On-Peak Deliverability Assessment Methodology (for Resource Adequacy Purposes)

Background

The California ISO's deliverability study methodology for resource adequacy purposes was discussed extensively in the CPUC's Resource Adequacy Proceeding in 2004, and was generally adopted in that proceeding. It was also accepted by FERC during the FERC Order 2003 compliance filing process.
The deliverability assessment methodology was developed for generation interconnection study purposes pursuant to the ISO tariff, and is used to ensure that the transmission system can reasonably deliver resources providing Resource Adequacy (RA) capacity to serve load during stressed system conditions. The methodology was previously modified to address evolving circumstances.
Given the rapid growth in generation development and procurement, increased diversification of the resource fleet, and the long lead-time necessary for development of transmission upgrades, in 2023 the ISO proposed additional refinements to its deliverability assessment methodology to provide short-term relief and long-term adjustments, while maintaining system reliability. After an extensive stakeholder process, additional refinements were made to the methodology in January 2024[1] and are incorporated in this version of document.

1.0 Introduction

A generator deliverability test is applied to ensure that capacity is not "bottled" from a resource adequacy perspective. This would require that each electrical area be able to accommodate the full output of all of its capacity resources and export, at a minimum, whatever power is not consumed by local loads during periods of peak system load.

Generation output capabilities at lower load levels can affect the economics of both the system and area generation, but generally they do not affect resource adequacy. Therefore, output capabilities at lower system load levels are not assessed in this deliverability test procedure.

Deliverability, from the perspective of individual generator resources, 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 chosen to produce energy at any given system load condition. Rather, its purpose is to demonstrate that the capacity in any electrical area can be run simultaneously, at peak load, and that the excess energy above load in that electrical area can be exported to the remainder of the control area, subject to contingency testing. Due to the increasing installation of behind-of-the-meter solar PV generation, the peak net load

[1] https://www.caiso.com/InitiativeDocuments/Final-Proposal-Generation-Deliverability-Methodology-Review-Jan-04-2024.pdf

observed from the transmission grid, i.e. peak sales, shifts to later hours when the solar PV output is down and the gross load consumption is still high, which becomes the most critical system condition for non-solar resources to deliver their energy to the aggregated load. For grid connected solar resources, the most critical time period is the peak consumption hours coincident with substantial solar output. The deliverability test assesses both peak load conditions – peak sale and peak consumption.

In short, the test ensures that bottled capacity conditions will not exist at peak load, limiting the availability and usefulness of capacity resources for meeting resource adequacy requirements.

In actual operating conditions energy-only resources may displace capacity resources in the economic dispatch that serves load. This test would demonstrate that the existing and proposed capacity units in any given electrical area could simultaneously deliver energy output to the control area.

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 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 capacity deficiencies should be tested when evaluating deliverability from the load perspective, the dispatch pattern in the remainder of the system is appropriately distributed as shown in Table 4.1.

Failure of the generator deliverability test when evaluating a new resource in the generation interconnection studies brings about the following possible consequences. If the addition of the resource will cause a deliverability deficiency, then the resource should not be fully counted towards resource adequacy reserve requirements until transmission system upgrades are completed to correct the deficiency.

A generator that meets this deliverability test may still experience substantial congestion in the local area. To adequately analyze the potential for congestion, various stressed conditions (i.e., besides the system peak load conditions) will be studied as part of the overall interconnection study for the new generation project. Depending on the results of these other studies, a new generator may wish to fund transmission reinforcements beyond those needed to pass the deliverability test to further mitigate potential congestion—or relocate to a less congested location.

The procedure proposed for testing generator deliverability follows.

2.0 Study Objectives

The goal of the proposed ISO Generator deliverability study methodology is to determine if the aggregate of generation output in a given area can be simultaneously transferred to the remainder of ISO Control Area. Any generators requesting Full Capacity Deliverability Status or Partial Capacity Deliverability Status in their interconnection request to the ISO

Controlled Grid will be analyzed for "deliverability" in order to identify the Delivery Network Upgrades 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 manner.

3.0 Modeling Assumptions

The deliverability assessment is performed under two distinct system conditions – the highest system need scenario and the secondary system need scenario.

3.1 Highest 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 sale with low solar output. The highest system need hours are hours ending 19 to 22 in the summer months during low supply conditions. For on-shore wind and solar resources low supply conditions are identified as hours 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. For off-shore wind resources, low supply conditions are defined as hours with high ISO load[2].

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 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 Pmax tested in the deliverability assessment. The CAISO will review the latest available CPUC ELCC study data, CAISO annual summer assessment data, and similar assessments in the long-term planning horizon to update the modeling assumptions, as needed[3].

Pmax 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 Pmax is set according to the interconnection request. For energy storage generation, the Pmax is set to the 4-hour

[2] On August 16, 2023 the ISO presented "20 Year Transmission Outlook and Approach to Offshore Wind" https://www.caiso.com/InitiativeDocuments/Presentation-20-Year-Transmission-Outlook-Aug-16-2023.pdf, pages 26 and 27.

[3] On June 6, 2022, the ISO presented "On-Peak Generation Deliverability Study Generation Dispatch Assumptions" (http://www.caiso.com/Documents/Presentation-GenerationDeliverabilityStudyDispatchAssumptions-Jun062022.pdf). Based on that analysis the study assumptions were updated.

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 based on the sum of each technology, but limited by the requested maximum output of the generation project.

Table 3.1: Modeling Assumption Guidelines for Highest System Need Scenario

Selected Hours	HE19 ~ 22 in summer month during low supply conditions
Load	1-in-5 peak sale forecast by CEC
Non-Intermittent Generators	Pmax set to highest summer month Qualifying Capacity in last three years
Intermittent Generators	Pmax set to 20% exceedance level during the selected hours
Import	MIC data with expansion approved in TPP

3.2 Secondary System Need Scenario

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

Pmax 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 Pmax is set according to the interconnection request. For energy storage generation, the Pmax is set at 50% of 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 3.2: Modeling Assumption Guidelines for Secondary System Need Scenario

Select Hours	HE15 ~ 18 in summer month during low supply conditions
Load	1-in-5 peak sale forecast by CEC adjusted to peak consumption hour
Non-Intermittent Generators	Pmax set to highest summer month Qualifying Capacity in last three years
Intermittent Generators	Pmax 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

4.0 General Procedures and Assumptions

Step 1: Electrically group the proposed new generation units that are to be tested for deliverability. These electrical groups will be based on engineering knowledge of the transmission system constraints on existing and new generation dispatch. Generating units will be grouped by transmission limitations that will be expected to constrain the generation. Base cases will be built that focus on each group. Because the total MW of proposed generation usually exceeds the amount that is needed to balance loads and resources, several base cases may need to be created, each of which will focus on at least one of the groups. If a group is not the focus, then generation in that group will be dispatched at zero, but will be available to be turned on during the analysis.

Step 2: For each base case created in step 1, dispatch ISO resources and imports as shown in Table 1. This base case will be used for two purposes: (1) it will be analyzed using a DC transfer capability/contingency analysis tool to screen for potential deliverability problems, (2) it will be used to verify the problems identified during the screening test, using an AC power flow analysis tool.

Step 3: Using the screening tool, the ISO transmission system is essentially analyzed facility by facility to determine if normal or contingency overloads can occur. For each analyzed facility, an electrical circle is drawn which includes all units (including unused Existing Transmission Contract (ETC) injections) that have a 5% (or 10% for 500 kV lines) or greater distribution factor (DFAX) or Flow Impact[4] on the facility being analyzed. Then load flow simulations are performed, which study the worst-case combination of generator output within each 5%/10% Circle. The 5%/10% Circle can also be referred to as the Study Area for the particular facility being analyzed.

Step 4: Using an AC power flow analysis tool and post processing software, verify and refine the analysis of the overload scenarios identified in the screening analysis.

The outputs of capacity units in the 5%/10% Circle are increased starting with units with the largest impact on the transmission facility. No more than twenty[5] units are increased to their maximum output. In addition, no more than 1500 MW of generation is increased. All remaining generation within the Control Area is proportionally displaced, to maintain a load and resource balance. The number of units to be increased within a local area is limited because the likelihood of all of the units within a local area being available at the same time becomes smaller as the number of units in the local area increases. 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 deficiency in local generation rather than a generation deliverability problem.

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[4] See note on Flow Impact in Section 4.1 Specific Assumptions. The electrical circle drawn which includes all generators that have a 5%/10% or greater distribution factor (DFAX) or Flow Impact on the facility being analyzed is referred to as the 5%/10% Circle. The Flow Impact is not considered for DFAX that are less than 2%.

[5] The cumulative availability of twenty units with a 7.5% forced outage rate would be 21%--the ISO proposes that this is a reasonable cutoff that should be consistently applied in the analysis of large study areas with more than 20 units. Hydro units that are operated on a coordinated basis because of the hydrological dependencies should be moved together, even if some of the units are outside the study area, and could result in moving more than 20 units.

For Study Areas 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 will also be included in the Facility Loading Adder, up to 20 units. Negative Facility Loading Adders should be set to zero.

Step 5: Once the initially identified overloaded facilities are verified, all new generators inside the 5%/10% Circle are responsible for mitigating the overload. Once a mitigation plan has been identified it will be modeled and the deliverability assessment will be repeated to demonstrate that all of the new generation is deliverable with the mitigation plan modeled. If additional overloaded facilities are found, then the mitigation plan will be modified or expanded, as needed, to ensure the deliverability of the new generation.

Table 4.1: Resource Dispatch Assumptions

Resource Type	**Base Case Dispatch**	**Available to Selectively Increase Output for Worst-Case Dispatch?**	**Available to Scale Down Output Proportionally with all Control Area Capacity Resources?**
Existing Capacity Resources (Note 2)	80% to 95% of PMAX (Note 1)	Y Up to 100% of PMAX	Y
Proposed Full Capacity Resources (Note 3)	80% to 95% of PMAX (Note 1)	Y Up to 100% of PMAX	N
Energy-Only Resources	Minimum commitment and dispatch to balance load and maintain expected imports	N	Y
Imports (Note 4)	Maximum summer peak simultaneous historical net imports by branch group during selected hours		
Load			
• Non-pump load	1 in 5 peak sale level for CAISO in the highest system need scenario and net sale for the peak consumption hours in the secondary system need scenario	N	N
• Pump load	Within expected range for the scenario hours	N	N

Note 1: Refer to Section 3 for Pmax for different types of resources in the highest system need scenario and the secondary system need scenario.
Note 2: All existing units should be dispatched at the same percentage of their Pmax, but this level may fluctuate to account for differing expectations of system-wide forced outages, retirements, and planning and operating reserve levels. Some large units with a high likelihood of retirement within the near future may be dispatched at zero to balance loads and resources, but will be available to be turned on during the analysis.
Note 3: Proposed capacity resources will be grouped electrically. Base cases will be developed that focus on each of the groups. If a group is not the focus, it will be dispatched at zero in that case.
Note 4: Refer to Section 3 for imports in the highest system need scenario and the secondary system need scenario. Maximum summer peak simultaneous historical net imports by branch group in the highest system need scenario are the basis for determining the maximum import capability that can be allocated for resource adequacy purposes. Historically unused ETCs will be considered during the analysis, but will not be simultaneously represented in the base case. Historically unused Existing Transmission Contracts (ETC's) crossing control area boundaries will be modeled as zero MW injections at the tie point, but available to be turned on at remaining contract amounts for screening analysis. For historically congested import paths expected to be increased by upgrades with all regulatory approvals in place, the portion of the incremental upgrade expected to be utilized immediately during summer peak can also be represented in the analysis similar to unused Existing Transmission Contracts. During the base case development, import flows on Branch Groups electrically remote from the generation group, that is the focus of the base case being created in Steps 1 and 2, can be moderately reduced to balance loads and resources.

4.1 Specific Assumptions

Distribution Factor (DFAX)
Percentage of a particular generation unit's incremental increase in output that flows on a particular transmission line or transformer when the displaced generation is spread proportionally, across all dispatched resources "available to scale down output proportionally with all control area capacity resources in the Control Area", shown in Table 1. Generation units are scaled down in proportion to the dispatch level of the unit.

Municipal Units
Treat like all other Capacity Resources unless existing system analysis identifies problems.

Energy-Only Resources
If it is necessary to dispatch Energy Resources to balance load and maintain expected import levels, these units should not contribute to any facility overloads with a DFAX of greater than 5%. Energy Resource units should also not mitigate any overloads with a DFAX of greater than 5%.

WECC Path Ratings
All WECC Path ratings (e.g. Path 15 and Path 26) must be observed during the deliverability test.

Flow Impact
Generators that have a Flow Impact (DFAX*Generation Capacity) > 5% of applicable facility rating or OTC will also be included in the Study Area.

Voltage and Stability Problems
If the delivery of output from proposed new generation projects result in voltage or stability problems under dispatch scenarios consistent with this procedure, then these problems must be mitigated in order to ensure the deliverability of these new requests.

5.0 <u>Application of Highest System Need Scenario and the Secondary System Need Scenario study results</u>

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 HSN scenario, then the constraint will be classified as either a Local Deliverability Constraint or an Area Deliverability Constraint.

The secondary system need scenario (SSN) represents when the capacity shortage risk will increase if the intermittent generation while producing at a significant output level is not deliverable. The SSN is not studied in the generation interconnection studies, but is studied in the transmission planning process studies.

A transmission upgrade identified as needed in the Transmission Planning Process under the highest system need scenario analysis can be considered for a recommendation of approval as a policy driven upgrade, based on that analysis alone.

A transmission upgrade identified as needed in the Transmission Planning Process under the secondary system need scenario analysis will go through a comprehensive economic, policy, and reliability benefit analysis to determine if the upgrade would provide sufficient benefits to be considered for a recommendation of approval as a policy driven or economic upgrade. The transmission planning process could make a determination that an upgrade is not needed for the identified secondary system need deliverability constraint.

6.0 Special Consideration of N-2 Contingencies

The ISO studies all P1 contingencies and P7 (N-2) double circuit tower contingencies in the deliverability studies. These studies are a part of complying with TPL-001 to ensure that well-reasoned base case dispatch assumptions are used and that overloads are mitigated by transmission upgrades. If the only reason that a generator is not deliverable is due to an N-2 contingency then that generator can be given Full Capacity Deliverability Status (FCDS) or Partial Capacity Deliverability Status (PCDS) as long as transmission upgrades have been approved by the ISO to mitigate that N-2 contingency.

If an N-2 contingency results in an overloaded facility, but not cascading outages, then upgrades would be required but would not delay generation projects from becoming deliverable. Generation projects would be eligible for FCDS or PCDS during the development period of the transmission upgrades necessary to mitigate the N-2 contingency, assuming that no other constraints are binding.

If a cascading outage risk is identified or if the N-2 contingency is considered always credible in the operations horizon, then the mitigation for that contingency would be required to be in-service before the assigned or later generation projects behind that constraint could obtain FCDS or PCDS.