (IPE 2023) is looking at proposals to reduce the amount of generation that will need to be studied in future cluster studies, and should largely address the risk of deliverability constraints in places like the LA Basin[16].

5.2.11 Transmission Plan Deliverability Allocation Process

Some stakeholders provided comments focused on enhancing the TPD allocation process. There were also comments on the ability to construct needed transmission in a timely manner.

The ISO response is that these comments will be directed into the IPE 2023 stakeholder process.

5.2.12 Net Qualifying Capacity versus Exceedance Based Study Amounts

The generation dispatch assumptions in the deliverability study are described above under the heading of Generation Capacity Study Assumptions.

CalWEA stated that the ISO should not wait to modify its assumed dispatch conditions where all Variable Energy Resources (VERs) in a particular area are assumed to operate at levels higher than their NQC. Instead, the ISO should assume generation levels that are expected during the hour(s) of peak demand being studied in the HSN test and that in CalWEA's view, the use of expected peak-hour generation levels in the HSN test should converge with the NQC levels adopted by the CPUC in future years. Under the CPUC's new "24 hour" RA framework, the CPUC is moving to establish QC values that reflect expected generation levels during the hour of potential resource shortfall of each month. However, there is no need for the ISO to wait for the CPUC to adopt such an NQC methodology before assuming expected peak-hour production levels in the HSN deliverability test. The ISO's current practice of using values that exceed current QCs for VERs requesting deliverability and NQCs for previously studied VERs is inappropriate because the system is designed to rely only on the NQCs of VERs, not more, to meet the peak scenario demand during the operating conditions that ISO studies. Hence, ISO should adjust, typically dial back, VERs' dispatch levels to their QC or NQC levels in its deliverability assessment studies and TPD allocation processes and avoid allocating TPD capacity beyond what is required based on the QC or NQC level of the resource.

[16] In the Cluster 14 Phase I study, area constraints were identified in the LA Basin that had not been observed in earlier cluster studies.

The ISO response is that the HSN study amounts for wind and solar resources are based on their 20% exceedance production levels during hours ending 19-22 with low unloaded capacity margin levels, and the SSN study amounts for wind and solar resources are based on their 50% exceedance production levels during hours ending 15-18 with low unloaded capacity margin levels[17]. This approach generally aligns with the comment above that they should be values based on “expected generation levels during the hour of potential resource shortfall”. The solar study amount levels in the HSN study are already at 10% of nameplate capacity, which are lower than the NQC values during the summer months. Though the HSN wind study amounts are higher than the NQC, wind production levels are variable. On a particular day the wind generation in area A may be producing higher than NQC levels while wind generation in area B is producing nothing. The NQC value is based on the aggregate production of areas A and B. If the wind generation in area A had to be curtailed to its NQC value because of transmission constraints, then the actual aggregate production of the wind generation in areas A and B would be less than their combined NQC values because of the transmission constraint. The HSN window represents the period of time when load is still high and solar generation production is minimal, and the ISO considers that the HSN study amounts are reasonable.

The SSN solar study amounts are higher than their NQC values, but NQC values mostly align with the HSN study period. The SSN study amounts are reasonable for the time period they represent, and with the recent modification to that study it is almost always less binding than the HSN study. With the planned changes to the RA process to study scenarios representing each of hour of the day, it is acknowledged that studying a wide range of scenarios is needed.

5.3 Off-Peak Deliverability Assessment Methodology[18]

The ISO Tariff requires the ISO to perform an off-peak deliverability study as well as the on-peak deliverability study discussed above. The off-peak deliverability assessment is not for RA purposes. It is a supplemental study that focuses on renewable energy delivery during hours outside of the summer peak load period. The objective of the off-peak deliverability assessment is to identify local transmission upgrades needed to relieve excessive renewable

[17] The HSN and SSN off-shore wind study values were estimated without the benefit of stochastic simulation date or historical data that includes information of capacity margin levels. The ISO plans to update the off-shore wind study values with the benefit of such data.

[18] http://www.caiso.com/Documents/Off-PeakDeliverabilityAssessmentMethodology.pdf

curtailment caused by transmission constraints. It also informs generators of their curtailment risk due to large area constraints. The Tariff states that the Off-Peak Deliverability Assessment will be performed to identify transmission upgrades in addition to those Delivery Network Upgrades identified in the On-Peak Deliverability Assessment, if any, for resources where the fuel source or source of energy for the resource substantially occurs during off-peak conditions.[19] The resources included in this study are those that (a) use a primary fuel source or source of energy that is in a fixed location and cannot practicably be transported from that location; and (b) are located in an Energy Resource Area.[20] Generating Units meeting this criterion include, but are not be limited to, wind, solar, geothermal, hydroelectric, digester gas, landfill gas, ocean wave and ocean thermal tidal current generating units. The ISO tariff defines an Energy Resource Area as a geographic region certified by the CPUC and the CEC for renewable RA resources.

During the off-peak load period, ISO system load is between 55% to 60% of summer peak load. As a result, minimum required conventional generation is kept online at minimum output levels to be available later in the day. The off-peak deliverability studies should reflect this reality. In addition, because replacement generation is practically always available during the off-peak, even low-cost generation that has a controllable fuel source is reduced in the study, without regard to marginal economic cost in order to mitigate transmission constraints found during the analysis. However, generation that does not have a controllable fuel source (e.g., wind and solar) is assumed to be running at its expected output during the study.

In the past, only wind generation has had a fuel source or source of energy for the resource that substantially occurs during off-peak conditions. However, today and going forward, with the peak load condition occurring later in the day, solar generation, some hydro, geothermal, digester gas, and landfill gas produce a significant amount of energy during the off-peak conditions.

The off-peak deliverability assessment is built around the following principles:

[19] In the past, only resource areas that had wind generation were considered to meet this criteria. However, today and going forward most solar generation production will occur outside of the net peak load condition.

[20] A geographic region certified by the California Public Utilities Commission and the California Energy Commission as an area in which multiple LCRIGs could be located, provided that, for the interim period before those agencies certify such areas and for LCRIFs that are proposed to connect LCRIGs located outside the State of California, an Energy Resource Area shall mean a geographic region that would be connected to the ISO Controlled Grid by an LCRIF with respect to which the ISO Governing Board determines that all of the requirements of Section 24.1.3 are satisfied, except for the requirement that the LCRIGs to which the LCRIF would connect are located in an area certified as an ERA by those agencies.

1. Identify transmission bottlenecks that would cause excessive renewable curtailment, but the study assumptions should focus on system conditions when a system-wide oversupply of resources is not likely.
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 specific generation projects interconnecting in a small localized area. These local constraints are hit by a relatively high simultaneous output of local generation before the system-wide oversupply situation occurs.
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 for any upgrades.
4. The curtailment risk is regardless of the generator's deliverability status, so this study considers both full capacity and energy only generators.

The estimated costs of Local Off-Peak Network Upgrades identified in the Off-Peak Deliverability Assessment are assigned to Interconnection Requests selecting Off-Peak Deliverability Status. The estimated costs of Area Off-Peak Network Upgrades are for information only and not assigned to any Interconnection Requests as those upgrades are addressed, if necessary, in the transmission planning process.

6 Next Steps

In this issue paper the ISO has summarized stakeholders' comments and provided responses. The ISO will hold a stakeholder call on June 8, 2023 to review this issue paper. The ISO encourages all stakeholders to submit comments on this Issue Paper. After reviewing the comments, the ISO will develop a more comprehensive stakeholder process for additional papers and stakeholder calls as necessary.

This deliverability methodology review initiative is occurring in parallel with the IPE 2023 Track 2 process as well as the RA Initiative. As mentioned earlier, some of the comments received in this process will be coordinated with or handed off to be considered in the IPE 2023 Track 2 process. For example, the issues of potentially awarding FCDS based on the originally scheduled in-service dates for required transmission upgrades, not based on later delays to transmission projects, may be an issue to be coordinated with the IPE process. In addition, granting interim deliverability even if n-2 upgrades are not already in place, as long there aren't any reliability concerns, may also be coordinated with the IPE initiative. Discussion on the local capacity deliverability issue may also be coordinated with the IPE initiative.

May 31, 2023*	Issue paper posting
Jun 08, 2023*	Meeting
Jun 22, 2023*	Comments due
Jul 26, 2023*	Straw proposal posting
Aug 02, 2023*	Meeting
Aug 16, 2023*	Comments due
Sep 25, 2023*	Draft final proposal posting
Oct 02, 2023*	Meeting
Oct 16, 2023*	Comments due
Winter 2023*	Board of governors meeting