APPENDIX F: Detailed Policy Assessment

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Contents

F. Policy-Driven Need Assessment

F.1 Background and Objectives

The overarching public policy objective for the California ISO's Policy-Driven Need Assessment is the state's mandate for meeting renewable energy and greenhouse gas (GHG) reduction targets while maintaining reliability. For the purposes of the transmission planning process, this high-level objective is comprised of two sub-objectives: first, to support Resource Adequacy (RA) deliverability status for the renewable generation and energy storage resources identified in the portfolio as requiring that status, and second, to support the economic delivery of renewable energy over the course of all hours of the year.

The more coordinated and proactive approach taken in the ISO's current annual transmission planning process is part of a larger set of interrelated and coordinated planning and resource development activities being undertaken between the state energy agencies and the ISO. The ISO, for example, relies in particular on the CPUC for its lead role in developing resource forecasts for the long-term planning horizon, with both the ISO and CEC providing input to the CPUC for those resource forecasts. The ISO also relies on the CEC for its lead role in forecasting customer load requirements and the MOU signed by the three parties in December 2022 reaffirms our respective roles and commitment to ensure we are working in concert with one another. As such, the MOU also sets the overall strategic direction for tightening linkages among resource and transmission planning activities, interconnection processes and resource procurement so the three entities are synchronized in working for the timely integration of new resources.

The CPUC issued a Decision[1] on February 8, 2018, which adopted the integrated resource planning (IRP) process designed to ensure that the electric sector is on track to help the State achieve its 2030 GHG reduction target, at least cost, while maintaining electric service reliability and meeting other state goals. In subsequent years, the CPUC has been developing integrated resource plans and transmitting them to the ISO for use in the annual transmission planning process.

The CPUC issued Decision 24-02-047[2] adopting a Preferred System Plan (PSP) portfolio and a sensitivity portfolio for use in the 2024-2025 Transmission Planning Process (TPP). The portfolios are based on the 25 million metric ton (MMT) greenhouse gas (GHG) target for the electric sector in 2035 and the California Energy Commission's 2022 Integrated Energy Policy Report demand forecast. The PSP portfolio is used to identify reliability and policy-driven transmission needs for approval in the ISO 2024-2025 TPP. The sensitivity portfolio is designed to test the transmission buildout needed for a grid stress case where about 16 GW of natural gas generation resources are retired by 2039. The Decision is accompanied by a document

[1] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M209/K878/209878964.PDF

[2] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M525/K918/525918033.PDF

entitled Modeling Assumptions for the 2024-2025 Transmission Planning Process[3], which provides the methodology and results of the resources-to-busbar mapping process as well as other assumptions for use in the ISO TPP.

F.2 Objectives of policy-driven assessment

Key objectives of the policy-driven assessment are to:

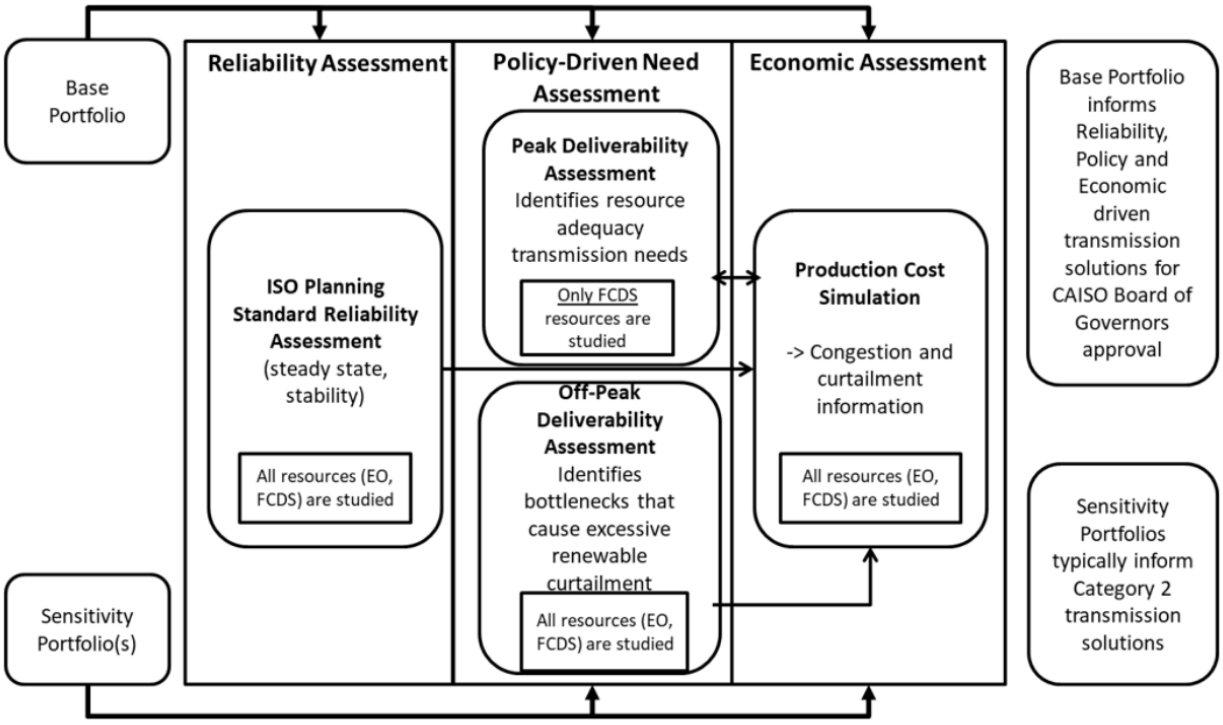
- Assess the transmission impacts of portfolio resources using:
  - Reliability assessment,
  - Peak and Off-peak deliverability assessment, and
  - Production cost simulation;
- Identify transmission upgrades or other solutions needed to ensure reliability deliverability or alleviate excessive curtailment; and
- Gain further insights to inform future portfolio development.
- Set out the zonal capacities that are being established through coordinated transmission planning and resource planning, to shape and guide interconnection and resource procurement.

F.3 Study methodology and components

The policy-driven assessment is an iterative process comprised of three types of technical studies as illustrated in Figure F.3-1. These studies are geared towards capturing the impact of the resource build-out on transmission infrastructure, identifying any required upgrades and generating transmission-related input for use by the CPUC in the next cycle of portfolio development.

[3] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/modeling_assumptions_24-25tpp.pdf

Figure F.3-1: Policy-Driven Assessment Technical Studies



Reliability assessment

The CPUC's base resource portfolio is a key input in the ISO's long term reliability assessment. The reliability assessment is used to assess transmission needs in accordance with NERC, WECC and CAISO transmission planning standards and criteria. It is also used to identify constraints and potential solutions that may be modeled in production cost simulations to assess the impact of the constraints on congestion and renewable curtailment, which may lead to identification of economic transmission projects. The reliability assessment is presented in Chapter 2 and Appendix B.

On-peak deliverability assessment

The on-peak deliverability assessment is designed to ensure portfolio resources selected with full capacity deliverability status (FCDS) are deliverable and can count towards meeting resource adequacy needs. The assessment examines whether sufficient transmission capability exists to transfer resource output from a given area to the aggregate of the ISO control-area load when the generation is needed most. The ISO performs the assessment in accordance with its On-peak Deliverability Assessment Methodology.[4]

[4] https://www.caiso.com/documents/on-peak-deliverability-assessment-methodology.pdf

Off-peak deliverability assessment

The off-peak deliverability assessment is performed to identify potential transmission system limitations that may cause excessive renewable energy curtailment. Like the reliability assessment, the offpeak assessment is also used to identify constraints and transmission solutions as candidates for detailed production cost simulation studies and economic assessment. The ISO performes the assessment in accordance with its Off-Peak Deliverability Assessment Methodology.[5]

Production cost model (PCM) simulation

Production cost models for the base and sensitivity portfolios are developed and simulated to identify renewable curtailment and transmission congestion in the ISO Balancing Authority Area. The PCM for the base portfolio is used in the policy-driven assessment that is covered in this section as well as the economic assessment covered in Chapter 4 and Appendix G. The PCM with the sensitivity portfolio is used in the policy-driven assessment only. The PCM cases are developed based on study assumptions for the ISO-controlled grid outlined in the 2024-2025 transmission planning process study plan. Details of PCM modeling assumptions and approaches are provided in Appendix G.

F.4 Resource Portfolios

As mentioned in Section F.1, the 2023 PSP base portfolio and high gas generation retirement sensitivity portfolio were transmitted by the CPUC for study in the ISO 2024-2025 transmission planning process. The portfolio documents are available at the CPUC website.[6]

The following documents provide details regarding the base portfolio.

Final 2034 and 2039 busbar mapping results for the base portfolio: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/final_dashboard_24-25tpp_02-15-24.xlsx

Final 2039 busbar mapping results for the high gas generation retirement sensitivity portfolio:

https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/dashboard_gasretire_sensitivity_02152024.xlsx

Baseline reconciliation and in-development resources: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/baseline_reconcile_ruling_10-05-23.xlsx

Retirement list of thermal generation units: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-

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

[6] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp

procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/gasnotretained_mappingresults.xlsx

The composition of each of the portfolios by resource type is provided in Table F.4-1. The table includes resources selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO). The numbers also include any portfolio adjustments based on CPUC guidance including unaccounted for TPD allocation modeled and additional in-development resources modeled by PTOs based on projects status. The portfolios are comprised of solar, wind (in-state, out-of-state and offshore), battery storage, geothermal, long duration energy storage, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled. The portfolios assume some of the existing gas-fired generation fleet will be retired.

Table F.4-1: Portfolio composition – FCDS+EO resources (MW)[7]

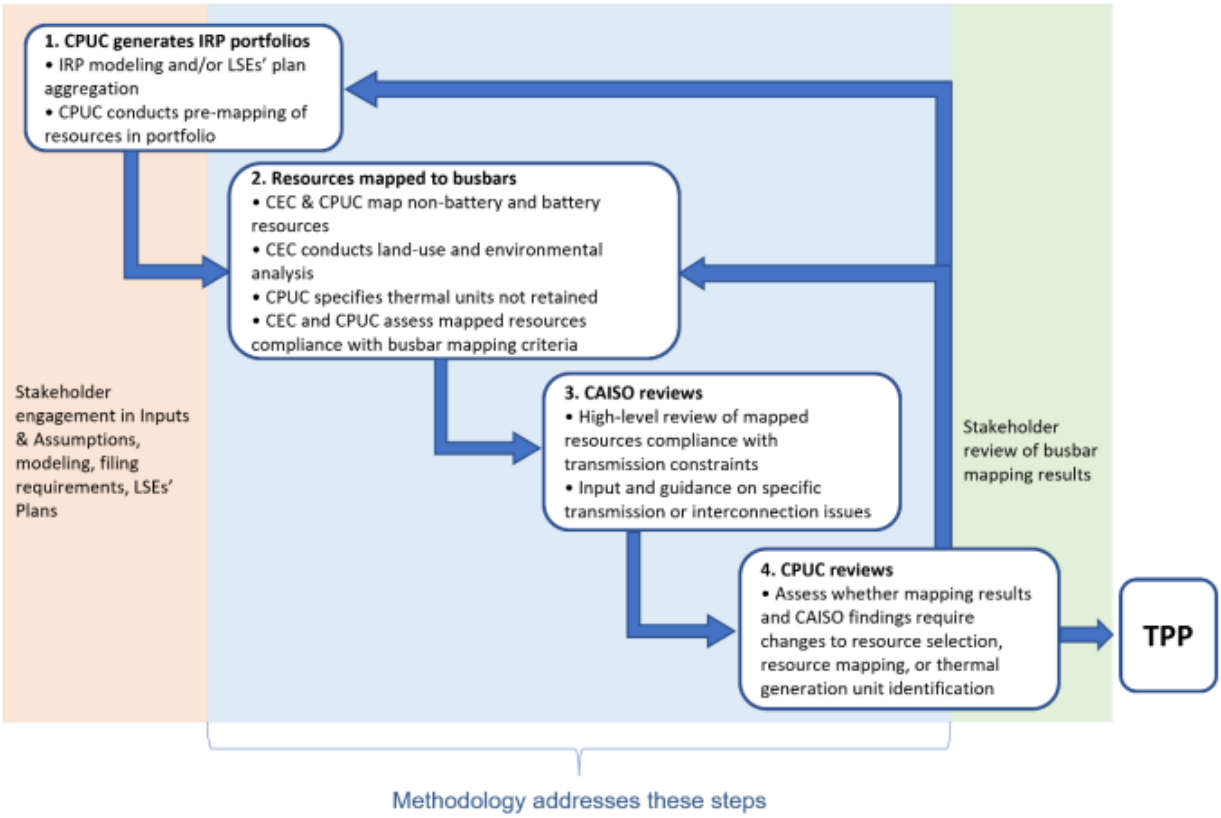
Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	8,501	10,715	19,216	10,878	19,608	30,486	21,324	30,614	51,938
Wind – In State	5,203	921	6,123	6,103	921	7,023	4,885	855	5,739
Wind – Out-of-State	6,096	0	6,096	9,096	0	9,096	7,066	0	7,066
Wind - Offshore	3,855	0	3,855	4,531	0	4,531	0	0	0
Li Battery – 4 hr	18,951	468	19,419	18,227	468	18,695	13,047	468	13,515
Li Battery – 8 hr	1,618	0	1,618	7,115	0	7,115	15,612	0	15,612
Long Duration Energy Storage (LDES)	1,030	0	1,030	1,080	0	1,080	3,680	0	3,680
Geothermal	1,969	0	1,969	1,969	0	1,969	5,089	0	5,089
Biomass/Biogas	171	0	171	171	0	171	22	0	22
Distributed Solar	260	0	260	283	0	283	335	0	335
Net Dependable Gas Capacity not Retained	(3,448)	0	(3,448)	(4,418)	0	(4,418)	(12,274)	0	(12,274)
Total	44,206	12,104	56,309	55,035	20,997	76,031	58,786	31,937	90,722

The portfolios that RESOLVE generates are at the zonal level. As a result, the portfolios have to be mapped to the busbar level for use in the ISO transmission planning process. The resource-to-busbar mapping process is documented in the CPUC report entitled Methodology for

[7] https://files.cpuc.ca.gov/energy/modeling/BusbarMapping_30MMT_HESens_Dashboard_08_22_22_TPD_v2.xlsx

Resource-to-Busbar Mapping & Assumptions for the Annual TPP[8] with further refinements as described in the CPUC staff report entitled Modeling Assumptions for the 2023-2024 Transmission Planning Process.[9] Figure F.4-1 shows a flowchart of the CPUC busbar mapping process for the 2023-2024 transmission planning process.

Figure F.4-1: Flowchart of the CPUC 2023-2024 TPP busbar mapping process[10]



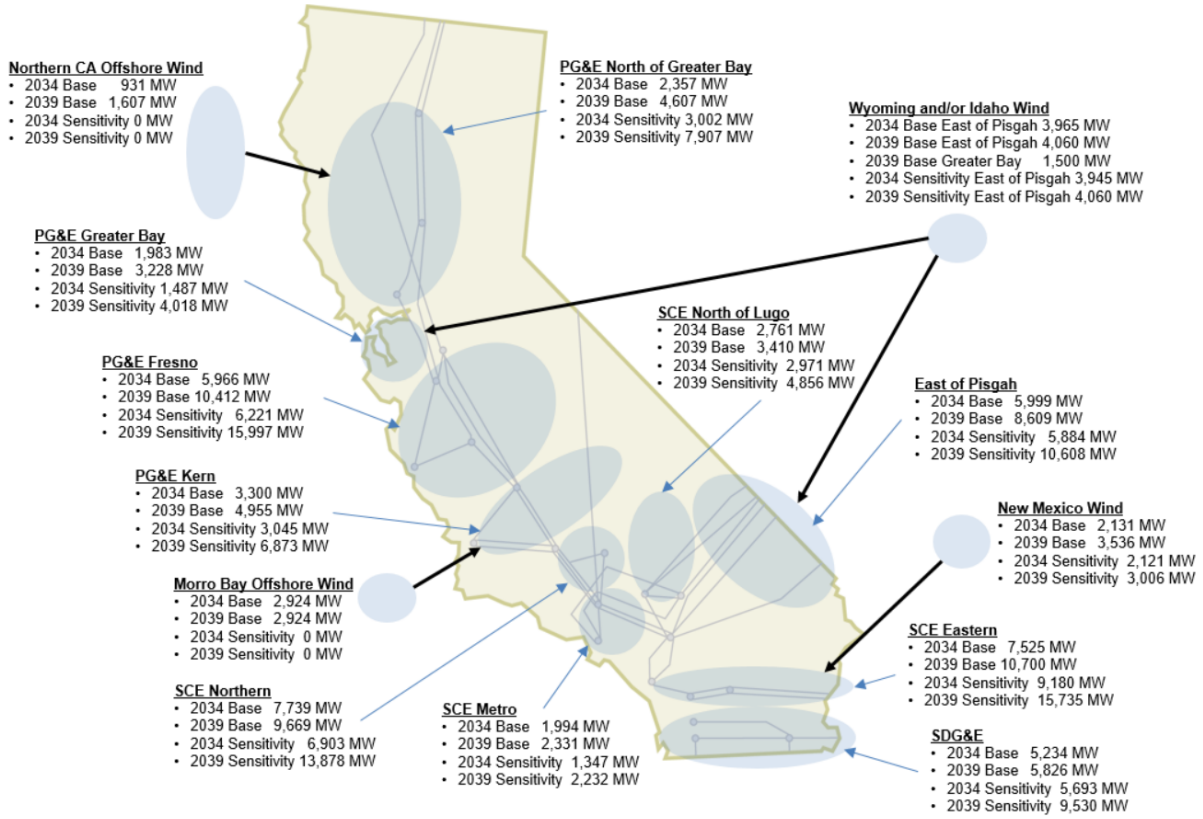
The porfolio resources were modeled in the ISO studies in accordance with the results of the mapping process. Figure F.4-2 below identifies the interconnection areas and the capacities of the resources in the CPUC's base and sensitivity portfolios. The resource types within each interconnection area and the mapping of the resources is provided in the sections below. Links to the detailed busbar mapping results have been provided in section F.4.

[8] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/2023-2024-tpp-portfolios-and-modeling-assumptions/busbarmethodologyfortppv20230109.pdf

[9] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/modeling_assumptions_2023-24tpp_v02-23-23.pdf

[10] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/2023-2024-tpp-portfolios-and-modeling-assumptions/busbarmethodologyfortppv20230109.pdf

Figure F.4-2: Base and Sensitivity Portfolios Total MW in each Interconnection Area



F.4.1 Approved Non-CPUC Jurisdictional Integrated Resource Plans

In this TPP cycle, approved IRP submitted by non-CPUC jurisdictional entities has been incorporated in the analysis with the CPUC busbar mapped IRP base portfolio. Future resources identified in the Northern California Power Agency (NCPA) 2023 Inter-Agency Resource Plan (2023 IARP) and approved IRP from Colton, Banning and Six Cities were submitted as comments to the 2024-2025 transmission draft study plan. Existing resources included in the non-CPCU jurisdictional entities' resource plans appear to have already been included in the TPP study models and as a result will not impact the assessment. There was one new resouce from NCPA being included in the 2024-2025 TPP policy study based on the details provided by this entity. The CAISO will continue to coordinate with the non-CPUC jurisdictional entities in the future planning cycles on resources that have not been included as baseline or portfolio resources in the CPUC IRP, or in the starting WECC or PTO power flow models.

F.4.2 Transmission capability estimates and utilization by portfolios

One of the key inputs in the portfolio development and busbar mapping process is the transmission capability estimates provided by the ISO. The transmission capability estimates limit the amount of FCDS and EODS resources that can be selected in the part of the system

that is affected by the constraint. Due to timing, the previous transmission capability estimates the ISO published in a white paper on June 29, 2023[11] were used in the development of the resource portfolios for the current TPP. Some capability estimates have been updated by CPUC based on information provided by the ISO.

The utilization of estimated available FCDS and EODS transmission capability by resource portfolios is monitored by the CPUC in the portfolio development process using RESOLVE and in the busbar mapping process using spreadsheet calculations. The results of the evaluation for the 2024-2025 TPP base portfolio based on the 2023 white paper are posted on the CPUC website[12].

Exceedances of actual transmission capability limits indicate a high likelihood of the need for transmission upgrades or other mitigation solutions for the delivery of portfolio resources behind the constraints, which the CPUC takes into account in the development and mapping of the resource portfolios. However, the spreadsheet analysis should not be viewed as a substitute for the analysis the ISO performed as part of this policy-driven assessment using detailed power system models.

F.5 Additional Guidance from CPUC regarding the Portfolios

In the Modeling Assumptions for the 2024-2025 Transmission Planning Process, CPUC staff provide the additional guidance below on the base and sensitivity portfolios. The ISO has considered this guidance when conducting the policy-driven assessment.

Alignment with CAISO Queue Resources with Allocated TPD

As was done for the 2023-2024 TPP, CPUC staff requested that the that CAISO continue the necessary studies to inform and enable opportunities to provide Maximum Import Capability (MIC) expansion and the development of incremental transmission capacity to support the OOS and long-lead time (LLT) resources mapped in the base portfolio, while preserving the existing transmission capacity that has been allocated to other projects earlier in the interconnection queue. CPUC Working Group staff sought to align the mapping with resources in the ISO's interconnection queue that have been assigned transmission plan deliverability (TPD) while still aligning with the various other busbar mapping criteria. To that end, not all the assigned TPD in the transmission areas key to OOS and LLT resources were accounted for by mapped resources. CPUC staff compiled the MW amounts and locations of these TPD allocated resources as shown in **Error! Reference source not found.** so that the CAISO can include them in addition to the mapped portfolio resources when conducting TPP analysis[13]. Minor adjustments were also made to account for additional in-development resources identified by PTOs as shown in **Error! Reference source not found.**

[11] https://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=03DCF912-0ECF-4CF9-A304-A05F4ED5B2CD

[12] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/assumptions-for-the-2024-2025-tpp/final_dashboard_24-25tpp_02-15-24.xlsx See Exceedance_Summary tabs

[13] The CPUC compiled the MW amounts of TPD in Table F5-1 in February 2024 which was prior to the completion of the CAISO's 2024 TPD Allocation process in June 2024, so the TPD allocations in that process are not included in Table F5-1.

Table F.5-1: Adjustments to the base portfolio to account for adjustments to in-development resources and TPD allocations

				TPD in key MIC regions unaccounted for by mapped resources (MWs)		
CAISO Study Area	**Substation**	**Voltage**	**Resource Type**	**2034 Base**	**2039 Base**	**2039 Sensitivity**
SCE Eastern Study Area	Alberhill	500	Storage	500	500	500
SCE Eastern Study Area	Cielo Azul	500	Storage	590	90	499
East of Pisgah Study Area	Eldorado	230	Storage	250	-	-
East of Pisgah Study Area	Mohave	500	Storage	1,020	1,020	1,240
East of Pisgah Study Area	Trout Canyon	230	Storage	1,000	527	975
			Total	**3,360**	**2,137**	**3,214**

Table F.5-2: Adjustments to the base portfolio to account additional in-development resources identified

				2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
Transmission Area	**Substation**	**Voltage**	**Resource Type**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**
SCE Northern Area	Windhub	230	Li_Battery	375	-	375	125	-	125	250	-	250
SCE Northern Area	Windhub	230	Solar	-	400	400	-	-	-	-	-	-
SCE Northern Area	Windhub	66	Solar	20	-	20	20	-	20	20	-	20
SCE Northern Area	Rector	66	Li_Battery	80	-	80	80	-	80	80	-	80
SCE Northern Area	Springville	66	Solar	-	40	40	-	40	40	-	40	40
SCE Northern Area	Springville	66	Li_Battery	40	-	40	40	-	40	40	-	40
SCE NOL Area	Coolwater	115	Li_Battery	8	-	8	8	-	8	28	-	28
SCE NOL Area	Inyokern	115	Li_Battery	46	-	46	46	-	46	46	-	46
SCE NOL Area	Victor	115	Solar	-	27	27	-	27	27	-	27	27
SCE Eastern Area	Red Bluff	230	Li_Battery	-	468	468	-	468	468	-	468	468
SCE Metro Area	Alamitos	230	Li_Battery	84	-	84	84	-	84	84	-	84
			Total	**653**	**935**	**1,588**	**403**	**535**	**938**	**548**	**535**	**1,083**

Out-of-State Wind on New Out-of-State Transmission

The amount of OOS wind on new transmission is significantly higher (6,095 MW in 2034 and 9,095 MW in 2039) in this base case portfolio than in the past TPP base cases. As was done for the 2023-2024 TPP base case, the Working Group mapped the out-of-state wind to specific CAISO injection points and identified specific locations as sources of the OOS wind. Minor modification was later made by the CAISO staff during the policy study process and the final mapping was as follows. For the 2034 portfolio: 1,060 MW of Idaho Wind interconnected at Harry Allen using the proposed SWIP-North line, 1,500 MW of Wyoming wind interconnected at Harry Allen using the proposed TransWest Express line while the remaining 1,405 MW Wyoming wind interconnected at Eldorado 500 kV requiring new transmission, and 2,131 MW of New Mexico Wind interconnected at Pinal Central using the proposed SunZia line and existing transmission. In 2039, the amount of New Mexico wind increases to 3,535 MW and Wyoming Wind increases to 4,500 MW. The additional New Mexico wind was assumed the same interconnection at Pinal Central. For the additional 1,500 MW Wyoming wind, the CPUC staff mapped it as interconnecting using new transmission to Northern California in the Tesla area to align with results from the CAISO's 20-year outlook (2021-2022). Though, CPUC staff again note that this is not a mandate to assume this specific intertie if alternative, more effective solutions are available, such as any being identified in the current 20-year Transmission Outlook (2023-2024) or alternative options that could potentially accommodate the wind resources identified in northeastern California and other potential northern Nevada resources.

Out-of-CAISO Resources and Maximum Import Capability (MIC)

The 2023-24 TPP base portfolio, in addition to the over 4,800 MW of OOS wind on new transmission, has a significant amount of geothermal mapped to IID and areas in Nevada beyond the CAISO's Balancing Area. As was done for the 2022-2023 TPP portfolio, busbar Working Group staff specified in the Mapping Dashboard the out-of-CAISO transmission and MIC assumptions for these resources including whether the resources should be treated by CAISO in TPP analysis as using existing MIC allocations or require MIC expansion. For all the OOS wind on new transmission and most of the geothermal resources, Working Group staff identified the resources as requiring MIC expansion. Full details of the out-of-CAISO resources, which can be found on the "OutsideCAISO_Res_Summary" tab of the Mapping Dashboards, was used to model the resources.

Battery Storage-Specific Transmission Upgrades and Battery Storage as Transmission Upgrade Alternatives

As with the past TPP portfolio submittals, CPUC requests ISO to consult the CPUC before moving forward with any new policy-driven transmission upgrades associated specifically with storage mapping in this planning cycle. Additionally, to the extent that storage resources are required for mitigation of transmission issues identified in the CAISO 2023-2024 Transmission Plan, CPUC staff expect to coordinate with CAISO to enable small adjustments in the CPUC's mapping of storage resources to allow for the inclusion of this storage in the CAISO's analysis of the 2024-2025 TPP portfolio.Such adjustments were not made as storage resources were not required for mitigation of transmission issues identified in the CAISO's 2023-2024 Transmission Plan.

F.6 On-Peak Deliverability Assessment

The primary objective of the policy-driven on-peak deliverability assessment is to support deliverability of the renewable generation and energy storage resources that are identified in the portfolios as requiring FCDS status so they can count towards meeting resource adequacy needs. The assessment evaluates whether the net resource output from a given area can be simultaneously transferred to the remainder of the ISO Control Area during periods of peak system load. The on-peak deliverability assessment of the base and sensitivity portfolios was performed in accordance with the on-peak deliverability assessment methodology.[14]

F.6.1 On-peak deliverability assessment assumptions

The deliverability assessment is performed under two distinct system conditions – the highest system need (HSN) scenario and the secondary system need (SSN) scenario. The HSN scenario represents the period 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 represent the hours ending 19 to 22 in the summer months.

The secondary system need scenario represents the period when capacity shortage risk increases if variable resources are not deliverable during periods when the system depends on their high output for resource adequacy. In this scenario, the system load is modeled to represent the peak consumption level and solar output is modeled at a significantly higher output. The secondary system need hours are hours ending 15 to 18 in the summer months.

The ISO performed the on-peak deliverability assessment for both HSN and SSN scenarios. For each scenario and each portfolio, the ISO developed a master on-peak deliverability assessment base case from which area cases are derived. Key assumptions of the deliverability assessment are described below.

Transmission

The ISO modeled the same transmission system as in the 2034 and 2039 peak load base cases that are used in the reliability assessment performed as part of the current transmission planning process.

System load

The ISO modeled the coincident 1-in-5 year peak for the ISO balancing authority area load in the HSN base case. Pump load was dispatched within the expected range for summer peak load hours. The load in the SSN base case was adjusted from HSN to represent the net customer load at the time of forecasted peak consumption.

Maximum resource output (Pmax) assumptions

Pmax in the on-peak deliverability assessment represents the resource-type specific maximum resource output assumed in the deliverability assessment. For existing non-intermittent generating units, the highest summer month NQC in the last three years is used as Pmax. For proposed FCDS non-intermittent generators that do not have NQC, the Pmax is set according to

[14] https://www.caiso.com/documents/on-peak-deliverability-assessment-methodology.pdf

the interconnection request. For non-intermittent generic portfolio resources, the FCDS capacity provided in the portfolio is used as the Pmax. For FCDS energy storage resources, the Pmax in the HSN scenario is set to the 4-hour discharging capacity, limited by the requested maximum output from the generator. Pmax for energy storage in the SSN scenario is set at half of the HSN value. For hybrid projects, the study amount for each technology is first calculated separately. Then the total study amount among all technologies is based on the sume of each technology, but limited by the requested maximum output of the generation project.

FCDS intermittent resources are modeled in the HSN scenario based on the output profiles during the highest system need hours with low unloaded capacity levels. A 20% exceedance production level for wind and solar resources during these hours sets the Pmax tested in the HSN deliverability assessment. In the SSN scenario, intermittent resources are modeled based on the output profiles during the secondary system need hours with low unloaded capacity levels. 50% exceedance production level for wind and solar resources during those hours sets the Pmax tested in the SSN deliverability assessment.

The maximum resource output (Pmax) assumptions used in the HSN and SSN deliverability assessment for FCDS resources are shown in

Table F.6-1. For resources with partial deliverability status (PCDS), the Pmax amounts in the table are derated by the deliverable percentage.

Table F.6-1: Maximum FCDS resource output tested in the deliverability assessment

Area	HSN				SSN			
	SDG&E	**SCE**	**PG&E**	**VEA**	**SDG&E**	**SCE**	**PG&E**	**VEA**
Solar	6%	13%	15%	8%	71%	80%	71%	66%
Wind	35%	48%	50%	48%	10%	17%	19%	17%
Out-of-state Wind (NM, WY, ID)	67%				35%			
Off-shore Wind	83%				45%			
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%							

Import Levels

For the HSN scenario, the net scheduled imports at all branch groups as determined in the latest annual Maximum Import Capability (MIC) assessment set the base import targets in the study. Approved MIC expansions will be added to the import levels. Historically unused Existing Transmission Contracts (ETC's) crossing control area boundaries were modeled as zero MW

injections at the tie point, but available to be turned on at remaining contract amounts for screening analysis. MIC expansions needed to accommodate portfolio resources outside the ISO BAA are added to the import targets. Valid MIC expansion requests are similarly modeled but are not allowed to trigger transmission upgrades.

For the SSN scenario, 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 import targets in the study. Approved and requested MIC expansions and MIC expansions needed to accommodate portfolio resources outside the ISO BAA are are modeled similar to the HSN scenario.

F.6.2 General On-peak deliverability assessment procedure

The main steps of the California ISO on-peak deliverability assessment procedure are described below.

Screening for Potential Deliverability Problems Using DC Power Flow Tool

A DC transfer capability/contingency analysis tool is used to identify potential deliverability problems. For each analyzed facility, an electrical circle is drawn which includes all generating units including unused Existing Transmission Contract (ETC) injections that have a 5% (or 10% for 500 kV lines) or greater:

Distribution factor (DFAX) = (Δ flow on the analyzed facility / Δ output of the generating unit) *100%

or

Flow impact = (DFAX * Full Study Amount / Applicable rating of the analyzed facility) *100%.

Load flow simulations are performed, which study the worst-case combination of generator output within each 5%/10% Circle.

Verifying and Refining the Analysis Using AC Power Flow Tool

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 20 units are increased to their maximum output. In addition, no more than 1,500 MW of generation is increased. All remaining generation within the Control Area is proportionally displaced, to maintain a load and resource balance.

When the 20 units with the highest impact on the facility can be increased more than 1,500 MW, the impact of the remaining amount of generation to be increased is 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 multiplied by the DFAX of each unit. An equivalent MW amount of generation with negative DFAX is also included in the Facility Loading Adder, up to 20 units. Negative Facility Loading Adders should be set to zero.

The ISO's on-peak deliverability assessment simulation procedure as implemented in PowerGem's Transmission Adequacy & Reliability Assessment (TARA) software was used to perform the policy-driven on-peak deliverability assessment.

On-peak deliverability assessment for the 2034 and 2039 base portfolios and 2039 high gas generation retirement sensitivity portfolio were performed for both southern and northern California.

Potential mitigation options considered to address on-peak deliverability constraints include Remedial Action Schemes (RAS), reduction of energy storage behind the constraints and transmission upgrades. Transmission upgrades identified for the base portfolio HSN scenario are recommended as policy driven upgrades. Transmission upgrades identified for the base portfolio SSN scenario will go through a comprehensive economic, policy and reliability benefit analysis to be considered for approval as a policy driven or economic upgrade.

F.7 Off-Peak Deliverability assessment

The ISO modified its on-peak deliverability assessment to reflect the changing contribution of solar to meeting resource adequacy needs. Additional solar resources provide a much lower incremental resource adequacy benefit to the system than the initial solar resources, because their output profile ceases to align with the peak hour of demand on the transmission system which has shifted to later in the day due to the proliferation of behind-the-meter solar. As a result, there is a reduced need for transmission upgrades to support deliverability of additional solar resources for resource adequacy purposes. Generation developers have been relying on transmission upgrades required under the previous on-peak deliverability assessment methodology to ensure that generation would not be exposed to excessive curtailment due to transmission limitations. Therefore, the off-peak deliverability assessment methodology[15] was developed to address renewable energy delivery during hours outside of the summer peak load period to ensure some minimal level of protection from otherwise potentially unlimited curtailment.

Accordingly, the key objectives of the policy-driven off-peak deliverability assessment are to:

- Identify transmission constraints that would cause excessive renewable curtailment in accordance with the off-peak deliverability methodology
- Identify potential transmission upgrades and other solutions needed to relieve excessive renewable curtailment
- Select the constraints and the identified transmission upgrades as candidates for a more thorough evaluation using production cost simulation

F.7.1 Off-peak deliverability assessment methodology

The general system study conditions are intended to capture a reasonable scenario for the load, generation, and imports that stress the transmission system, but not coinciding with an oversupply situation. By examining the renewable curtailment data from 2018, a load level of about 55% to 60% of the summer peak load and an import level of about 6000 MW was selected for the off-peak deliverability assessment.

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

The production of wind and solar resources under the selected load and import conditions varies widely. The production duration curves for solar and wind were examined. The production level under which 90% of the annual energy was selected to set the outputs to be tested in the off-peak deliverability assessment. The dispatch of the remaining generation fleet is set by examining historical production associated with the selected renewable production levels. The hydro dispatch is about 30% of the installed capacity and the thermal dispatch is about 15%. All energy storage facilities are assumed offline.

The dispatch assumptions discussed above apply to both full capacity and energy-only resources. However, depending on the amount of generation in the portfolio, it may be impossible to balance load and resources under such conditions with all portfolio generation dispatched. The dispatch assumptions are applied to all existing, under-construction and contracted generators first, then some portfolio generators if needed to balance load and resources. This establishes a system-wide dispatch base case or master base case that is the starting case for developing each of the study area base cases to be used in the off-peak deliverability assessments. Table F.7-1 summarizes the generation dispatch assumptions in the master base case.

Table F.7-1: ISO System-Wide Generator Dispatch Assumptions

	Dispatch Level
Wind	44%
Solar	68%
Battery storage	0
Hydro	30%
Thermal	15%

The off-peak deliverability assessment is performed for each study area separately. The study areas in general are the same as the reliability assessment areas in the generation interconnection studies.

Study area base cases are created from the system-wide dispatch base case. All generators in the study area, existing or future, are dispatched to a consistent output level. In order to capture local curtailment, the renewable dispatch is increased to the 90% energy level for the study area, which is higher than the system-wide 90% energy level. The study area 90% energy level was determined from representing individual plants in different areas. For out-of-state and off-shore wind, the dispatch values are based on data obtained from NREL for the PCM model.

If the renewables inside the study area are predominantly wind resources (more than 70% of total study area capacity), wind resource dispatch is increased as shown in Table F.7-2. All the solar resources in the wind pocket are dispatched at the system-wide level of 68%. If the renewables inside the study area are not predominantly wind resources, then the

dispatch assumptions in Table F.7-3 are used. The dispatch assumptions for out-of-state and off-shore wind used in the current study are provided in Table F.7-4.

Table F.7-2: Local Area Solar and Wind Dispatch Assumptions in Wind Area

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

Table F.7-3: Local Area Solar and Wind Dispatch Assumptions in Solar Area

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

Table F.7-4: Additional Local Area Dispatch Assumptions

Resource	Dispatch Level
Offshore Wind	100%
New Mexico Wind	67%
Wyoming Wind	67%

As the generation dispatch increases inside the study area, the following resource adjustment can be performed to balance the loads and resources:

- Reduce new generation outside the study area (staying within the Path 26, 4000 MW north to south, and 3000 MW south to north limits);
- Reduce thermal generation inside the study area;
- Reduce imports; and
- Reduce thermal generation outside the study area.

Once each study area case has been developed, a contingency analysis is performed for normal conditions and selected contingencies:

- Normal conditions (P0);
- Single contingency of transmission circuit (P1.2), transformer (P1.3), single pole of DC lines (P1.5) and two poles of PDCI if impacting the study area; and
- Multiple contingency of two adjacent circuits on common structures (P7.1) and loss of a bipolar DC line (P7.2).

For overloads identified under such dispatch, resources that can be re-dispatched to relieve the overloads are adjusted to determine if the overload can be mitigated:

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

The remaining overloads after the re-dispatch will be mitigated by the identification of transmission upgrades or other solutions. Generators with 5% or higher distribution factor (DFAX) on the constraint are considered contributing generators. The distribution factor is the percentage of a particular generation unit's incremental increase in output that flows on a particular transmission line or transformer under the applicable contingency condition when the displaced generation is spread proportionally, across all dispatched resources available to scale down output proportionally. Generation units are scaled down in proportion to the dispatch level of the unit.

Off-peak deliverability assessment for the 2034 base portfolio was performed for both southern and northern California. The potential solutions considered to address off-peak deliverability constraints include Remedial Action Schemes (RAS), dispatching available battery storage behind the constraints and transmission upgrades. Transmission upgrades identified to address off-peak deliverability constraints will be considered as candidates for a more thorough evaluation using production cost simulation.

F.8 PG&E North of Greater Bay Interconnection Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the PG&E North of Greater Bay interconnection area are listed in Table F.8-1. The portfolios in the interconnection area are comprised of solar, wind (in-state and offshore), battery storage, geothermal, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.8-1: PG&E North of Greater Bay Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	275	320	595	430	1,115	1,545	1,275	2,457	3,732
Wind – In State	778	320	1,097	1,678	320	1,997	674	260	933
Wind – Out-of-State	0	0	0	1,500	0	1,500	0	0	0
Wind - Offshore	931	0	931	1,607	0	1,607	0	0	0
Li Battery – 4 hr	293	0	293	293	0	293	93	0	93
Li Battery – 8 hr	88	0	88	488	0	488	1,073	0	1,073
Long Duration Energy Storage (LDES)	5	0	5	5	0	5	959	0	959
Geothermal	144	0	144	144	0	144	1,074	0	1,074
Biomass/Biogas	96	0	96	96	0	96	6	0	6
Distributed Solar	37	0	37	37	0	37	37	0	37
Total	**2,647**	**639**	**3,287**	**6,279**	**1,434**	**7,713**	**5,191**	**2,716**	**7,907**

The resources as identified in the CPUC busbar mapping for the PG&E North of Greater Bay interconnection area are illustrated on the single-line diagrams in Figure F.8-1 and Figure F.8-2. No adjustments were made to the portfolios in this area to account for allocated TPD and additional in-development resources identified.

Figure F.8-1: North of Greater Bay Interconnection Area – Mapped 2034 Base Portfolio

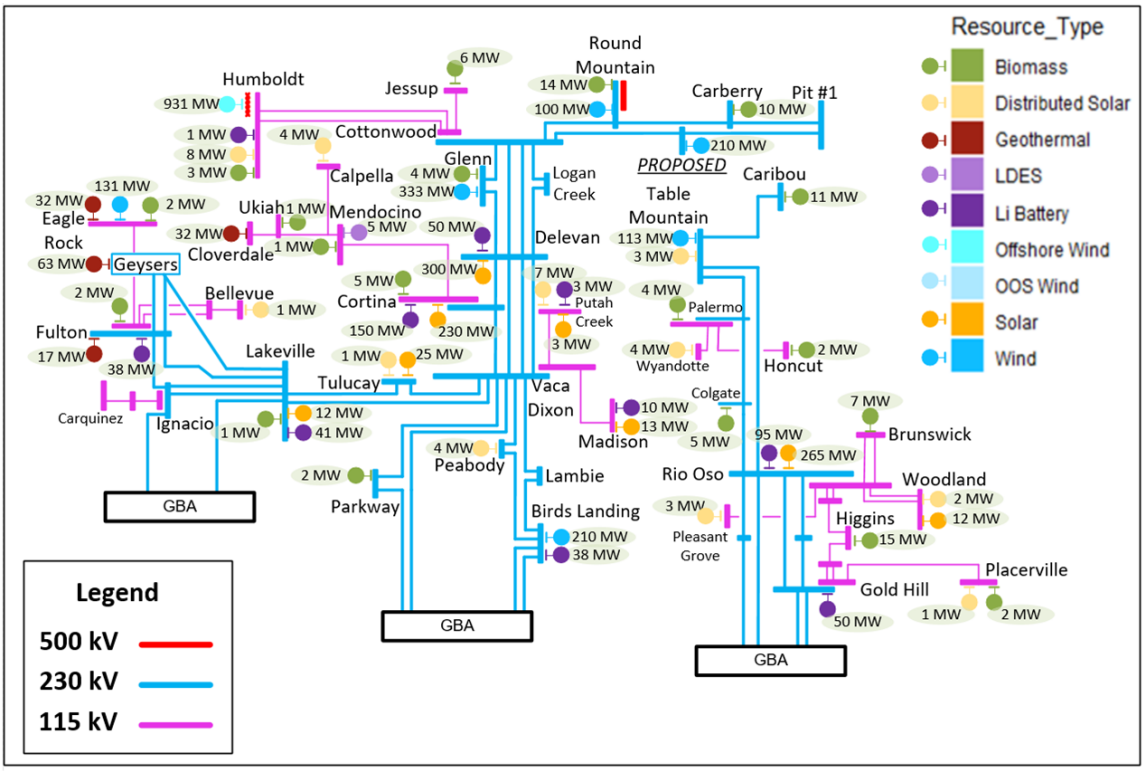
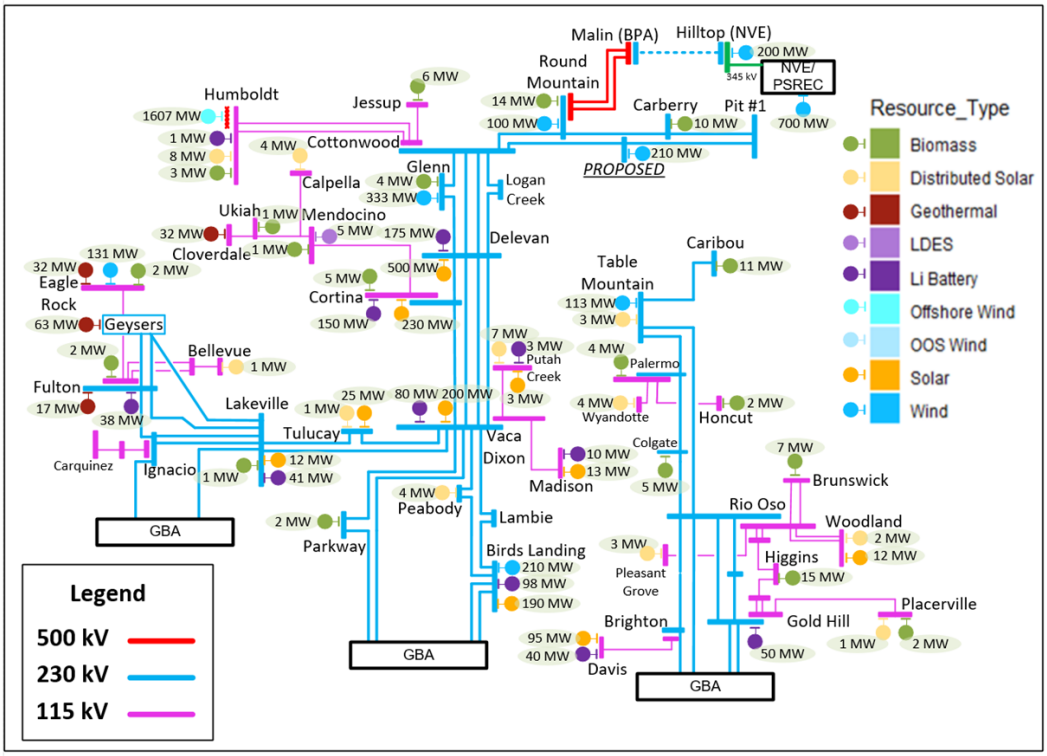


Figure F.8-2: North of Greater Bay Interconnection Area – Mapped 2039 Base Portfolio



With the resource mix specified in **Error! Reference source not found.** modeled in the base cases, the on-peak deliverability assessment identified the following constraints in PG&E study areas:

F.8.1 2034 On-peak results

Hopland Bank 115/60 kV #2 on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Hopland Bank 115/60 kV #2 under N-2 conditions as shown in Table F.8-2. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-3, 39 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint can be mitigated by a planned PG&E maintenance project.

Table F.8-2: Hopland Bank 115/60 kV #2 on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
HOPLAND BANK 115/60 BANK NO.2	GEYSERS #9-LAKEVILLE & EAGLE ROCK-FULTON-SILVERADO LINES	HSN	139.72%	124.25%

Table F.8-3: Hopland Bank 115/60 kV #2 on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		202
Portfolio battery storage behind the constraint (Installed FCDS capacity)		0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		39
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		239
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	Maintenance Project
Recommended Mitigation		Maintenance Project

Ukiah-Hopland-Cloverdale 115 kV (Ukiah sub 115 kV to Hopland Jct 115 kV) line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Ukiah-Hopland-Cloverdale 115 kV 115 kV line under N-2 conditions as shown in Table F.8-4. This constraint was identified in baseline portfolio under HSN

conditions. As shown in Table F.8-5, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint would be considered a local costraintand therefore will be addressed through the GIP.

Table F.8-4: Ukiah-Hopland-Cloverdale 115 kV (Ukiah sub 115 kV to Hopland Jct 115 kV) line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Ukiah-Hopland-Cloverdale 115 kV (Ukiah sub 115kv to Hopland Jct 115kv)	EAGLE ROCK-REDBUD & CORTINA-MENDOCINO #1 LINES	HSN	117.78%	<100%

Table F.8-5: Ukiah-Hopland-Cloverdale 115 kV (Ukiah sub 115 kV to Hopland Jct 115 kV) line on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		191
Portfolio battery storage behind the constraint (Installed FCDS capacity)		0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		455
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP

Geyser # 3 - Cloverdale 115 kV (Cloverdale 115 kV to MPE TAP 115 kV) line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Geyser # 3 - Cloverdale 115 kV (Cloverdale 115 kV to MPE TAP115 kV) line under N-2 conditions as shown in Table F.8-6. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-7, 0 MW of renewable and energy

storage would be deliverable without any transmission upgrades. The constraint would be considered a local constraint and therefore will be addressed through the GIP.

Table F.8-6: Geyser # 3 - Cloverdale 115kV (Cloverdale 115kV to MPE TAP 115kV) line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Geyser # 3 - Cloverdale 115kV (Cloverdale 115kV to MPE TAP 115kV)	EAGLE ROCK-REDBUD & CORTINA-MENDOCINO #1 LINES	HSN	102.64%	<100%

Table F.8-7: Geyser # 3 - Cloverdale 115 kV (Cloverdale 115 kV to MPE TAP 115 kV) line on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		159
Portfolio battery storage behind the constraint (Installed FCDS capacity)		0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		353
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP

Fulton – Hopland 60 kV Line (Hopland Jct. 60 kV to Cloverdale Jct. 60 kV) line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of several lines in the Fulton – Hopland 60 kV Line (Hopland Jct. 60 kV to Cloverdale Jct. 60 kV) line under N-2 conditions as shown in Table F.8-8. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-9, 53 MW of renewable and energy storage would be deliverable without any transmission upgrades. The

constraint would be considered a local constraint and therefore will be addressed through the GIP.

Table F.8-8: Fulton – Hopland 60 kV Line (Hopland Jct. 60 kV to Cloverdale Jct. 60 kV) line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Fulton - Hopland 60 kV (Hopland Jct 60 kV to Cloverdale Jct 60 kV to Geysers Jct 60 kV)	GEYSERS #9-LAKEVILLE & EAGLE ROCK-FULTON-SILVERADO LINES	HSN	166.10%	160.46%

Table F.8-9: Fulton – Hopland 60 kV Line (Hopland Jct. 60 kV to Cloverdale Jct. 60 kV) line on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		202
Portfolio battery storage behind the constraint (Installed FCDS capacity)		150
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		53
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		350
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP

Geyser #3 - Eagle Rock 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Geyser #3 - Eagle Rock 115 kV line under N-2 conditions as shown in Table F.8-10. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-11, 64 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint would be considered a local constraint and therefore will be addressed through the GIP.

Table F.8-10: Geyser #3 - Eagle Rock 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Geyser #3 - Eagle Rock 115 kV Line	MENDOCINO-UKIAH & UKIAH-HOPLAND-CLOVERDALE LINES	HSN	113.95%	116.25%

Table F.8-11: Geyser #3 - Eagle Rock 115 kV Line on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		90
Portfolio battery storage behind the constraint (Installed FCDS capacity)		0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		64
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		30
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP

Eagle Rock- Fulton- Silverado 115 kV line (Eagle rock sub to Ricon Jct 115 kV) on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Eagle Rock- Fulton- Silverado 115 kV line (Eagle rock sub to Ricon Jct 115 kV) under N-2 conditions as shown in Table F.8-12. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-13, 147 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint would be mitigated by reconductoring the Eagle Rock- Fulton- Silverado 115 kV line.

Table F.8-12: Eagle Rock- Fulton- Silverado 115 kV line (Eagle rock sub to Ricon Jct 115 kV) on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading

			HSN	SSN
Eagle Rock- Fulton-Silverado 115 kv (Eagle rock sub to Ricon Jct Jct2 115 kV)	Tulucay-Vaca 230 kV Line & Vaca-Lakeville #1 230 kV Line	HSN	124.45%	<100%

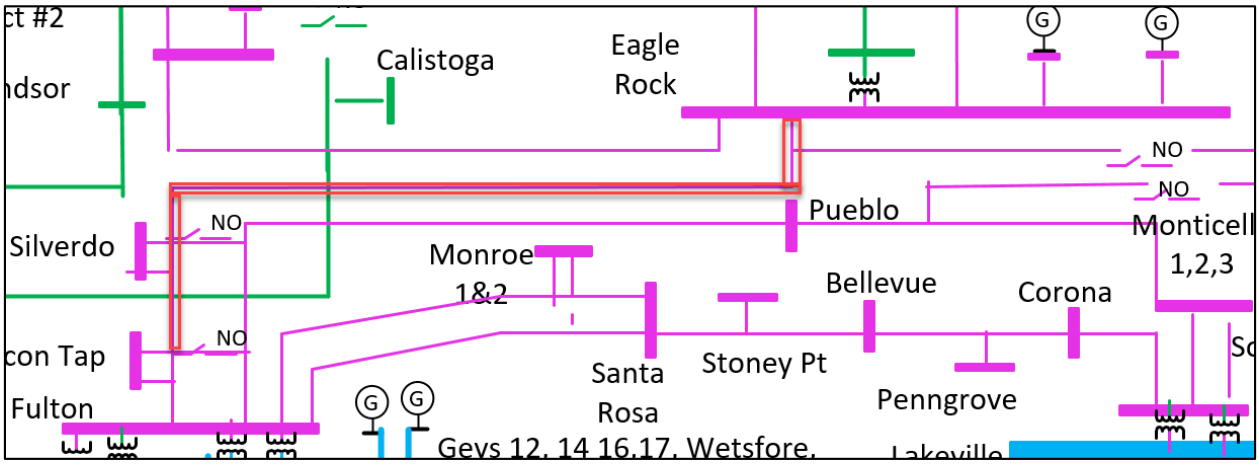
Table F.8-13: Eagle Rock- Fulton- Silverado 115 kV (Eagle rock sub to Ricon Jct 115 kV) on-peak deliverability constraint summary

Affected transmission zones		North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		282
Portfolio battery storage behind the constraint (Installed FCDS capacity)		150
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		147
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		290
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	Reconductor ($92.9M)
Recommended Mitigation		Reconductor

Eagle Rock- Fulton- Silverado 115 kV Line Reconductor

To mitigate overloads identified in the on-peak baseline deliverability study, the ISO is recommending for approval the reconductor of the Eagle Rock- Fulton- Silverado 115 kV line. The estimated project cost is $92.9M, with an estimated time to construct of 64 months. The scope Reconductor Eagle Rock-020/087A with minimum rating of 1236 Amps or higher and update any limiting components at the substation (if any). Reconductor 020/87A-037/191A with minimum rating of 1687 Amps or higher and update any limiting components at the substation (if any).

Figure F.8-3: Eagle Rock- Fulton- Silverado 115 kV Line Reconductor



Konocti - Eagle Rock 60 kV line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Konocti - Eagle Rock 60 kV line under N-2 conditions as shown in Table F.8-14. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.8-15, 53 MW of renewable and energy storage would be deliverable without any transmission upgrades. This constraint is a currently identified LDNU and will be addressed in GIP.

Table F.8-14: Konocti - Eagle Rock 60 kV line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Konocti - Eagle Rock 60kV	UKIAH-HOPLAND-CLOVERDALE 115KV [4050]	HSN	108.96%	<100%

Table F.8-15: Konocti - Eagle Rock 60 kV line on-peak deliverability constraint summary

Affected transmission zones	North of Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)	191
Portfolio battery storage behind the constraint (Installed FCDS capacity)	0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)	53

Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		179
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP

F.8.2 2034 Off-peak results

In the off-peak deliverability assessment of the North of Greater Bay interconnection no constraints were identified for the base portfolio.

F.8.3 2039 On-peak results

Geyser # 12 - Fulton 230 kV (Fulton - Geyser#14 Jct) Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the North of Greater Bay area is limited by thermal overloading of the Geyser # 12 - Fulton 230 kV (Fulton - Geyser#14 Jct) Line under N-2 conditions as shown Table F.8-16. This constraint was identified in baseline portfolio under sensitivity conditions. As shown in Table F.8-17, 61 MW of renewable and energy storage would be deliverable without any transmission upgrades. The CAISO will continue to monitor this constraint.

Table F.8-16: Geyser # 12 - Fulton 230 kV (Fulton - Geyser#14 Jct) Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Geyser # 12 - Fulton 230 kV (Fulton - Geyser# 14 Jct)	Base Case	HSN	101.99%	<100%

Table F.8-17: Geyser # 12 - Fulton 230 kV (Fulton - Geyser#14 Jct) Line on-peak deliverability constraint summary

Affected transmission zones: PG&E North of Greater Bay Area		
	Base	**Sensitivity**

Generic Portfolio MW behind the constraint (installed FCDS capacity)		60	N/A
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	N/A
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		61	N/A
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		2	N/A
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Continue to monitor	N/A
Recommended Mitigation		Continue to monitor	

Cortina - Vaca 230 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the North of Greater Bay area is limited by thermal overloading of the Cortina - Vaca 230 kV Line under N-2 conditions as shown Table F.8-18. This constraint was identified in the 2039 baseline portfolio only. As shown in Table F.8-19, 549 MW of renewable and energy storage would be deliverable without any transmission upgrades. The CAISO will continue to monitor this constraint.

Table F.8-18: Cortina - Vaca 230 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Cortina - Vaca 230 kV Line	Delevan-Vaca Dixon No.2 230 kV Line & Delevan-Vaca Dixon No.3 230 kV Line	HSN	105.02%	103.44%

Table F.8-19: Cortina - Vaca 230 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E North of Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		720	706
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	330
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		549	680
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		1224	1693
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Continue to monitor	N/A

Recommended Mitigation	Continue to monitor

Cortina - Mendocino No.1 115 kV (Mendocino Sub 115 kV to Lucerine Jct1 115 kV) Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the North of Greater Bay area is limited by thermal overloading of the Cortina - Mendocino No.1 115 kV (Mendocino Sub 115 kV to Lucerine Jct1 115 kV) Line under N-2 conditions as shown Table F.8-20. As shown in Table F.8-21, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint is identified only in the sensitivity scenario.

Table F.8-20: Cortina - Mendocino No.1 115 kV (Mendocino Sub 115 kV to Lucerine Jct1 115 kV) Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Cortina - Mendocino No.1 115 kV (Mendocino Sub 115kV to Lucerine Jct1 115 kv)	EAGLE ROCK-CORTINA & EAGLE ROCK-REDBUD LINES (2)	HSN	<100%	110.75%

Table F.8-21: Cortina - Mendocino No.1 115 kV (Mendocino Sub 115 kV to Lucerine Jct1 115 kV) Line on-peak deliverability constraint summary

Affected transmission zones: PG&E North of Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	81
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	150
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	347
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	Mitigation not needed
Recommended Mitigation		Mitigation not needed	

Lincoln - Pleasant Grove 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the North of Greater Bay area is limited by thermal overloading of the Lincoln - Pleasant Grove 115 kV Line under N-2 conditions as shown Table F.8-22. This constraint was identified in 2039 baseline portfolio and sensitivity conditions.

Asshown in Table F.8-23, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. This constraint is a currently identified LDNU and will be addressed in GIP.

Table F.8-22: Lincoln - Pleasant Grove 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Lincoln - Pleasant Grove 115 kV Line	Rio Oso-Atlantic 230 kV Line & Rio Oso-Gold Hill 230 kV Line	HSN	114.73%	114.78%

Table F.8-23: Lincoln - Pleasant Grove 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E North of Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		100	82
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	135
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		459	539
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	This constraint is a currently identified LDNU and will be addressed in GIP	This constraint is a currently identified LDNU and will be addressed in GIP
Recommended Mitigation		This constraint is a currently identified LDNU and will be addressed in GIP	

F.8.4 Conclusion and recommendation

The PGE North of Greater Bay area base and sensitivity portfolios deliverability assessment identified on-peak deliverability constraints. The Eagle Rock- Fulton- Silverado 115 kV (Eagle rock sub to Ricon Jct Jct2 115 kV) line constraint is identified in 2034 on-peak scenario and the CAISO recommends reconductoring the line as mitigation.

F.9 PG&E Greater Bay Interconnection Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the PG&E Greater Bay interconnection area are listed in Table F.9-1. The portfolios in the interconnection area are

comprised of solar, wind (in-state and offshore), battery storage, geothermal, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.9-1: PG&E Greater Bay Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	0	100	100	470	215	685	670	670	1,340
Wind – In State	688	90	778	688	90	778	698	90	788
Wind – Out-of-State	0	0	0	0	0	0	0	0	0
Wind - Offshore	0	0	0	0	0	0	0	0	0
Li Battery – 4 hr	829	0	829	879	0	879	170	0	170
Li Battery – 8 hr	212	0	212	822	0	822	1,645	0	1,645
Long Duration Energy Storage (LDES)	0	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0	0	0
Biomass/Biogas	26	0	26	26	0	26	5	0	5
Distributed Solar	40	0	40	40	0	40	69	0	69
Total	1,794	190	1,984	2,924	305	3,229	3,258	760	4,018

The resources as identified in the CPUC busbar mapping for the PG&E Greater Bay interconnection area are illustrated on the single-line diagrams in Figure F.9-1 and Figure F.9-2. No adjustments were made to the portfolios in this area to account for allocated TPD and additional in-development resources identified.

Figure F.9-1: Greater Bay Interconnection Area – Mapped 2034 Base Portfolio

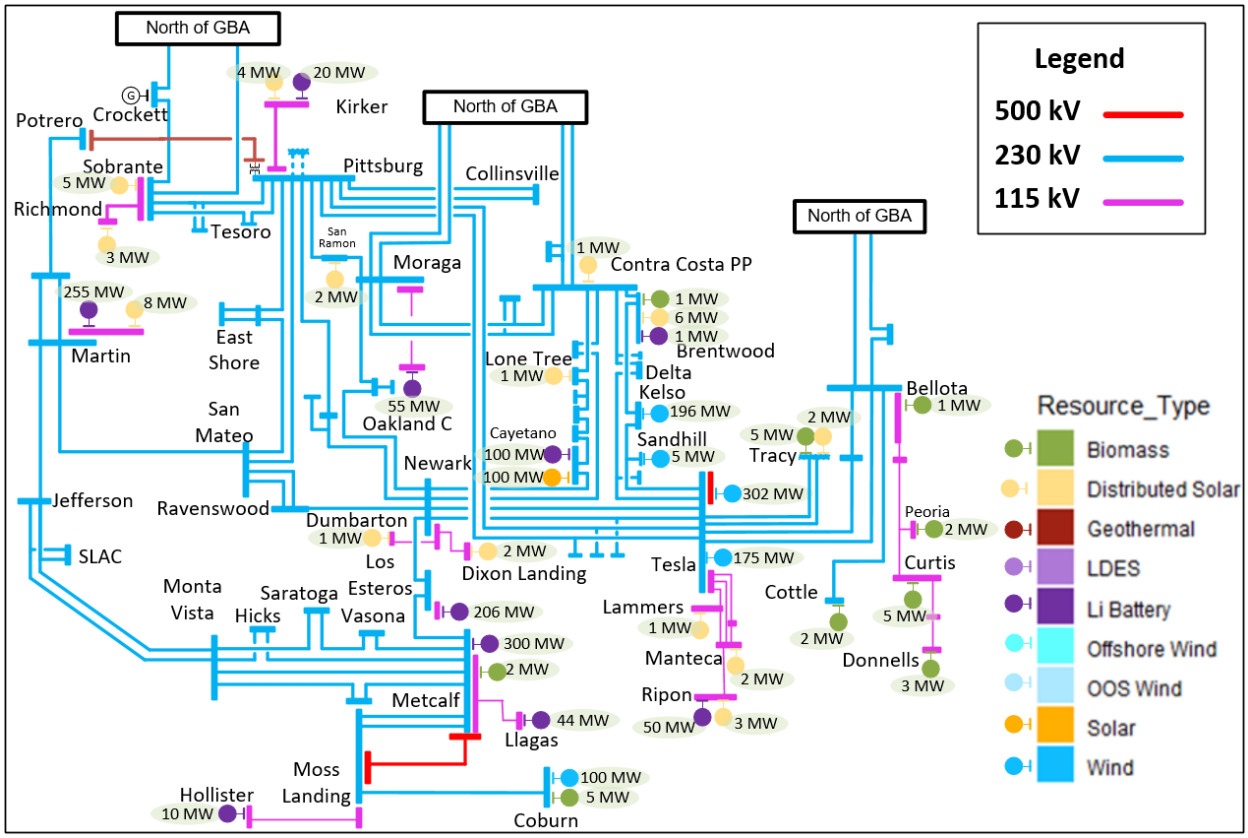
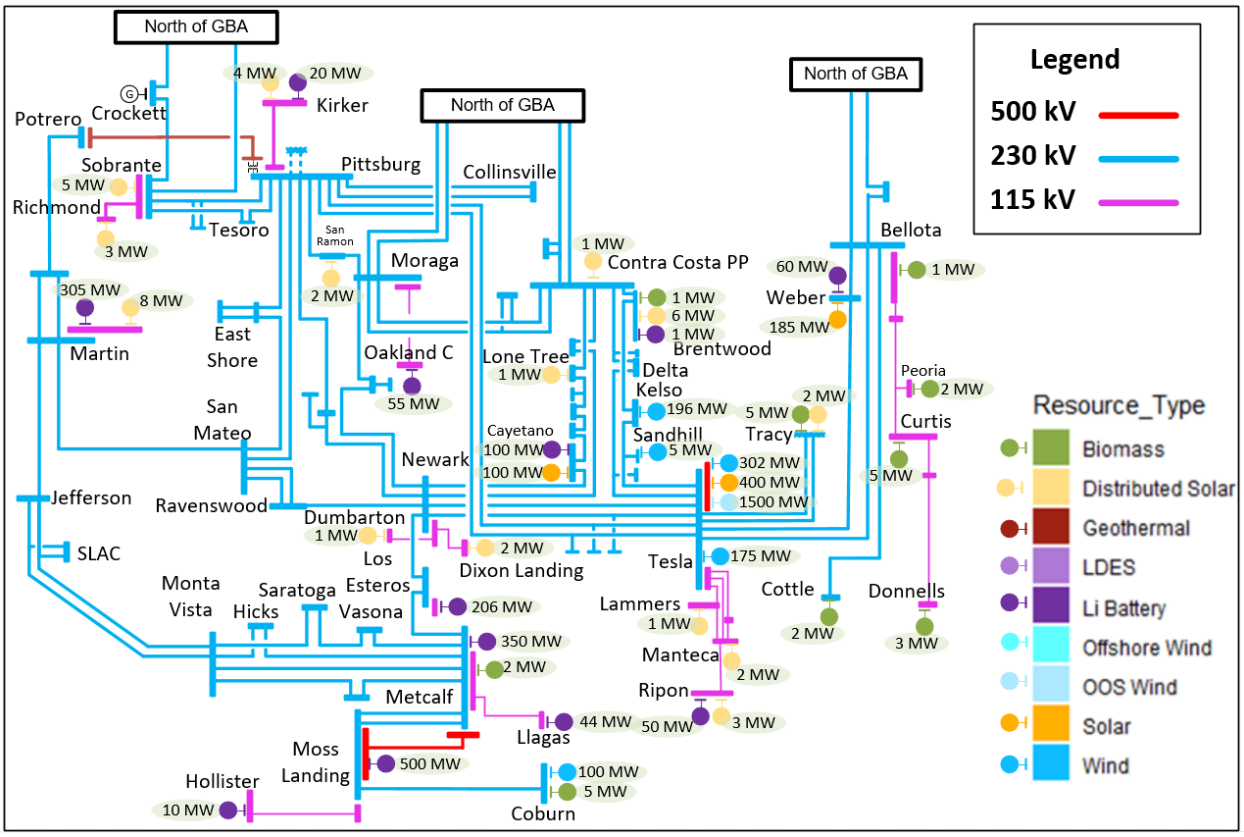


Figure F.9-2: Greater Bay Interconnection Area – Mapped 2039 Base Portfolio



With the resource mix specified in Table F.9-1 modeled in the base cases, the on-peak deliverability assessment identified the following constraints in PG&E study areas:

F.9.1 2034 On-peak results

Eastshore-San Mateo 230 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Eastshore-San Mateo 230kV Line under N-2 conditions as shown in Table F.9-2. This constraint was identified with marginal overload in baseline portfolio under HSN conditions. As shown in Table F.9-3, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. The CAISO will continue to monitor this constraint.

Table F.9-2: Eastshore-San Mateo 230 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Eastshore-San Mateo 230 kV Line	Newark-Ravenswood 230 kV and Tesla-Ravenswood 230 kV lines	HSN	100.09%	<100%

Table F.9-3: Eastshore-San Mateo 230 kV Line on-peak deliverability constraint summary

Affected transmission zones		Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		1
Portfolio battery storage behind the constraint (Installed FCDS capacity)		0
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		11
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	N/A
Recommended Mitigation		Continue to Monitor

Kifer-FMC 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Kifer-FMC 115 kV Line under N-2 conditions as shown in Table F.9-4. This constraint was identified in baseline portfolio under HSN conditions. As shown inTable F.9-5, 299 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint can be mitigated by reducing portfolio BESS.

Table F.9-4: Kifer-FMC 115 kV Line deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Kifer-FMC 115 kV Line	Newark - Los Esteros & Los Esteros - Metcalf 230 KV Lines	HSN	103.41%	<100%

Table F.9-5: Kifer-FMC 115 kV Line on-peak deliverability constraint summary

Affected transmission zones		Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		2
Portfolio battery storage behind the constraint (Installed FCDS capacity)		376
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		299
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		149
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	N/A

Recommended Mitigation	Reduce Portfolio BESS

Metcalf-El Patio No. 2 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Metcalf-El Patio No. 2 115 kV Line under N-1 conditions as shown in Table F.9-6. This constraint was identified with a marginal overload in baseline portfolio under HSN conditions. As shown in Table F.9-7, 240 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint can be mitigated by reducing portfolio BESS.

Table F.9-6: Metcalf-El Patio No. 2 115 kV Line deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Metcalf-El Patio No. 2 115 kV Line	SANJOSEBHVDC-SANJOSEB #1 115 KV [0]	HSN	100.86%	<100%

Table F.9-7: Metcalf-El Patio No. 2 115 kV Line on-peak deliverability constraint summary

Affected transmission zones		Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		0
Portfolio battery storage behind the constraint (Installed FCDS capacity)		300
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		240
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		60
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	N/A
Recommended Mitigation		Reduce Portfolio BESS

Ripon - Ripon Jct 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Ripon - Ripon Jct 115 kV Line under base case conditions as shown in Table F.9-8. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-9, 48 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint can be mitigated by reducing portfolio BESS.

Table F.9-8: Ripon - Ripon Jct 115 kV Line deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Ripon - Ripon Jct 115 kV Line	Base Case	HSN	104.98%	<100%

Table F.9-9: Ripon - Ripon Jct 115 kV Line on-peak deliverability constraint summary

Affected transmission zones		Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		3
Portfolio battery storage behind the constraint (Installed FCDS capacity)		50
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		48
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		5
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	N/A
Recommended Mitigation		Reduce Portfolio BESS

Tesla - Westley 230 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Northern California area is limited by thermal overloading of the Tesla - Westley 230 kV Line under N-1 conditions as shown in Table F.9-10. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-11, 159 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint will be addressed by the reliability project in Greater Bay Area.

Table F.9-10: Tesla - Westley 230 kV Line deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Tesla - Westley 230 kV Line	TESLA 500/230KV TB 2	HSN	106.8%	<100%

Table F.9-11: Tesla - Westley 230 kV Line on-peak deliverability constraint summary

Affected transmission zones		Greater Bay Area
Portfolio resources behind the constraint (Installed FCDS capacity)		1099
Portfolio battery storage behind the constraint (Installed FCDS capacity)		201
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		159
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		1901
Mitigation Options	RAS	N/A
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	N/A
Recommended Mitigation		Reliability project in Greater Bay Area

Table F.9-12 lists constraints identified only in the SSN scenario. These are provided for informative purposes and mitigation is not required for this scenario.

Table F.9-12: Deliverability constraints identified only in SSN scenario.

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Deliverable Portfolio MW without mitigation	Potential Mitigation
Manteca - Vierra 115 kV Lin	SCHULTE SW STA-KASSON-MANTECA 115KV [7472] & TESLA-SALADO-MANTECA 115KV [4000]	124.47%	1	0	0	Local constraint. Will be addressed in GIP
San Jose - Trimble 115 kV Line	FMC-SAN JOSE B 115KV [2021]	116.97%	2	420	0	SSN only, No mitigation required
Melones - Cottle 230 kV Line	WARNERVILLE-WILSON 230KV [5870]	112.83%	455	0	0	SSN only, No mitigation required

F.9.2 2034 Off-peak results

In the off-peak deliverability assessment of the Greater Bay interconnection there was one constraint identified for the base portfolio. The constraint observed is listed in Table F.9-13.

Table F.9-13: Greater Bay Interconnection Area Off-Peak Deliverability Constraints

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Renewable curtailment without mitigation	Potential Mitigation
Trimble - San Jose B - DG 115 kV line	FMC-SAN JOSE B 115KV	122.07	1.8	344	344	Reconductor if economic

Critical constraints identified in off peak study have been evaluated as part of the economic study. For mitigation please refer to the economic study process.

F.9.3 2039 On-peak results

El Patio-San Jose Sta. 'A' 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the El Patio-San Jose Sta. 'A' 115 kV Line under N-2 conditions as shown Table F.9-14. This constraint was identified in baseline portfolio under sensitivity conditions. As shown in Table F.9-15, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. No mitigation proposed since it's identified only in the sensitivity scenario.

Table F.9-14: El Patio-San Jose Sta. 'A' 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
El Patio-San Jose Sta. 'A' 115 kV Line	Metcalf - Evergreen#1 and #2 115 KV Lines	HSN	<100%	117.85%

Table F.9-15: El Patio-San Jose Sta. 'A' 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	0
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	470
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	683
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Sensitivity only	

Los Esteros - Nortech 115 kV line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the Los Esteros - Nortech 115 kV line under N-1 conditions as shown Table F.9-16. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-17, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. No mitigation proposed since it's identified only in the sensitivity scenario.

Table F.9-16: Los Esteros - Nortech 115 kV line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Los Esteros - Nortech 115 kV line	SSS-NRSriser SVP 230 kV path	HSN	127.22%	127.56%

Table F.9-17: Los Esteros - Nortech 115 kV line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	0
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	206
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	479
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Mitigation not needed, sensitivity only	

Manteca - Vierra 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the Manteca - Vierra 115 kV Line under N-2 conditions as shown Table F.9-18. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-19, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. This is a local constraint and will be addressed in GIP.

Table F.9-18: Manteca - Vierra 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Manteca - Vierra 115 kV Line	SCHULTE SWSTA-KASSON-MANTECA 115KV [7472] & TESLA-SALADO-MANTECA 115KV [4000]	HSN	111.98%	<100%

Table F.9-19: Manteca - Vierra 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		1	N/A
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	N/A
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0	N/A
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		186	N/A
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Local constraint. Will be addressed in GIP	N/A
Recommended Mitigation		Local constraint. Will be addressed in GIP	

Bellota - Lockford 230 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the Bellota - Lockford 230 kV Line under N-1 conditions as shown Table F.9-20. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-21, 362 MW of renewable and energy storage would be deliverable without any transmission upgrades. This is a local constraint and will be addressed in GIP.

Table F.9-20: Bellota - Lockford 230 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Bellota - Lockford 230 kV Line	LOCKEFORD-BELLOTA230KV [4990]	HSN	106.39%	133.36%

Table F.9-21: Bellota - Lockford 230 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area		
	Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)	253	244
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)	0	228
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)	0	362
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)	861	762

Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Local constraint. Will be addressed in GIP	Local constraint. Will be addressed in GIP
Recommended Mitigation		Local constraint. Will be addressed in GIP	

Newark-Northern Receiving Station #1 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the Newark-Northern Receiving Station #1 115kV Line under N-2 conditions as shown Table F.9-22. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-23, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. No mitigation proposed since it's identified only in the sensitivity scenario.

Table F.9-22: Newark-Northern Receiving Station #1 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
Newark-Northern Receiving Station #1 115kV Line	Newark - Los Esteros & Los Esteros - Metcalf 230 KV Lines	HSN	<100%	103.41%

Table F.9-23: Newark-Northern Receiving Station #1 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	1
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	0
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	115
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Sensitivity only	

San Jose Sta 'A'-'B' 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Bay area is limited by thermal overloading of the San Jose Sta 'A'-'B' 115 kV Line under N-2 conditions as shown Table F.9-24. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.9-25, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. No mitigation proposed since it's identified only in the sensitivity scenario.

Table F.9-24: San Jose Sta 'A'-'B' 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			Base	Sensitivity
San Jose Sta 'A'-'B' 115 kV Line	Metcalf - Evergreen#1 and #2 115 KV Lines	HSN	<100%	116.69%

Table F.9-25: San Jose Sta 'A'-'B' 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Greater Bay Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	0
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	470
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	560
Mitigation Options	RAS	N/A	N/A
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Sensitivity only	

F.9.4 Conclusion and recommendation

The PGE Greater Bay area base and sensitivity portfolio deliverability assessment identified on-peak and off-peak deliverability constraints. These constraints are provided for informative purposes and do not require mitigation. These constraints will be mitigated through the GIP track or through projects that are already approved. No new mitigation is identified.

F.10PG&E Greater Fresno Interconnection Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the PG&E Greater Fresno

interconnection area are listed in Table F.10-1. The portfolios are comprised of solar, wind (in-state), battery storage, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.10-1: PG&E Greater Fresno Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	2,636	869	3,505	3,027	3,404	6,430	5,338	5,823	11,160
Wind – In State	394	96	490	394	96	490	360	40	400
Wind – Out-of-State	0	0	0	0	0	0	0	0	0
Wind - Offshore	0	0	0	0	0	0	0	0	0
Li Battery – 4 hr	1,554	0	1,554	1,669	0	1,669	1,455	0	1,455
Li Battery – 8 hr	200	0	200	1,607	0	1,607	2,780	0	2,780
Long Duration Energy Storage (LDES)	130	0	130	130	0	130	131	0	131
Geothermal	0	0	0	0	0	0	0	0	0
Biomass/Biogas	20	0	20	20	0	20	3	0	3
Distributed Solar	66	0	66	66	0	66	68	0	68
Total	**5,001**	**965**	**5,966**	**6,913**	**3,500**	**10,412**	**10,134**	**5,863**	**15,997**

The resources as identified in the CPUC busbar mapping for the PG&E Greater Fresno interconnection area are illustrated on the single-line diagrams in Figure F.10-1 and F.10-2. No adjustments were made to the portfolios in this area to account for allocated TPD and additional in-development resources identified.

Figure F.10-1: PG&E Greater Fresno Interconnection Area – Mapped 2034 Base Portfolio

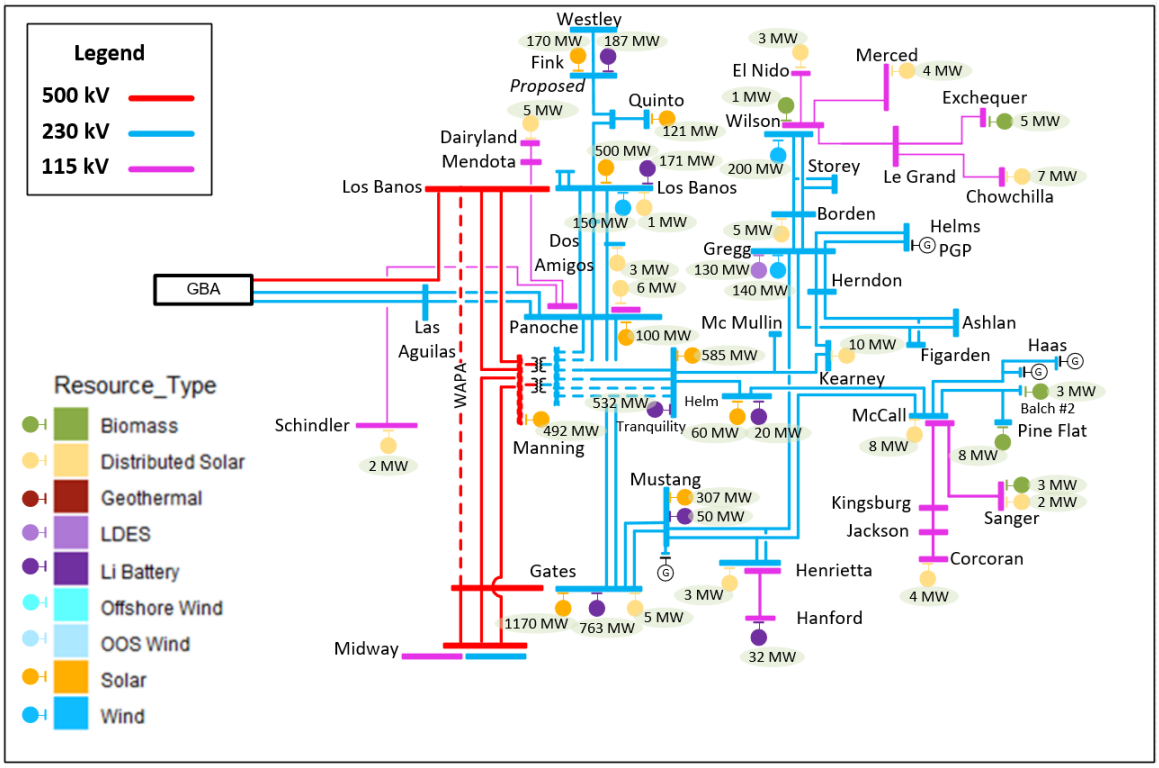
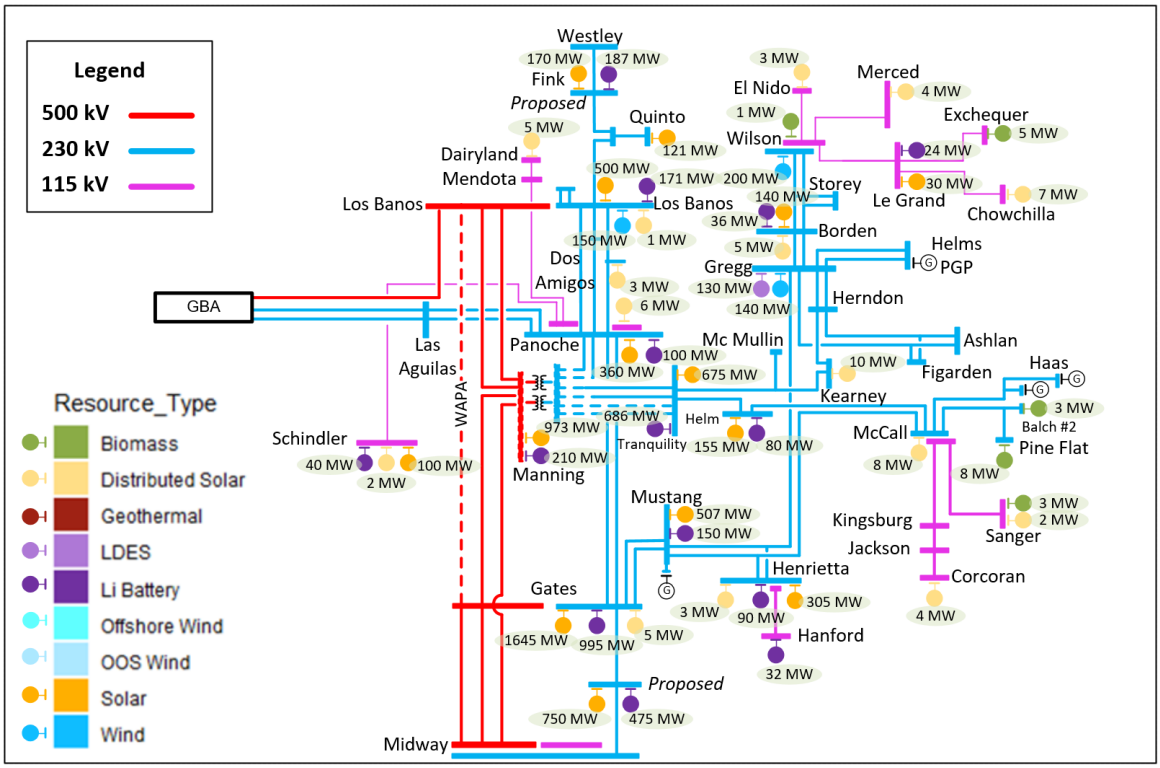


Figure F.10-2: PG&E Greater Fresno Interconnection Area – Mapped 2039 Base Portfolio



F.10.1 2034 On-peak results

GWF-Kingsburg 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Greater Fresno area is limited by thermal overloading of the GWF-Kingsburg 115 kV Line under N-2 conditions as shown in Table F.10-2. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-3, 314 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint would be mitigated by reconductoring the GWF-Kingsburg 115 kV Line.

Table F.10-2: GWF-Kingsburg 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
GWF-Kingsburg 115 kV Line	HELM-MCCALL 230KV & HENTAP2-MUSTANGSS #1 230KV	HSN	122.18%	<100%

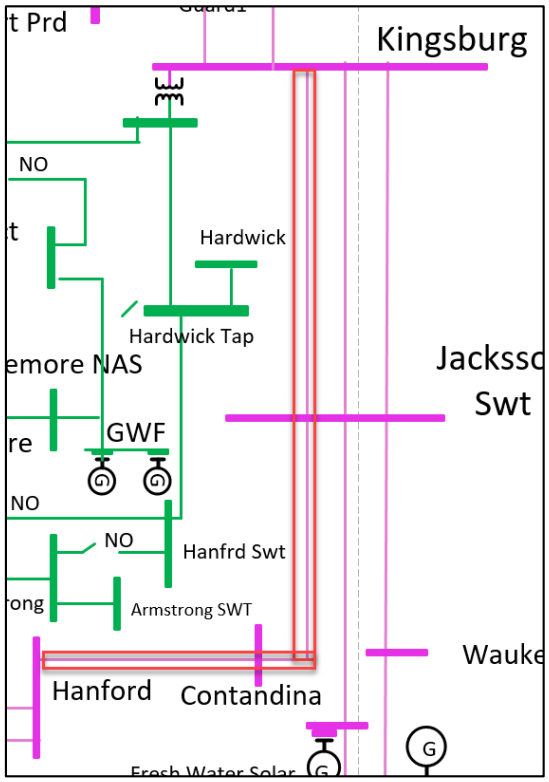
Table F.10-3: GWF-Kingsburg 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area		
		Base
Generic Portfolio MW behind the constraint (installed FCDS capacity)		314
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		32
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		314
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		127
Mitigation Options	RAS	N/A
	Re-locate generic portfolio battery storage (MW)	N/A
	Transmission upgrade including cost	Reconductor ($81.6M)
Recommended Mitigation		Reconductor

Reconductor of GWF – Kingsburg 115 kV line

To mitigate overloads identified in the on-peak baseline deliverability study, the ISO is recommending for approval the reconductor of the GWF – Kingsburg 115kV line. The Project will cost $81.6M, with an estimated time to construct of 36 months. The scope includes Reconductor the entire GWF-Kingsburg 115 kV Line with minimum summer emergency rating of 1500 Amps or higher and update the limiting components at the substations if there is any.

Figure F.10-3: Reconductor of GWF-Kingsburg 115 kV Line



Herndon-Woodward 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the Herndon-Woodward 115 kV Line under N-2 conditions as shown in Table F.10-4. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-5, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. This is a local constraint and will be addressed in GIP.

Table F.10-4: Herndon-Woodward 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Herndon-Woodward 115 kV Line	HERNDON-BARTON 115KV & HERNDON-MANCHESTER 115KV	HSN	120.15%	<100%

Table F.10-5: Herndon-Woodward 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area	
	Base

Generic Portfolio MW behind the constraint (installed FCDS capacity)		240
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		566
Mitigation Options	RAS	N/A
	Re-locate generic portfolio battery storage (MW)	N/A
	Transmission upgrade including cost	N/A
Recommended Mitigation		Local constraint, will be addressed in GIP

McCall-Sanger #3 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the McCall-Sanger #3 115 kV Line under N-2 conditions as shown Table F.10-6. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-7, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades.this is a local constraint and will be addressed in GIP.

Table F.10-6: McCall-Sanger #3 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
McCall-Sanger #3 115 kV Line	MCCALL-SANGER #1 115KV & MCCALL-SANGER #2 115KV	HSN	113.11%	<100%

Table F.10-7: McCall-Sanger #3 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area		
		Base
Generic Portfolio MW behind the constraint (installed FCDS capacity)		21
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		32
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		316
Mitigation Options	RAS	N/A
	Re-locate generic portfolio battery storage (MW)	N/A
	Transmission upgrade including cost	N/A

Recommended Mitigation	constraint meets LDNU criteria and will be addressed in GIP

Helm-Crescent 70 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the Helm-Crescent 70 kV Line under N-1 conditions as shown Table F.10-8. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-9, 184 MW of renewable and energy storage would be deliverable without any transmission upgrades. The constraint would be mitigated by installing a new Helm 230/70kV Bank #2.

Table F.10-8: Helm-Crescent 70 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	SSN
Helm-Crescent 70 kV Line	HELM 230/70KV TB 1	HSN	280.2%	511.12%

Table F.10-9: Helm-Crescent 70 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area		
		Base
Generic Portfolio MW behind the constraint (installed FCDS capacity)		200
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		81
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		184
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		97
Mitigation Options	RAS	N/A
	Re-locate generic portfolio battery storage (MW)	N/A
	Transmission upgrade including cost	Install new Helm 230/70kV Bank #2 ($115M)
Recommended Mitigation		Install new Helm 230/70kV Bank #2

New Helm 230/70 kV Bank #2

To mitigate overloads identified in the on-peak baseline deliverability study, the ISO is recommending for approval the addition of a new 230/70 kV bank at Helm. The Project will cost $115M, with an estimated time to construct of 48-60 months. The scope includes a new 230/70

kV Bank at Helm Substation with a 200 MVA rating. It will also include any bus upgrades and limiting equipment upgrades to achieve this transformer rating.

Figure F.10-4: New Helm 230/70 kV Bank #2

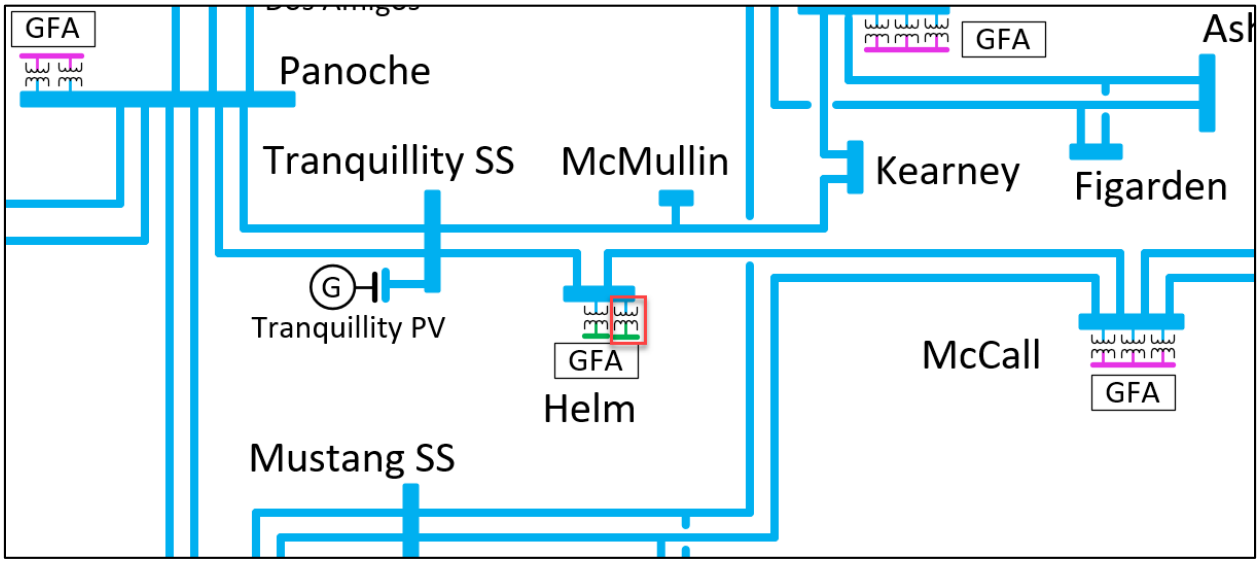


Table F.10-10 lists constraints identified only in the SSN scenario. These are provided for informative purposes and mitigation is not required for this scenario.

Table F.10-10: Deliverability constraints identified only in SSN scenario.

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Deliverable portfolio MW without mitigation	Potential Mitigation
Helm 230/70 kV Transformer #1	CRESCENTSS-SCHLNDLR #1 70KV [0]	119.87%	200	81	220	SSN Only, No Mitigation Required
Panoche-Schindler #2 115 kV Line	HELM 230/70KV TB 1	101.52%	202	81	182	SSN Only, No Mitigation Required
Schindler - Paiges SLR JCT 70kV Line	HELM 230/70KV TB 1	112.66%	202	81	162	SSN Only, No Mitigation Required
Schindler 115/70 kV Transformer #1	HELM 230/70KV TB 1	131.39%	200	91	166	SSN Only, No Mitigation Required
Schindler-Coalinga #2 70 kV Line	HELM 230/70KV TB 1	110.64%	202	81	168	SSN Only, No Mitigation Required

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Deliverable portfolio MW without mitigation	Potential Mitigation
Schindler-Huron-Gates 70 kV Line	HELM 230/70KV TB 1	113.61%	202	81	190	SSN Only, No Mitigation Required
Warnerville - Wilson 230 kV Line	COTTLE-MELONES 230KV [4530]	151.31%	789	102	300	SSN Only, No Mitigation Required
Wilson- Borden -Storey 230 kV Line	WILSON-BORDEN #1 230KV [5890]	108.79%	596	82	300	SSN Only, No Mitigation Required

F.10.2 2034 Off-peak results

The off-peak deliverability constraints identified in the base portfolio assessment of the Greater Fresno interconnection areas, along with the recommended mitigation plans, are identified in Table F.10-11.

Table F.10-11: PG&E Greater Fresno Interconnection Area Off-Peak Deliverability Constraints

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Renewable curtailment without mitigation	Potential Mitigation
BARTON-AIRWAYS-SANGER 115kV Line	P7-1:A14:26:_HENTAP1-MUSTANGSS #1 230KV [0] & TRANQLTYSS-MCMULLN1 #1 230KV [0]	106.82	23	0	0	Reconductor if economic
Chowchilla-Kerckhoff 115kV Line	P7-1:A13:1:_WILSON-BORDEN 230KV #1 & #2 [9001]	149.78	2	0	0	Reconductor if economic
Crescent Switching Station - Schindler 70kV Line	P12:A13:22:_TRANQUILLITY SW STA-HELM 230KV [5370]	167.58	371	101	68	68 MW Portfolio Battery dispatched in charging mode
Fink Switching Station - Westley 230kV Line	P1-2:A13:4:_QUINTO SW STA-WESTLEY 230KV [5070]	123.55	985	201	201	Reconductor if economic
Fivepoint SSS - Calflax #1 70kV Line	P1-3:A14:28:_HELM 230/70KV TB 1	144.6	350	81	49	49 MW Portfolio Battery dispatched in charging mode
Gates - Huron - Calflax 70 kV Line	P1-3:A14:28:_HELM 230/70KV TB 1	154.31	350	81	58	58 MW Portfolio Battery dispatched in charging mode
Gates-Panoche #1 230kV Line	P1-2:A0:23:_GATES-MANNING 500KV [0]	149.18	858	116	116	Reconductor if economic
Gates-Panoche #2 230kV Line	P1-2:A0:23:_GATES-MANNING 500KV [0]	158.49	858	116	116	Reconductor if economic
GWF - Kingsburg 115kV Line	P7-1:A14:17:_HELM-MCCALL 230KV [4860] &	126.15	14	33	33	Reconductor if economic

	HENTAP2-MUSTANGSS #1 230KV [0]					
Helm 230/70KV TB 1	P7-1:A14:10:_PANOCHE-SCHINDLER #1 115KV [3250] & EXCELSIORSS-PANOCHE2 115KV [3231]	152.25	350	91	91	Reconductor if economic
Le Grand - Dairyland 115kV Line	P7-1:A13:13:_BORDEN-GREGG 230KV #1 & #2 [4400]	111.57	5	0	0	Reconductor if economic
Los Banos - Manning #1 500kV Line	P1-2:A0:16:_LOSBANOS-MANNING 500KV [0] (2)	158.53	492	0	0	Reconductor if economic
Los Banos - Manning #2 500kV Line	P1-2:A0:15:_LOSBANOS-MANNING 500KV [0]	158.53	492	0	0	Reconductor if economic
Los Banos - Panoche #2 230kV Line	P1-3:A0:15:_LOSBANOS 500/230KV TB 1	125.32	108	0	0	Reconductor if economic
Los Banos-Quinto Switching Station 230kV Line	P1-2:A0:11:_TESLA-LOS BANOS #1 500KV [6100]	173.06	836	171	171	Reconductor if economic
Manning - Gates 500kV Line	Base Case	135.84	3783	307	307	Reconductor if economic
Mc Call - Sanger #3 115kV Line	P7-1:A14:26:_HENTAP1-MUSTANGSS #1 230KV [0] & TRANQLTYSS-MCMULLN1 #1 230KV [0]	115.27	21	0	0	Reconductor if economic
Melones - Wilson 230kV Line	P12:A13:3:_WARNERVILLE-WILSON 230KV [5870]	124.14	519	0	0	Reconductor if economic
Moss Landing-Las Aguilas Switching Station 230kV Line	P1-2:A0:13:_MOSS LANDING-LOS BANOS 500KV [6040]	144.61	100	0	0	Reconductor if economic
Panoche - Excelsior Switching Station #2 115kV Line	P1-3:A14:28:_HELM 230/70KV TB 1	124.02	350	81	33	33 MW Portfolio Battery dispatched in charging mode
Panoche-Schindler #1 115 kV Line	P1-3:A14:28:_HELM 230/70KV TB 1	123.35	431	81	56	56 MW Portfolio Battery dispatched in charging mode
Quinto Switching Station - Fink Switching Station 230kV Line	P1-2:A13:4:_QUINTO SW STA-WESTLEY 230KV [5070]	117.19	985	201	201	Reconductor if economic
Quinto Switching Station-Westley 230kV Line	P1-2:A13:1:_FINKSWSTA-WESTLEY #1 230KV [0]	123.24	985	201	201	Reconductor if economic
Schindler 115/70 kV Transformer #1	P1-3:A14:28:_HELM 230/70KV TB 1	214.23	348	90	90	Reconductor if economic
Schindler-Coalinga #2 70 kV Line	P1-3:A14:28:_HELM 230/70KV TB 1	123.84	350	81	21	21 MW Portfolio Battery dispatched in charging mode
Warnerville - Wilson 230 kV Line	P1-2:A12:2:_COTTLE-MELONES 230KV [4530]	220.06	554	83	83	Reconductor if economic
Wilson - Borden #1 230kV Line	P1-2:A13:27:_WILSON-BORDEN #2 230KV [9001]	178.29	332	83	83	Reconductor if economic
Wilson - Borden #2 230kV Line	P1-2:A13:26:_WILSON-BORDEN #1 230KV [5890]	154.45	332	83	83	Reconductor if economic
Wilson-Le Grand 115 kV Line	P7-1:A13:1:_WILSON-BORDEN 230KV #1 & #2 [9001]	105.41	17	0	0	Reconductor if economic
Wilson-Oro Loma 115 kV Line	P7-1:A13:13:_BORDEN-GREGG 230KV #1 & #2 [4400]	186.31	0.8	0	0	Reconductor if economic

Critical constraints identified in off peak study have been evaluated as part of the economic study. For mitigation please refer to the economic study process.

F.10.3 2039 On-peak results

McCall-Sanger #1 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the McCall-Sanger #1 115 kV Line under N-2 conditions as shown Table F.10-12. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-13, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. This is a local constraint and will be addressed in GIP.

Table F.10-12: McCall-Sanger #1 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	Sensitivity
McCall-Sanger #1 115 kV Line	MCCALL-REEDLEY 115KV [2320] & MCCALL-SANGER #3 115KV [2350]	HSN	104.58%	107.65%

Table F.10-13: McCall-Sanger #1 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		21	10
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	32
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		163	146
Mitigation Options	RAS	N/A	N/A
	Re-locate generic portfolio battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Local constraint. Will be addressed in GIP	

McCall-Sanger #2 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the McCall-Sanger #2 115 kV Line under N-2 conditions as shown Table F.10-14. This constraint was identified in baseline portfolio under HSN conditions. As shown in Table F.10-15, 0 MW of renewable and energy storage would be deliverable without any transmission upgrades. This is a local constraint and will be addressed in GIP.

Table F.10-14: McCall-Sanger #2 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading

			HSN	Sensitivity
McCall-Sanger #2 115 kV Line	MCCALL-REEDLEY 115KV [2320] & MCCALL-SANGER #3 115KV [2350]	HSN	118.1%	121.56%

Table F.10-15: McCall-Sanger #2 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area			
		Base	**Sensitivity**
Generic Portfolio MW behind the constraint (installed FCDS capacity)		21	10
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		0	32
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		0	0
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		163	146
Mitigation Options	RAS	N/A	N/A
	Re-locate generic portfolio battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	N/A	N/A
Recommended Mitigation		Local constraint. Will be addressed in GIP	

Corcoran-Smyrna (Alpaugh-Smyrna) 115 kV Line on-peak deliverability constraint

The deliverability of renewable portfolio resources in the Fresno area is limited by thermal overloading of the Corcoran-Smyrna (Alpaugh-Smyrna) 115 kV Line under base case condition as shown Table F.10-16. This constraint was identified in sensitivity portfolio under HSN conditions. As shown in Table F.10-17, 34 MW of renewable and energy storage would be deliverable without any transmission upgrades. No mitigationproposed since it is only observed in the sensitivity scenario.

Table F.10-16: Corcoran-Smyrna (Alpaugh-Smyrna) 115 kV Line on-peak deliverability constraint

Overloaded Facility	Contingency	Scenario	Loading	
			HSN	Sensitivity
Corcoran-Smyrna (Alpaugh-Smyrna) 115 kV Line	Base Case	HSN	<100%	112.27%

Table F.10-17: Corcoran-Smyrna (Alpaugh-Smyrna) 115 kV Line on-peak deliverability constraint summary

Affected transmission zones: PG&E Fresno Area	

		Base	Sensitivity
Generic Portfolio MW behind the constraint (installed FCDS capacity)		N/A	24
Generic Battery storage portfolio MW behind the constraint (installed FCDS capacity)		N/A	10
Deliverable Generic Portfolio MW w/o mitigation (Installed FCDS capacity)		N/A	34
Total undeliverable baseline and portfolio MW (Installed FCDS capacity)		N/A	0
Mitigation Options	N/A	N/A	N/A
	N/A	N/A	N/A
	N/A	N/A	N/A
Recommended Mitigation		Sensitivity only, no mitigation required	

F.10.4 Conclusion and recommendation

The PGE Greater Fresno area base and sensitivity portfolios deliverability assessment identified on-peak and off-peak deliverability constraints. The GWF-Kingsburg 115 kV line constraint is identified in 2034 on-peak scenario and the CAISO recommends reconductoring the line as mitigation. The CAISO also recommends installing a second 230/70kV transformer bank at Helm substation to mitigate the Helm-Crescent 70kV line constraint.

F.11 PG&E East Kern Interconnection Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the PG&E East Kern interconnection area are listed in Table F.11-1. The portfolios in the interconnect area are comprised of solar, wind (in-state and offshore), battery storage, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.11-1: PG&E East Kern Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	680	1,301	1,981	1,036	2,061	3,096	2,029	2,762	4,791
Wind – In State	300	10	310	300	10	310	190	10	200
Wind – Out-of-State	0	0	0	0	0	0	0	0	0
Wind - Offshore	2,924	0	2,924	2,924	0	2,924	0	0	0
Li Battery – 4 hr	777	0	777	777	0	777	186	0	186
Li Battery – 8 hr	142	0	142	682	0	682	1,217	0	1,217
Long Duration Energy Storage (LDES)	0	0	0	0	0	0	400	0	400
Geothermal	0	0	0	0	0	0	0	0	0
Biomass/Biogas	18	0	18	18	0	18	0	0	0

Distributed Solar	73	0	73	73	0	73	79	0	79
Total	**4,913**	**1,311**	**6,224**	**5,809**	**2,071**	**7,879**	**4,101**	**2,772**	**6,873**

The resources as identified in the CPUC busbar mapping for the PG&E East Kern interconnection area are illustrated on the single-line diagrams in Figure F.11-1 and Figure F.11-2. No adjustments were made to the portfolios in this area to account for allocated TPD and additional in-development resources identified.

Figure F.11-1: PG&E East Kern Interconnection Area – Mapped 2034 Base Portfolio

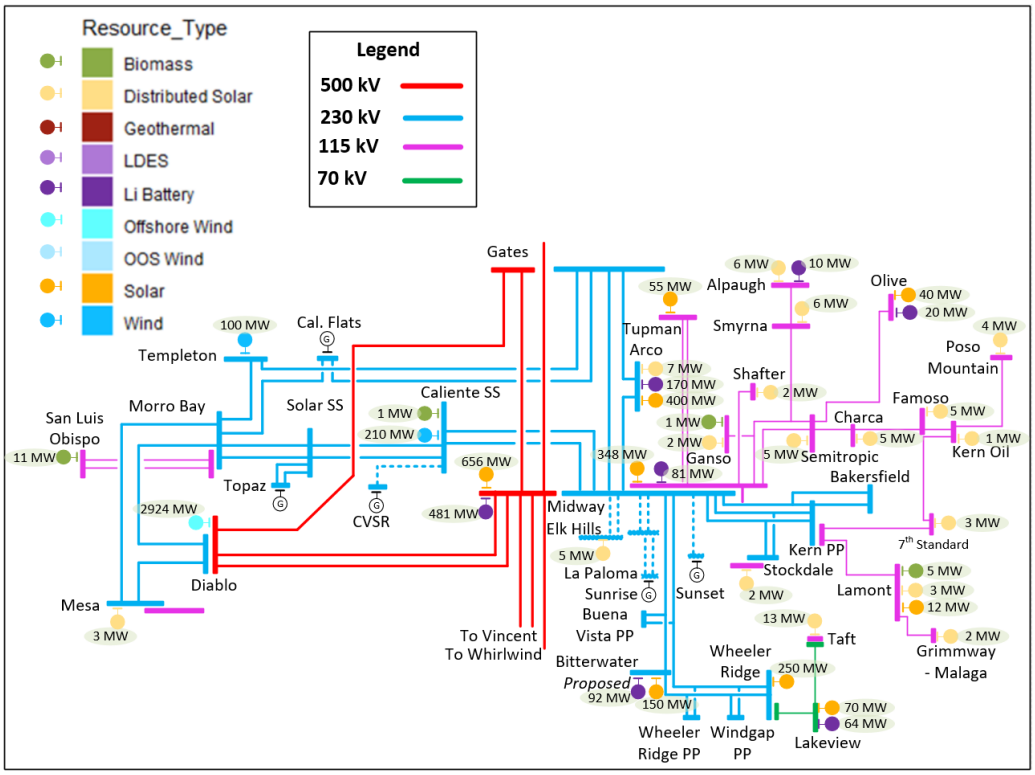
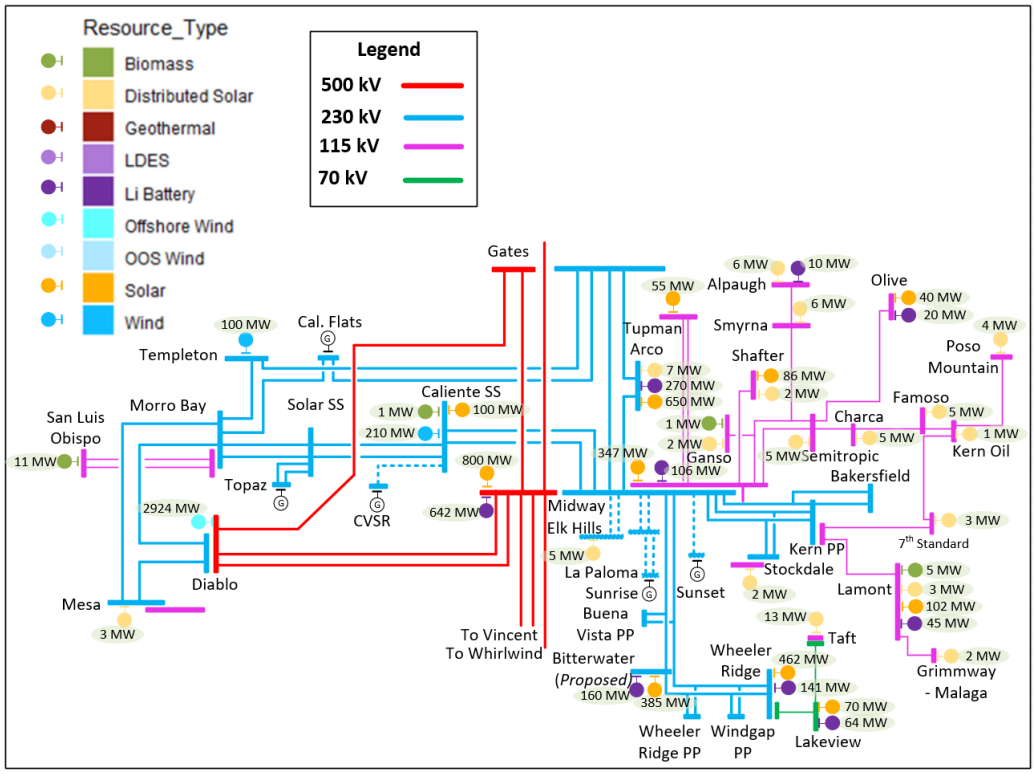


Figure F.11-2: PG&E East Kern Interconnection Area – Mapped 2039 Base Portfolio



F.11.1 2034 On-peak results

There were no constraints observed in 2034 HSN on-peak scenario. Table F.11-2 lists constraints identified only in the SSN scenario. These are provided for informative purposes and mitigation is not required for this scenario.

Table F.11-2: Deliverability constraints identified only in SSN scenario

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Deliverable Portfolio MW without mitigation	Potential Mitigation
Copus-Old River 70 kV Line	MIDWAY-KERN #4 & KERN-BAKERSFIELD & MIDWAY-KERN #3 LINES	103.24%	13	0	0	SSN Only, No Mitigation Required
Oceano-Callender Sw. Sta 115 kV Line	MORROBAY 230/115KV TB 6	108.98%	189	110	29	SSN Only, No Mitigation Required
South Kern Jct - San Emidio 70 kV Line	MIDWAY-KERN #4 & KERN-BAKERSFIELD & MIDWAY-KERN #3 LINES	103.45%	13	0	0	SSN Only, No Mitigation Required

F.11.2 2034 Off-peak results

The off-peak deliverability constraints identified in the base portfolio assessment of the Kern interconnection area, along with the recommended mitigation plans, are identified in Table F.11-3.

Table F.11-3: PG&E Greater Kern Interconnection Area Off-Peak Deliverability Constraints

Constraint	Contingency	Loading	Renewable Portfolio MW behind Constraint	Energy Storage Portfolio MW behind Constraint	Renewable curtailment without mitigation	Potential Mitigation
Callendar Switching Station - Mesa 115kV Line	P7-1:A20:16:_Morro Bay-Mesa and Morro Bay-Diablo 230 kV Lines	271.12	503.2	115.92	105.92	Reconductor if economic
San Miguel - UnionPGAE 70kV Line	P7-1:A14:14:_TEMPLETON-GATES 230KV [5934] & GATES-CALFLATSSS #1 230KV [0]	114.38	614.2	115.92	104	104 MW Portfolio Battery dispatched in charging mode

Critical constraints identified in off peak study have been evaluated as part of the economic study. For mitigation please refer to the economic study process.

F.11.3 2039 On-peak results

There were no constraints observed in the 2039 on-peak scenario.

F.11.4 Conclusion and recommendation

The PGE Kern area base portfolio deliverability assessment identified on-peak (SSN scenario only) and off-peak deliverability constraints. These constraints are provided for informative purposes and do not require mitigation.

F.12 East of Pisgah area

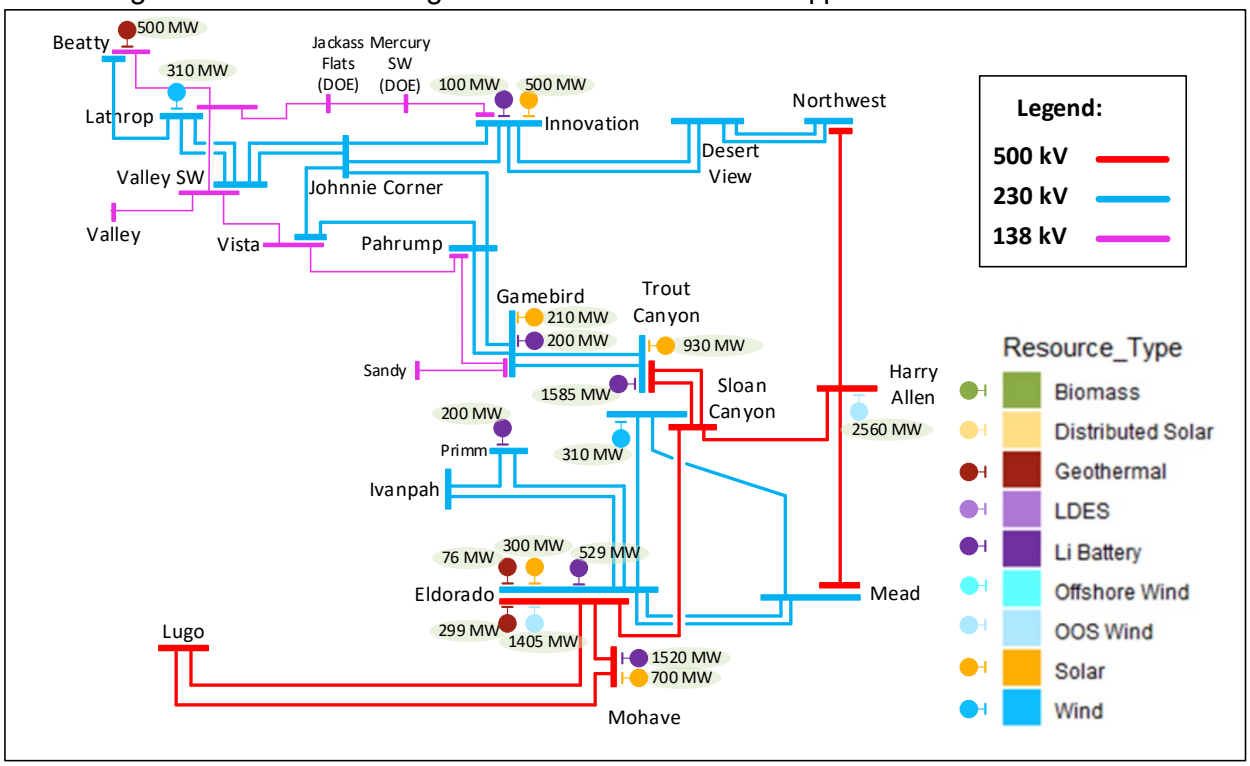
The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the East of Pisgah interconnection area are listed in Table F.12-1. The portfolios in the interconnection area are comprised of solar, wind (in-state and out-of-state), battery storage and geothermal resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.12-1: East of Pisgah Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	1,075	1,565	**2,640**	1,200	3,030	**4,230**	2,425	3,855	**6,280**
Wind – In State	620	0	**620**	620	0	**620**	620	0	**620**
Wind – Out-of-State	3,965	0	**3,965**	4,060	0	**4,060**	4,060	0	**4,060**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	3,954	0	**3,954**	3,735	0	**3,735**	2,839	0	**2,839**
Li Battery – 8 hr	180	0	**180**	696	0	**696**	1,769	0	**1,769**
Long Duration Energy Storage (LDES)	0	0	**0**	0	0	**0**	0	0	**0**
Geothermal	875	0	**875**	875	0	**875**	1,315	0	**1,315**
Biomass/Biogas	0	0	**0**	0	0	**0**	0	0	**0**
Distributed Solar	0	0	**0**	0	0	**0**	0	0	**0**
Total	**10,669**	**1,565**	**12,234**	**11,186**	**3,030**	**14,216**	**13,028**	**3,855**	**16,883**

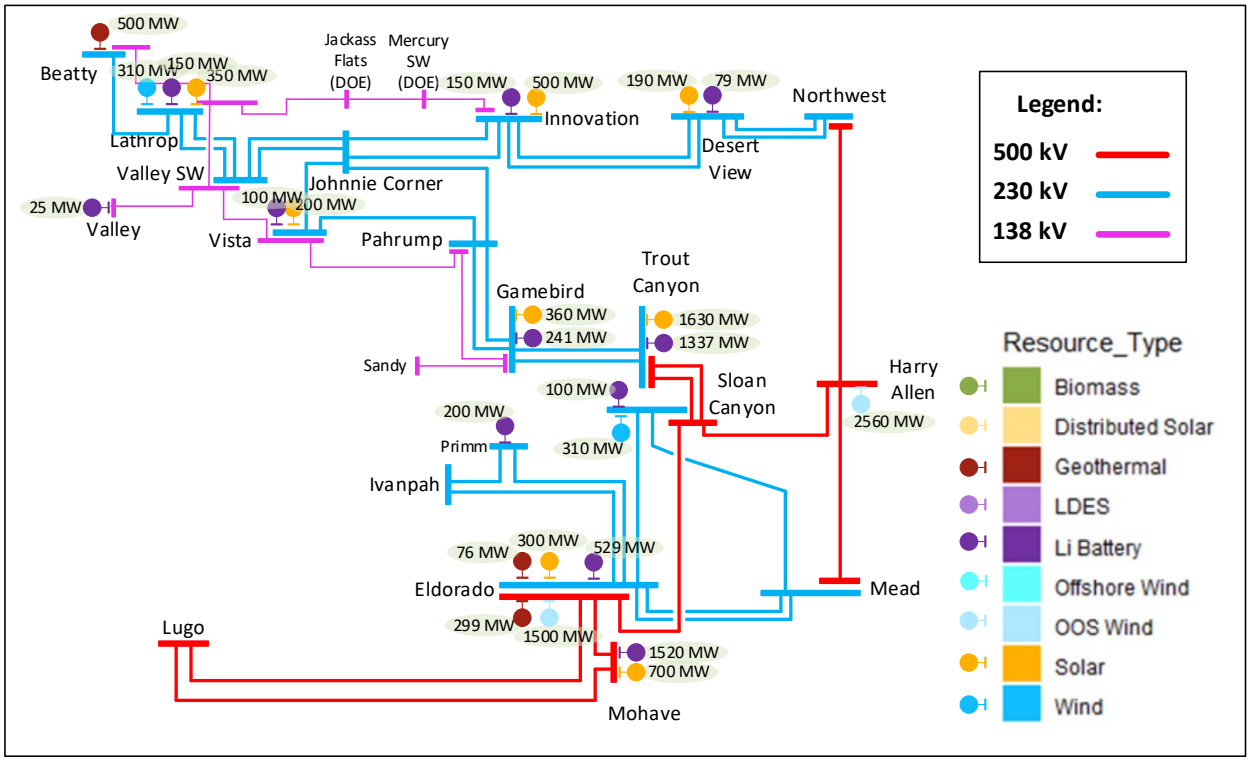
The resources as identified in the CPUC busbar mapping for the East of Pisgah interconnection area are illustrated on the single-line diagram in Figure F.12-1 and Figure F.12-2.

Figure F.12-1: East of Pisgah Interconnection Area – Mapped[16] 2034 Base Portfolio



[16] Mapped base portfolio includes the adjustments to the base portfolio made by CPUC staff in the East of Pisgah Interconnection Area to account for allocated TPD and additional in-development resources identified.

Figure 12-2: East of Pisgah Interconnection Area – Mapped[17] 2039 Base Portfolio



F.12.1 2034 On-peak results

GLW-VEA Area Constraint

The deliverability of full capacity portfolio resources in the VEA and GLW area is limited by thermal overloading of multiple 138 kV lines following Category P7 contingencies as shown in Table F.12-2. This constraint was identified in base portfolio under HSN and SSN conditions. As shown in Table F.12-3, 3,460 MW of renewable and energy storage resources are behind the constraint and 1,892 MW would be undeliverable.

Table F.12-2: VEA-GLW 2034 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Gamebird 230/138kV transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	152	151
Gamebird – Sandy 138kV line		127	138
Sandy – Amargosa 138kV line		146	159
Amargosa 230/138kV transformer		111	121

[17] Mapped base portfolio includes the adjustments to the base portfolio made by CPUC staff in the East of Pisgah Interconnection Area to account for allocated TPD and additional in-development resources identified.

Innovation PST – IS Tap – Northwest 138kV tie line		140	147
Innovation PST – Is Tap 138kV line	Innovation – Desert View 230kV Nos.1&2 lines	101	109
	Desert View – Northwest 230kV Nos.1&2 lines	101	109

Table F.12-3: VEA-GLW 2034 on-peak constraint summary

Affected transmission zones		GLW and VEA area
Portfolio resources behind the constraint (Installed FCDS capacity)		3,460 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1,700 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		1,568 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		1,892 MW
Mitigation Options	RAS	RAS identified in GIP and reduce generic battery storage in the area
	Reduce generic battery storage (MW)	
	Transmission upgrade including cost	Trout Canyon – Lugo 500 kV line ($2 B)
Recommended Mitigation		TBD

The constraint can be mitigated by the future Trout Canyon RAS as proposed in the GIDAP process along with reducing battery storage in the area. The new Trout Canyon – Lugo 500 kV line would also mitigate all the overloads identified. But the need for Trout Canyon – Lugo 500 kV line will also be coordinated with the transmission upgrade to accommodate the out-of-state wind portfolio. As will be discussed later, the recommended mitigation at this time remains TBD.

Eldorado - McCullough 500 kV Constraint

The deliverability of full capacity portfolio resources of in the East of Pisgah area and the deliverability of out-of-state wind resources is limited by thermal overloading of Eldorado - McCullough 500 kV line following Category P1 contingencies as shown in Table F.12-4. This constraint was identified in base portfolio under both HSN and SSN conditions with HSN more limiting. As shown in Table F.12-5, 10,480 MW of renewable and energy storage resources are behind the constraint and 2,759 MW would be undeliverable. MIC expanstion request on the MEAD_ITC intertie is behind this constraint and the 114 MW MIC expansion request is undeliverable. A few alternatives were evaluated to mitigate the constraint. The final mitigation plan will be coordinated with Eldorado 500 kV SCD mitigation and the transmission upgrade to accommodate the out-of-state wind portfolio.

Table F.12-4: Eldorado - McCullough 500 kV 2034 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Eldorado – McCullough 500 kV line	Eldorado – Lugo 500 kV line	143	122
	Lugo – Mohave 500 kV line	134	118
	Harry Allen – Mead 500 kV line	109	103
	Eldorado – Mohave 500 kV line	104	<100

Table F.12-5: Eldorado - McCullough 500 kV 2034 on-peak constraint summary

Affected transmission zones		East of Pisgah, Out-of-state Wind
Portfolio resources behind the constraint (Installed FCDS capacity)		10,480 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		4,070 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		7,721 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		2,759 MW
Mitigation Options	RAS	Not applicable
	Reduce generic battery storage (MW)	Not sufficient
	Transmission upgrade including cost	1. 10 Ohms series reactor on Eldorado – McCullough line 2. Trout Canyon – Lugo 500kV line ($2B) 3. Marketplace-Adelanto AC-DC Conversion 4. Western Bounty HVDC
Recommended Mitigation		TBD

Lugo – Victorville 500 kV Constraint

The deliverability of full capacity portfolio resources of in the East of Pisgah, SCE Eastern, SCE Northern and SDG&E areas and the deliverability of out-of-state wind resoruces is limited by thermal overloading of Lugo – Victorville 500 kV lines following Category P1 contingency as shown in Table F.12-6. This constraint was identified in base portfolio under HSN condition. As shown in Table F.12-7, 14,178 MW of renewable and energy storage resources are behind the constraint and 184 MW would be undeliverable. MIC expansion request on the MEAD_ITC and BLYTHE_ITC interties are behind this constraint and the 282 MW MIC expansion request is deliverable taken into account the existing RAS operation. The constraint can be mitigated by utilizing the existing Lugo – Victorville RAS.

Table F.12-6: Lugo - Victorville 500 kV 2034 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Lugo – Victorville 500 kV line	Eldorado – Lugo 500 kV line	102	<100

Table F.12-7: Lugo – Victorville 500 kV 2034 on-peak constraint summary

Affected transmission zones		East of Pisgah, SCE Eastern, SCE Northern, SDG&E, Out-of-state Wind
Portfolio resources behind the constraint (Installed FCDS capacity)		14,178 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		5,022 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		13,994 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		184 MW
Mitigation Options	RAS	Existing Lugo – Victorville RAS
	Reduce generic battery storage (MW)	Not needed
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Existing Lugo – Victorville RAS

Affected interties	MEAD_ITC,BLYTHE_ITC
MIC expansion request MW behind constraint	282
Deliverable MIC expansion request MW	282

F.12.2 2034 Off-peak results

The off-peak deliverability assessment did not identify any constraints in EOP area under 2034 base portfolio.

F.12.3 2039 On-peak results

GLW-VEA Area Constraint

The deliverability of full capacity portfolio resources in the VEA and GLW area is limited by thermal overloading of multiple 138 kV lines following Category P7 contingencies as shown in Table F.12-8. This constraint was identified for both 2039 base and sensitivity portfolios. Table F.12-9 summarizes the renewable and energy storage resources behind the constraint and the undeliverable resources in both base and sensitivity portfolios. The future Trout Canyon RAS

identified in the GIDAP process is sufficient to mitigate the constraint for 2039 base portfolio. For 2039 sensitivity portfolio, additional transmission upgrade will be needed.

Table F.12-8: GLW-VEA 2039 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	161
Gamebird – Sandy 138 kV Line		128	143
Sandy – Amargosa 138 kV Line		147	165
Amargosa 230/138 kV Transformer		110	126
VEA PST – IS Tap – Northwest 138 kV Tie Line		153	152
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	135
	Innovation – Desert View 230kV Nos. 1&2 lines	109	127

Table F.12-9: GLW-VEA 2039 on-peak constraint summary

Affected transmission zones		GLW and VEA area	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		3,476 MW	4,239 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1,891 MW	2,033 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		2,259 MW	2,016 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		1,217 MW	2,223 MW
Mitigation Options	RAS	RAS identified in GIP	Not applicable
	Reduce generic battery storage (MW)	Not sufficient	Not sufficient
	Transmission upgrade including cost	Not needed	Trout Canyon – Lugo 500kV line ($2 B)
Recommended Mitigation		RAS identified in GIDAP	TBD

Eldorado - McCullough 500 kV Constraint

The deliverability of full capacity portfolio resources of in the East of Pisgah area and the deliverability of out-of-state wind resources is limited by thermal overloading of Eldorado -

McCullough 500 kV line in base case and following Category P1 contingencies as shown in Table F.12-10. This constraint was identified for both 2039 base and sensitivity portfolios. Table F.12-11 summarizes the renewable and battery resources behind the constraint and the undeliverable resources for both 2039 base and sensitivity portfolios. MIC expanstion request on the MEAD_ITC intertie is behind this constraint and the 114 MW MIC expansion request is undeliverable. A few alternatives were evaluated to mitigate the constraint. The final mitigation plan will be coordinated with Eldorado 500 kV SCD mitigation and the transmission upgrades to accommodate the out-of-state wind portfolio.

Table F.12-10: Eldorado - McCullough 500 kV 2039 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Eldorado – McCullough 500 kV line	Base Case	<100	101
	Eldorado – Lugo 500 kV line	157	161
	Lugo – Mohave 500 kV line	142	146
	Harry Allen – Mead 500 kV line	108	113

Table F.12-11: Eldorado – McCullough 500 kV 2039 on-peak constraint summary

Affected transmission zones		East of Pisgah, Out-of-state Wind	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		11,119 MW	13,133 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		4,413 MW	4,660 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		7,072 MW	8,243 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		4,047 MW	4,890 MW
Mitigation Options	RAS	Not applicable	
	Reduce generic battery storage (MW)	Not applicable	
	Transmission upgrade including cost	1. 10 Ohms series reactor on Eldorado – McCullough line 2. Trout Canyon – Lugo 500kV line ($2 B) with 200-400MW battery storage relocation 3. Marketplace-Adelanto AC-DC Conversion 4. Western Bounty HVDC	
Recommended Mitigation		TBD	

Affected interties	MEAD_ITC	
	Base	Sensitivity
MIC expansion request MW behind constraint	114	114
Deliverable MIC expansion request MW	0	0

Lugo – Victorville 500 kV Constraint

The deliverability of full capacity portfolio resources of in the East of Pisgah, SCE Easter, SCE North and SDG&E areas and the deliverability of out-of-state wind resources are limited by thermal overloading of Lugo – Victorville 500 kV line as shown in Table F.12-12. This constraint was identified for both 2039 base and sensitivity portfolios. Table F.12-13 summarizes the renewable and battery resources behind the constraint and the undeliverable resources for both 2039 base and sensitivity portfolios. MIC expanstion requests on the MEAD_ITC and BLYTHE_ITC interties are behind this constraint and the 282 MW MIC expansion requests are undeliverable. A few alternatives were evaluated to mitigate the constraint. The final mitigation plan will be coordinated with transmission upgrades to accommodate the out-of-state wind portfolio.

Table F.12-12: Lugo – Victorville 500 kV 2039 on-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Lugo – Victorville 500 kV line	Base Case	112	114
	Eldorado – Lugo 500 kV line	127	130
	Lugo – Mohave 500 kV line	142	146
	Harry Allen – Mead 500 kV line	108	113
Eldorado – Lugo 500 kV line	Lugo – Victorville 500 kV line	111	113

Table F.12-13: Lugo – Victorville 500 kV 2039 on-peak constraint summary

Affected transmission zones	East of Pisgah, SCE Eastern, SCE Northern, SDG&E	
	Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)	17,145 MW	18,697 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)	5,770 MW	5,808 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)	12,610 MW	12,009 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)	4,535 MW	6,688 MW

Mitigation Options	RAS	Not sufficient
	Reduce generic battery storage (MW)	Not applicable
	Transmission upgrade including cost	1. Trout Canyon – Lugo 500kV Line ($2 B) 2. Marketplace-Adelanto AC-DC Conversion 3. Western Bounty HVDC
Recommended Mitigation		TBD

Affected interties	MEAD_ITC, BLYTHE_ITC	
	Base	Sensitivity
MIC expansion request MW behind constraint	282	282
Deliverable MIC expansion request MW	0	0

F.12.4 Wyoming Wind Sensitivity Study

The overloads in 2039 were largely driven by the out-of-state wind resources and load increase when comparing to 2034 results. A sensitivity study was performed on the 2039 base portfolio HSN case to better understand the impact of out-of-state wind on the constraint and to evaluate the alternatvies. To model the out-of-state wind resources more accurately, the CAISO added the SWIP-North and TWE AC models and relocated the 1,050 MW Idaho wind and 1,500 MW Wyoming wind from Harry Allen to Midpoint and TWE-IPP 500 kV buses respectively. For the remaining 1,500 MW Wyoming wind that required new transmission, the following HVAC and HVDC alternatvies were studied:

- AC Option 1: a new TWE-IPP – Muddy – Lugo 500 kV series compensated line, inject the 1,500 MW Wyoming wind at TWE-IPP 500 kV bus
- AC Option 2: a new 500 kV series compensated line from TWE-IPP to Eldorado and a new Trout Canyon – Lugo 500 kV series compensated line; inject the 1,500 MW Wyoming wind at TWE-IPP 500 kV bus
- DC Option 1: HVDC line from Wyoming to Lugo; inject the 1,500 MW Wyoming wind at Lugo 500 kV bus
- DC Option 2 (same as policy study): DC line from Wyoming to Eldorado, requires Trout Canyon – Lugo or Muddy – Lugo 500 kV line based on the policy study result

In addition, Marketplace – Adelanto HVDC conversion project and West Bounty Project were also evaluated as potential mitigations to the Lugo – Victorville constraint.

The results of each alternative are provided in the following tables:

Table F.12-14: AC Option 1 Result (TWE-IPP – Muddy, Muddy – Lugo)

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	AC Option 1 (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	147
Gamebird – Sandy 138 kV Line		128	126
Sandy – Amargosa 138 kV Line		147	145
Amargosa 230/138 kV Transformer		110	109
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	137
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	120
	Innovation – Desert View 230kV Nos. 1&2 lines	109	111
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	105
	Lugo – Mohave 500kV line	141	99
Lugo – Victorville 500 kV Line	Base Case	112	<95
	Eldorado – Lugo 500kV line	127	<95
	Lugo – Mohave 500kV line	117	<95
	Eldorado – Mohave 500kV line	101	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	<95

Table F.12-15: AC Option 2 Result (TWE-IPP – Eldorado, Trout Canyon - Lugo)

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	AC Option 2 (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	<95
Gamebird – Sandy 138 kV Line		128	<95
Sandy – Amargosa 138 kV Line		147	<95
Amargosa 230/138 kV Transformer		110	<95
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	<95
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	<95
	Innovation – Desert View 230kV Nos. 1&2 lines	109	<95
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	102
	Lugo – Mohave 500kV line	141	<95
Lugo – Victorville 500 kV Line	Base Case	112	<95
	Eldorado – Lugo 500kV line	127	<95
	Lugo – Mohave 500kV line	117	<95
	Eldorado – Mohave 500kV line	101	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	<95

Table F.12-16: DC Option 1 Result (DC from Wyoming to Lugo)

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	DC Option1 (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	148
Gamebird – Sandy 138 kV Line		128	128
Sandy – Amargosa 138 kV Line		147	147
Amargosa 230/138 kV Transformer		110	111
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	138
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	118
	Innovation – Desert View 230kV Nos. 1&2 lines	109	108
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	132
	Lugo – Mohave 500kV line	141	120
Lugo – Victorville 500 kV Line	Base Case	112	100
	Eldorado – Lugo 500kV line	127	113
	Lugo – Mohave 500kV line	117	105
	Eldorado – Mohave 500kV line	101	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	99

Based on the initial result, while injecting the additional 1,500 MW Wyoming wind to Lugo instead of Eldorado reduced the overloads on Lugo – Victorville and Eldorado – McCullough lines, it alone could not fully mitigate the overloads and RAS was still not sufficient in this case. Other transmission solutions, like Trout Canyon – Lugo or Muddy – Lugo 500 kV line are still needed.

Table F.12-17: DC Option 1 plus Trout Canyon – Lugo or Muddy – Lugo Result

Overloaded Facility	Contingency	DC Option1 +Trout-Lugo (%)	DC Option1 +Muddy-Lugo (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	<95	147
Gamebird – Sandy 138 kV Line		<95	125
Sandy – Amargosa 138 kV Line		<95	143
Amargosa 230/138 kV Transformer		<95	108
VEA PST – IS Tap – Northwest 138 kV Tie Line		<95	136
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	<95	122
	Innovation – Desert View 230kV Nos. 1&2 lines	<95	112
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	<95	96
	Lugo – Mohave 500kV line	<95	<95
Lugo – Victorville 500 kV Line	Base Case	<95	<95
	Eldorado – Lugo 500kV line	<95	<95
	Lugo – Mohave 500kV line	<95	<95

Overloaded Facility	Contingency	DC Option1 +Trout-Lugo (%)	DC Option1 +Muddy-Lugo (%)
	Eldorado – Mohave 500kV line	<95	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	<95	<95

Table F.12-18: DC Option 2 Result (DC from Wyoming to Eldorado)

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	DC Option2+ Trout-Lugo (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	<95
Gamebird – Sandy 138 kV Line		128	<95
Sandy – Amargosa 138 kV Line		147	<95
Amargosa 230/138 kV Transformer		110	<95
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	<95
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	<95
	Innovation – Desert View 230kV Nos. 1&2 lines	109	<95
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	103
	Lugo – Mohave 500kV line	141	97
Lugo – Victorville 500 kV Line	Base Case	112	<95
	Eldorado – Lugo 500kV line	127	<95
	Lugo – Mohave 500kV line	117	<95
	Eldorado – Mohave 500kV line	101	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	<95

Marketplace – Adelanto HVDC Conversion Project (MAP)

The project was proposed to convert the marketplace – Adelanto transmission line from its existing HVAC operation to HVDC operation. It would increase the usable transmission capacity on the existing MAP path from its current level of 1,296 MW to 3,500 MW of bi-directional capacity. According to Lotus Infrastructure Partners estimate, approximately 1,800 – 2,200 MW associated with MAP upgrade would be available to the CAISO. As part of the project scope, two options were proposed to integrate the new capacity into the bulk transmission network: option 1 would build a 500 kV Llano switchyear looping into Lugo – Vincent 500 kV lines, build two new 17 miles 500 kV single circuit lines from Llano to Adelanto converter station and tentatively install one 30 ohm series reactor between Adelanto converter station and Adelanto substation for flow balancing; option 2 would construct two new 16 miles 500 kV single circuit lines from Adelanto converter station to Lugo 500 kV bus without the need for series reactor.

The Wyoming wind sensitivity study assumed 1,800 MW of capacity increase would be available to the CAISO. The additional 1,500 MW Wyoming wind was modeled at Eldorado 500 kV bus. The results are shown in the table below.

Table F.12-19: Marketplace – Adelanto HVDC Conversion Project (MAP) Results

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	MAP Alt 1 (%)	MAP Alt 2 (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	148	148
Gamebird – Sandy 138 kV Line		128	128	128
Sandy – Amargosa 138 kV Line		147	147	147
Amargosa 230/138 kV Transformer		110	111	111
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	139	139
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	116	116
	Innovation – Desert View 230kV Nos. 1&2 lines	109	106	106
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	101	101
	Lugo – Mohave 500kV line	141	<95	96
Lugo – Victorville 500 kV Line	Base Case	112	<95	<95
	Eldorado – Lugo 500kV line	127	<95	<95
	Lugo – Mohave 500kV line	117	<95	<95
	Eldorado – Mohave 500kV line	101	<95	<95
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	<95	<95

Western Bounty Transmission System

The project was submitted as an interregional transmission project and requested an evaluation in the 2024-2025 TPP. The project proposed a three segmented 500- to 800-kV HVDC transmission system connecting renewable energy resources near Western Bounty's Hub Auriga Converter Substation in Esmeralda County, NV to termini in southern California, central Oregon and southwestern Idaho. The segment to southern California consists of two HVDC circuits: Path 1 from Auriga to a proposed new substation looping into SCE's Lugo – Vincent 500 kV lines, Path 2 from Auriga to LADWP's Adelanto substation. Each path has a bidirectional capacity of 3,000 MW. For the purpose of this study, we focused on evaluating the impact of Path 1 and Path 2 with a loading of 3,000 MW. The additional 1,500 MW Wyoming wind was modeled at Eldorado 500 kV bus. The results are summarized in the table below.

Table F.12-20: Western Bounty Transmission Sytem Results

Overloaded Facility	Contingency	2039 Base HSN Loading (%)	West Bounty Path 1 (%)	West Bounty Path 1 and 2 (%)
Gamebird 230/138 kV Transformer	Trout Canyon – Sloan Canyon 500kV Nos. 1&2 lines	148	143	143

Gamebird – Sandy 138 kV Line		128	119	119
Sandy – Amargosa 138 kV Line		147	136	136
Amargosa 230/138 kV Transformer		110	102	102
VEA PST – IS Tap – Northwest 138 kV Tie Line		138	127	127
VEA PST – IS Tap – Northwest 138 kV Tie Line	Northwest – Desert View 230kV Nos. 1&2 lines	119	133	132
	Innovation – Desert View 230kV Nos. 1&2 lines	109	123	123
Eldorado – McCullough 500 kV Line	Eldorado – Lugo 500kV line	156	120	115
	Lugo – Mohave 500kV line	141	113	107
Lugo – Victorville 500 kV Line	Base Case	112	<95	111
	Eldorado – Lugo 500kV line	127	<95	119
	Lugo – Mohave 500kV line	117	<95	112
	Eldorado – Mohave 500kV line	101	<95	98
Eldorado – Lugo 500 kV Line	Lugo – Victorville 500kV line	111	<95	96

Based on the Wyoming wind sensitivity study results discussed above, a few conclusions could be made:

- Under all HVAC and HVDC alternatives to bring in the additional 1,500 MW Wyoming wind to CAISO footprint, additional transmission upgrade is needed to mitigated Lugo – Victorville and Eldorado – McCullough constraints.
- The Trout Canyon – Lugo 500 kV line, Muddy – Lugo 500 kV line, MAP Upgrade Project and Western Bounty Path 1 are all able to mitigate Lugo – Victorville overloads.
- Trout Canyon – Lugo 500 kV line can also mitigate all of the identified GLW overloads and eliminate the use of RAS, while the other options still require the RAS.
- Except the HVDC line from Wyoming to Lugo along with the Trout Canyon – Lugo 500 kV line option, all the other alternatives studied cannot fully mitigate Eldorado – McCullough overloads. RAS can be utilized to mitigate the overload or the potential Eldorado 500 kV SCD mitigation may also eliminate this constraint.
- The HVDC line from Wyoming to Lugo along with the Trout Canyon – Lugo 500 kV line can eliminate all the EOP overloads identified under 2039 base portfolio.
- The two AC upgrade options proposed in MAP Upgrade Project yield similar results
- Western Bounty Path 1 by itself would eliminate the Lugo – Victorville constraint. But Path 2 would exacerbate it. When both Path 1 and Path 2 are energized, it would not fully mitigate the Lugo – Victorville overloads.

F.12.5 Conclusion and recommendation

The SCE and GLW East of Pisgah area deliverability assessment identifies several on peak deliverability constraints in both base and sensitivity portfolios. The mitigations include curtailing MIC expansion request, relying on the existing RAS and the future planned RAS.

MIC expanstion request on the MEAD_ITC intertie is behind the Eldorado – McCullough constraint and none of the 114 MW of MIC expansion request is deliverable. Both MEAD_ITC and BLYTHE_ITC interties are behind the Lugo – Victorville constraint. The 282 MW of MIC expansion request is deliverable in 2034, but none is deliverable in 2039.

The CAISO also performed a sensitivity study to evaluate different alternatives to import the additional 1,500 MW Wyoming wind beyond TransWest Express capacity and to mitigate Lugo – Victorville constraint. To be consistent with the CPUC directive in the Proposed Decision not to trigger upgrades related to the additional OOS wind amounts in the portfolio that are beyond the amounts that can be accommodated on the already-identified and in-development transmission upgrades, the CAISO will keep evaluating potential transmission upgrades and will not recommend for approval of any in the current TPP cycle.

F.13 SCE Northern Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the SCE Northern interconnection area are listed in Table F.13-1. The portfolios in the interconnection area are comprised of solar, wind (in-state), battery storage, long duration energy storage, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.13-1: SCE Northern Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	1,653	2,093	**3,746**	1,654	3,057	**4,711**	3,259	5,107	**8,366**
Wind – In State	564	16	**580**	564	16	**580**	514	16	**530**
Wind – Out-of-State	0	0	**0**	0	0	**0**	0	0	**0**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	3,735	0	**3,735**	3,485	0	**3,485**	2,610	0	**2,610**
Li Battery – 8 hr	170	0	**170**	734	0	**734**	2,294	0	**2,294**
Long Duration Energy Storage (LDES)	458	0	**458**	458	0	**458**	500	0	**500**
Geothermal	0	0	**0**	0	0	**0**	0	0	**0**
Biomass/Biogas	1	0	**1**	1	0	**1**	0	0	**0**
Distributed Solar	5	0	**5**	5	0	**5**	8	0	**8**
Total	**6,586**	**2,109**	**8,695**	**6,901**	**3,073**	**9,974**	**9,185**	**5,123**	**14,308**

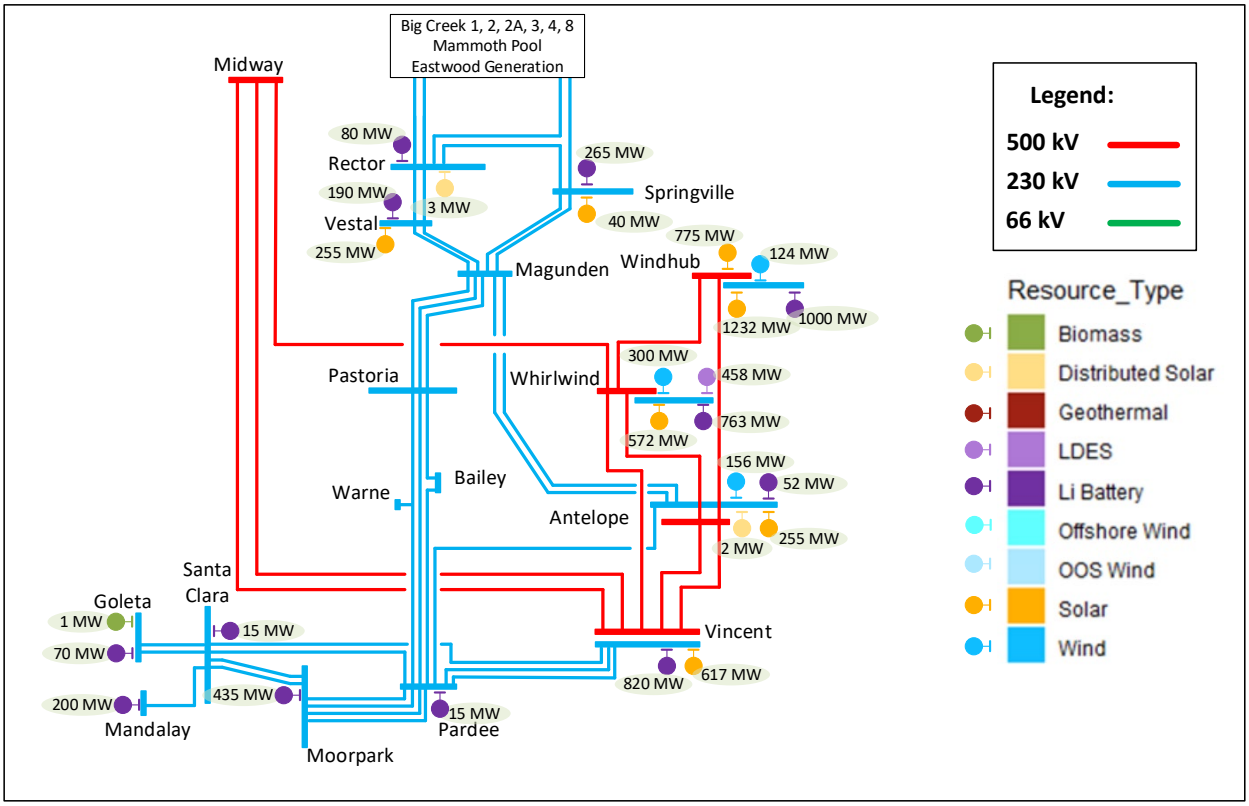
Table F.13-2 shows adjustments to the portfolios in the SCE Northern Interconnection Area made with CPUC staff guidance to account for additional in-development resources modeled by the PTO based on the project status.

Table F.13-2: SCE Northern Interconnection Area – Modifications to the portfolios to account for adjustments to in-development resources

Substation	Voltage	Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
			FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
Windhub	230	Li Battery	375	-	**375**	125	-	**125**	250	-	**250**
Windhub	230	Solar	-	400	**400**	-	-	**-**	-	-	**-**
Windhub	66	Solar	20	-	**20**	20	-	**20**	20	-	**20**
Rector	66	Li Battery	80	-	**80**	80	-	**80**	80	-	**80**
Springville	66	Solar	-	40	**40**	-	40	**40**	-	40	**40**
Springville	66	Li Battery	40	-	**40**	40	-	**40**	40	-	**40**
			515	**440**	**955**	**265**	**40**	**305**	**390**	**40**	**430**

The 2034 Base Portfolio resources, as identified in the CPUC busbar mapping for the SCE Northern interconnection area, are illustrated on the single-line diagram in Figure F.13-1.

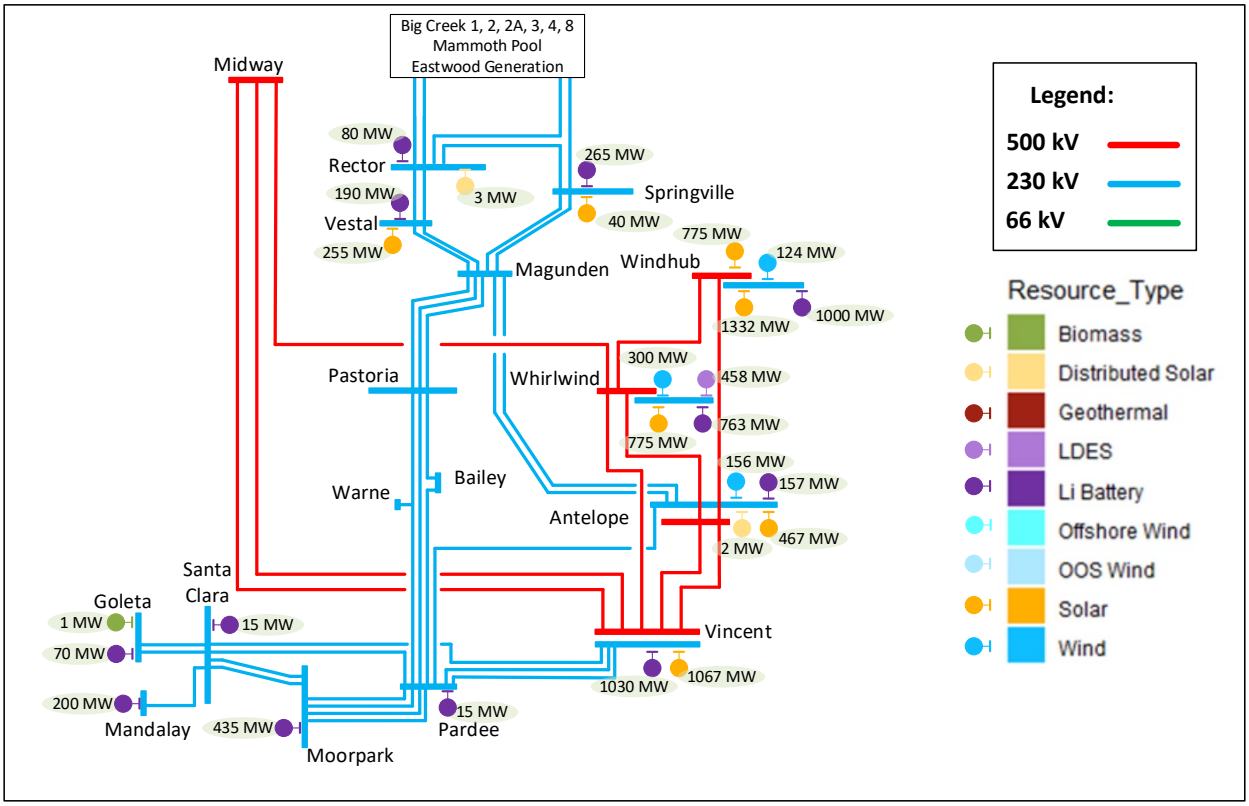
Figure F.13-1: SCE Northern Interconnection Area – Mapped[18] 2034 Base Portfolio



[18] Mapped base portfolio includes the adjustments to the base portfolio made by CPUC staff in the SCE Northern Interconnection Area to account for additional in-development resources identified.

The 2039 Base Portfolio resources, as identified in the CPUC busbar mapping for the SCE Northern interconnection area, are illustrated on the single-line diagram in Figure F.13-2.

Figure F.13-2: SCE Northern Interconnection Area – Mapped[19] 2039 Base Portfolio



F.13.1 2034 On-peak results

Windhub 500/230 kV Transformer Constraint

The deliverability of FC resources interconnecting at Windhub 230 kV buses is limited by thermal overloading of the 500/230 kV transformers under Category P1 conditions as shown in Table F.13-3. The constraint is identified in the base portfolio under the HSN condition, where 752 MW of capacity resources interconnected at Bus A, will be undeliverable without mitigation as shown in Table F.13-4. The constraint can be mitigated by the existing Windhub AA Bank CRAS.

[19] Mapped base portfolio includes the adjustments to the base portfolio made by CPUC staff in the SCE Northern Interconnection Area to account for additional in-development resources identified.

Table F.13-3: Windhub 500/230 kV transformer deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Windhub #1 500/230 kV transformer*	Windhub #2 500/230 kV transformer	135	< 100
Windhub #2 500/230 kV transformer*	Windhub #1 500/230 kV transformer	135	< 100

* The loading on the transformers depends on which Windhub 230 kV bus, Bus A or Bus B, generic portfolio resources are mapped to, could overload Banks #3 and #4 500/230 kV transformers.

Table F.13-4: Windhub #1 and #2 500/230 kV transformer constraint summary

Affected transmission zones		Tehachapi area – Windhub 230 kV Bus A
Portfolio resources behind the constraint (Installed FCDS capacity)		1373 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1016 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		621 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		752 MW
Mitigation Options	RAS	Existing Windhub AA Bank CRAS
	Re-locate portfolio battery storage (MW)	Not needed
	Transmission upgrade including cost	Not Needed
Recommended Mitigation		Existing Windhub AA Bank CRAS

Table F.13-5: Windhub #1 and #2 500/230 kV transformer constraint affected interties

Affected interties	N/A	
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW		

Whirlwind 500/230 kV Transformer Constraint

The deliverability of FC resources interconnecting at Whirlwind 230 kV bus is limited by thermal overloading of the 500/230 kV transformers under Category P1 conditions as shown in Table F.13-6. The constraint is identified in the base portfolio under the SSN condition, where 106 MW of capacity resources will be undeliverable without mitigation as shown in Table F.13-7. The constraint can be mitigated by the planned Whirlwind AA Bank CRAS.

Table F.13-6: Whirlwind 500/230 kV transformer deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Whirlwind #1 500/230 kV transformer	Whirlwind #3 or #4 500/230 kV transformer	< 100	102
Whirlwind #3 500/230 kV transformer	Whirlwind #1 or #4 500/230 kV transformer	< 100	102
Whirlwind #4 500/230 kV transformer	Whirlwind #1 or #3 500/230 kV transformer	< 100	102

Table F.13-7: Whirlwind 500/230 kV transformer constraint summary

Affected transmission zones		Tehachapi area – Whirlwind 230 kV
Portfolio resources behind the constraint (Installed FCDS capacity)		1848 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		758 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		1742 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		106 MW
Mitigation Options	RAS	Planned Whirlwind AA Bank CRAS
	Re-locate portfolio battery storage (MW)	Not needed
	Transmission upgrade including cost	Not Needed
Recommended Mitigation		Planned Whirlwind AA Bank CRAS

Table F.13-8: Whirlwind 500/230 kV transformer constraint affected interties

Affected interties	N/A	
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW		

Midway–Whirlwind 500 kV Line Constraint

The deliverability of FC resources interconnecting in the Tehachapi and Norh of Magunden areas is limited by thermal overloading of PG&E's portion of Midway–Whirlwind 500 kV line under Category P0 condition as shown in Table F.13-9. The constraint is identified in the base portfolio under the SSN condition, where 430 MW of capacity resources will be undeliverable without mitigation as shown in

Table F.13-10. Since the constraint occurs under normal system conditions, RAS is not a viable mitigation. Additionally, the ISO explored the alternative to re-locate generic portfolio battery storage to other substations outside the affected transmission zones, but this proved to be insufficient to mitigate the thermal overload.

Finally, the ISO assessed the following transmission alternatives:

1. Bypass the series capacitor of the Midway–Whirlwind 500 kV line

Bypassing the series capacitor of the Midway–Whirlwind 500 kV line is sufficient to address the on-peak deliverability constraint for both the base case condition without contingency and with the outage of both Vincent – Midway 500 kV lines, assuming a Path 26 south to north flow of 3,000 MW. The ISO performed a reliability study to determine if the series capacitor could be bypassed permanently, seasonally or if there is a requirement of constant switching dependent on changing system conditions. The assessment showed that the series capacitor could be bypassed permanently as no reliability concerns were identified even with a Path 26 north to south flow of 4,000 MW, while relying on Path 26 RAS and the 30-minute emergency ratings of Path 26 transmission lines. This alternative would not have any cost.

The economic benefits of bypassing the series capacitor were evaluated using production cost simulation. The results, did not show economic benefits or significant reduction on renewable energy curtailment.

2. Pacific Transmission Expansion Project (PTEP)

To mitigate the thermal olverload of Midway – Whirlwind 500 kV line in heavy Path 26 south to north flow conditions, the PTEP HVDC would need to transfer real power from SCE to PG&E. The main disadvantage of this alternative is that it could create a loop flow through Path 26 500 kV lines by having a south to north flow from Whirlwind to Midway and a north to south flow from Midway to Vincent if the transfer through PTEP HVDC is not adjusted correctly.

The alternative would have an estimated cost of $1.89-$2.32 billion. The economic benefits of the PTEP was evaluated using production cost simulation. The results, which are presented in Appendix G, did not find the line to be economic at this time.

3. Upgrade Midway – Whirlwind 500 kV line

This alternative involves increasing the normal and emergency ratings of both portions of Midway – Whirlwind 500 kV line by upgrading terminal equipment, the conductor for PG&E's portion, line to ground clearance for SCE's portion, and the series capacitor. The ISO, in collaboration, with PG&E and SCE will continue to investigate the feasibility of this option.

Based on the above considerations, congestion management is found to be the preferred solution to address the on-peak deliverability constraint for the SSN scenario at this time.

Table F.13-9: Midway–Whirlwind 500 kV line deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Midway–Whirlwind 500 kV line (PG&E segment)	Base Case	< 100	106

Table F.13-10: Midway–Whirlwind 500 kV line constraint summary

Affected transmission zones		Tehachapi and North of Magunden areas
Portfolio resources behind the constraint (Installed FCDS capacity)		5165 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		2838 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		4735 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		430 MW
Mitigation Options	RAS	Not applicable for P0 overload
	Re-locate portfolio battery storage (MW)	Not sufficient
	Transmission upgrade including cost	1. Bypass the series capacitor of the Midway–Whirlwind 500 kV line (No cost) 2. PTEP ($1.89-$2.32 B) 3. Upgrade Midway – Whirlwind 500 kV line
Recommended Mitigation		Congestion management

Table F.13-11: Midway–Whirlwind 500 kV line constraint affected interties

Affected interties	N/A	
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW		

F.13.2 2034 Off-peak results

Wind and solar resources in the SCE Northern area are subject to curtailment in the base portfolio due to loading constraints identified in Table F.13-12 under normal and/or contingency conditions, which are further discussed below.

Table F.13-12: SCE Northern area off-peak deliverability constraints

Overloaded Facility	Contingency	Loading (%)
Windhub #1 500/230 kV transformer*	Windhub #2 500/230 kV transformer	140
Windhub #2 500/230 kV transformer*	Windhub #1 500/230 kV transformer	140
Midway–Whirlwind 500 kV (PG&E segment)	Base Case	119

* Depending on which Windhub 230 kV bus, Bus A or Bus B, generic portfolio resources are mapped to, could overload Banks #3 and #4 500/230 kV transformers.

Windhub 500/230 kV transformers off-peak deliverability constraint

Wind and solar resources interconnecting to Windhub 230 kV Bus A are subject to curtailment in the base portfolio due to loading limitations of the Windhub 500/230 kV transformers under Category P1 conditions, as shown above. About 728 MW of portfolio resources were curtailed to mitigate the overload as presented in Table F.13-13. Pre-contingency curtailment can be avoided by relying on the existing Windhub AA Bank CRAS.

Table F.13-13: Windhub 500/230 kV transformers off-peak deliverability constraint summary

Affected renewable transmission zones		Tehachapi area – Windhub 230 kV Bus A
Portfolio solar and wind resources behind the constraint		1382 MW
Portfolio energy storage behind the constraint		1016 MW
Renewable curtailment without mitigation		728 MW
Mitigation Options	Portfolio ES (in charging mode)[20]	572 MW
	RAS	Existing Windhub AA Bank CRAS
	Transmission upgrades	Not needed
Recommended Mitigation		Existing Windhub AA Bank CRAS

Midway–Whirlwind 500 kV line off-peak deliverability constraint

Wind and solar resources in the Tehachapi and North of Magunden areas are subject to curtailment in the base portfolio due to loading limitations on PG&E's portion of the Midway–Whirlwind 500 kV line under normal conditions, as shown above. About 1258 MW of portfolio resources were curtailed to mitigate the overload as presented in Table F.13-14. The constraint occurs during periods of high renewable output and heavy south to north transfers on Path 26. Renewable curtailment can be avoided by reducing thermal generation and dispatching baseline energy storage in charging mode. Since the constraint occurs under normal system conditions, RAS is not a viable mitigation.

The transmission mitigation options studied for the off-peak deliverability constraint are described in section F.13 for the Midway – Whirlwind 500 kV line on-peak deliverability constraint. Based on the above considerations, dispatching baseline energy storage in charging mode is found to be the preferred solution to address the off-peak deliverability constraint at this time.

[20] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

Table F.13-14: Midway–Whirlwind 500 kV line off-peak deliverability constraint summary

Affected renewable transmission zones		Tehachapi and North of Magunden areas
Portfolio solar and wind resources behind the constraint		3755 MW
Portfolio energy storage behind the constraint		3202 MW
Renewable curtailment without mitigation		1258 MW
Mitigation Options	Portfolio ES (in charging mode)[21]	0 MW
	RAS	Not applicable for P0 overload
	Transmission upgrades	1. Bypass the series capacitor of the Midway–Whirlwind 500 kV line 2. PTEP 3. Upgrade Midway – Whirlwind 500 kV line
Recommended Mitigation		Baseline energy storage in charging mode

F.13.3 2039 On-peak results

Windhub 500/230 kV Transformer Constraint

The deliverability of FC resources interconnecting at Windhub 230 kV buses is limited by thermal overloading of the 500/230 kV transformers under Category P1 conditions as shown in Table F.13-15. The constraint is identified in both base and sensitivity portfolios, where 745 MW of capacity resources interconnected at Bus A, will be undeliverable without mitigation as shown in Table F.13-16. The constraint can be mitigated by the existing Windhub AA Bank CRAS.

Table F.13-15: Windhub 500/230 kV transformer deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Windhub #1 500/230 kV transformer*	Windhub #2 500/230 kV transformer	135	136
Windhub #2 500/230 kV transformer*	Windhub #1 500/230 kV transformer	135	136

* The loading on the transformers depends on which Windhub 230 kV bus, Bus A or Bus B, generic portfolio resources are mapped to, could overload Banks #3 and #4 500/230 kV transformers.

[21] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

Table F.13-16: Windhub #1 and #2 500/230 kV transformer constraint summary

Affected transmission zones		Tehachapi area – Windhub 230 kV Bus A	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		1368 MW	
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1012 MW	
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		623 MW	
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		745 MW	
Mitigation Options	RAS	Existing Windhub AA Bank CRAS	
	Re-locate portfolio battery storage (MW)	Not needed	
	Transmission upgrade including cost	Not Needed	
Recommended Mitigation		Existing Windhub AA Bank CRAS	

Table F.13-17: Windhub #1 and #2 500/230 kV transformer constraint affected interties

Affected interties	N/A	
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW		

Windhub Area Export Constraint

The deliverability of FC resources interconnecting at Windhub Substation is limited by the simultaneous or overlapping outage of Antelope – Windhub 500kV Line and Whirlwind – Windhub 500 kV Line without time for system adjustments, which results in islanding of the Windhub System and the consequential loss of 3000 to 6000 MW of generation.

The loss of one Windhub 500 kV line results in exposing the entire ISO and surrounding areas to voltage collapse-driven cascading outages for loss of the second Windhub 500 kV 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. Therefore, an area deliverability constraint has been enforced to address this voltage collapse and loss of resource issue.

The constraint is identified in the sensitivity portfolio, where 65 MW of capacity resources would be undeliverable without mitigation as shown in Table F.13-18**Error! Reference source not found.**. The recommended mitigation for the sensitivity portfolio is to relocate at least 65 MW of generic battery energy storage to other substations.

Table F.13-18: Windhub Area Export constraint summary

Affected transmission zones		Tehachapi area – Windhub	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		2142 MW	2338 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1012 MW	1154 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		2142 MW	2273 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		0 MW	65 MW
Mitigation Options	RAS	Not applicable	
	Re-locate portfolio battery storage (MW)	Not needed	Relocate at least 65 MW of generic storage
	Transmission upgrade including cost	Not Needed	New Whirlwind-Windhub 500 kV line ($612 M)
Recommended Mitigation		Not Needed	Relocate at least 65 MW of generic storage

F.13.4 Conclusion and recommendation

The SCE Northern area base and sensitivity portfolios deliverability assessment identified on-peak and off-peak deliverability constraints. The Windhub and Whirlwind 500/230 kV transformer constraints can be addressed by using CRAS. The Windhub area export constraint identified in the 2039 sensitivity portfolio can be mitigated by relocating at least 65 MW of generic battery energy storage to other substations. Several alternatives to mitigate the Midway-Whirlwind 500 kV line constraint were evaluated, but the economic assessment did not show sufficient economic benefits to reduce the Path 26 congestion or renewable energy curtailment.

In consequence, transmission upgrades were not found to be needed in the area in the current planning cycle.

F.14 SCE North of Lugo Area

Base portfolio resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the SCE North of Lugo (NOL) interconnection area are listed in Table F.14-1. The portfolio in the interconnection area are comprised of solar, battery storage, geothermal, biomass/biogas and distributed solar resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.14-1: SCE North of Lugo Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	672	937	**1,609**	752	1,285	**2,037**	1,268	1,723	**2,991**
Wind – In State	310	50	**360**	310	50	**360**	310	50	**360**
Wind – Out-of-State	0	0	**0**	0	0	**0**	0	0	**0**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	770	0	**770**	800	0	**800**	435	0	**435**
Li Battery – 8 hr	90	0	**90**	265	0	**265**	683	0	**683**
Long Duration Energy Storage (LDES)	0	0	**0**	0	0	**0**	0	0	**0**
Geothermal	0	0	**0**	0	0	**0**	454	0	**454**
Biomass/Biogas	2	0	**2**	2	0	**2**	0	0	**0**
Distributed Solar	11	0	**11**	27	0	**27**	34	0	**34**
Total	**1,855**	**987**	**2,842**	**2,156**	**1,335**	**3,491**	**3,184**	**1,773**	**4,957**

The base portfolio resources as identified in the CPUC busbar mapping for the SCE North of Lugo interconnection area are illustrated on the single-line diagram in Figure F.14-1 and Figure F.14-2 .

Figure F.14-1: SCE North of Lugo Interconnection Area – Mapped 2034 Base Portfolio

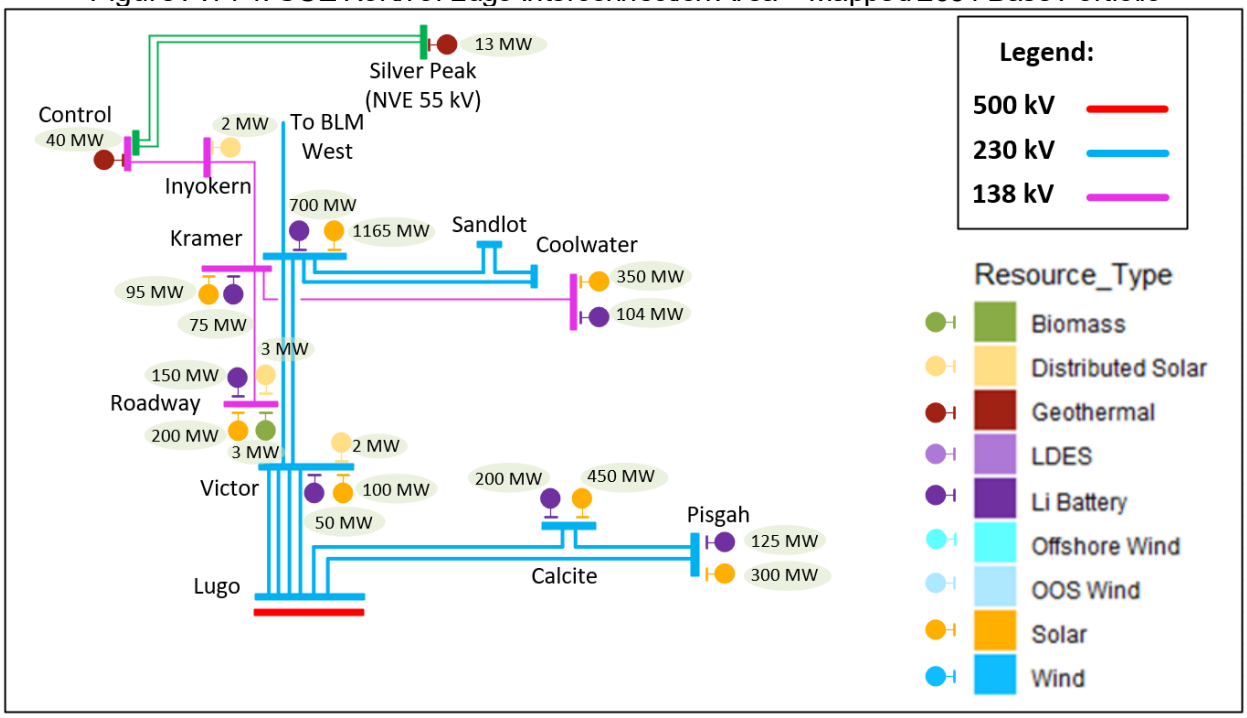
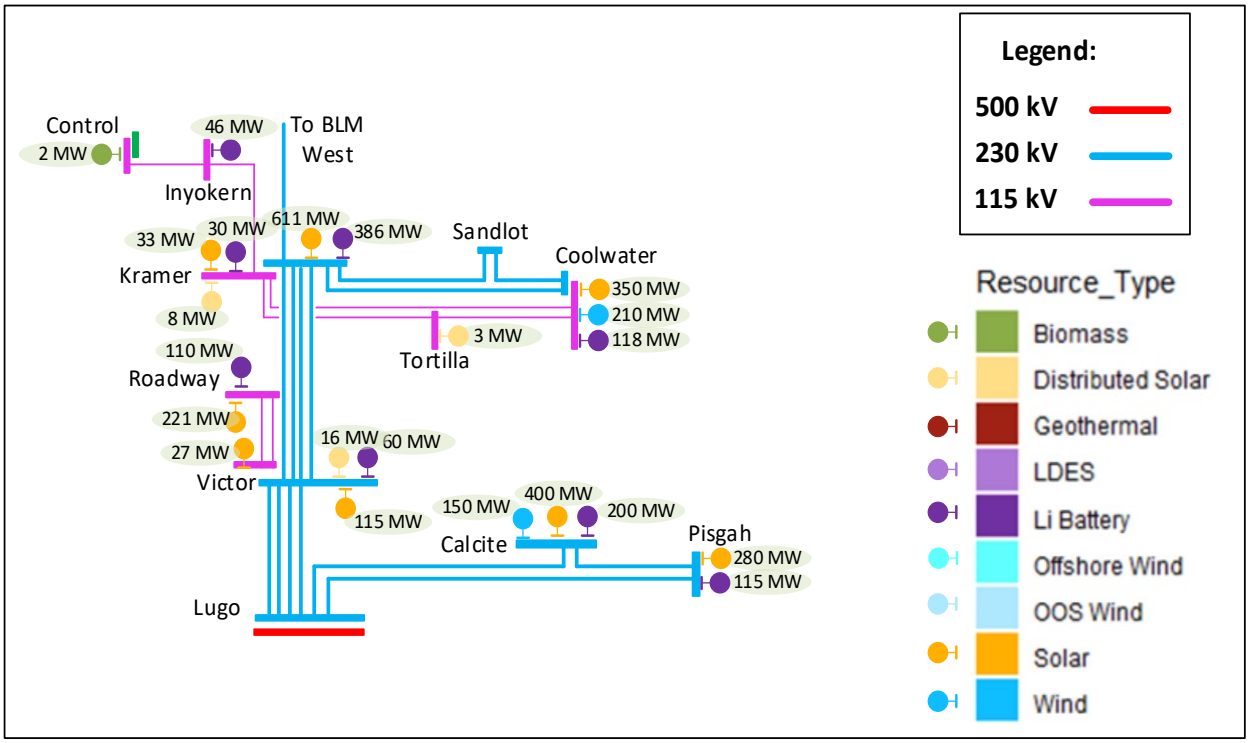


Figure F.14-2: SCE North of Lugo Interconnection Area – Mapped 2039 Base Portfolio



F.14.1 2034 On-peak results

Coolwater–Kramer Corridor Constraint

The Coolwater–Kramer corridor deliverability constraint, which is comprised of the constraints included in Table F.14-2, affect deliverability of capacity resources in the NOL area due to thermal overloading of the planned 230/115 kV transformer and 115 kV lines in the area under contingency conditions as shown in the table. Up to 553 MW of capacity resources in the base portfolio will be undeliverable without mitigation.

Table F.14-3: On-peak Coolwater–Kramer corridor constraint summary provides the constraint summary for the more limiting constraints.

Table F.14-2: Coolwater–Kramer corridor on-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Coolwater 230/115 kV Transformer	Kramer–Coolwater & Kramer–Sandlot 230 kV lines	160	214
	Kramer–Coolwater & Sandlot–Coolwater 230 kV lines	144	147
Tortilla–Coolwater 115 kV	Kramer–Coolwater & Kramer–Sandlot 230 kV lines	124	142
Coolwater–Kramer 115 kV		128	157
Sandlot- Kramer #1 230kV line	Kramer – Coolwater #2 230kV line	101	133
Kramer – Coolwater #2 230kV line	Sandlot- Kramer #1 230kV line	101	125

Table F.14-3: On-peak Coolwater–Kramer corridor constraint summary

Affected transmission zones		North of Lugo Area
		Base (SSN)
Portfolio MW behind constraint		1,227 MW
Portfolio battery storage MW behind constraint		417 MW
Deliverable portfolio MW w/o mitigation		880 MW
Total undeliverable baseline and portfolio MW		553 MW
Mitigation Options	RAS	Mohave Desert RAS
	Reduce generic battery storage (MW)	Not needed
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Mohave Desert RAS

The Coolwater–Kramer corridor constraint was not found to impact MIC expansion requests as shown in Table F.14-4.

Table F.14-4: On-peak Coolwater–Kramer corridor constraint affected interties

Affected interties	N/A	
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW		

Remedial Action Schemes (RAS), reducing generic portfolio battery storage and transmission alternatives were considered to address the constraints. Since the existing Mohave Desert RAS adequately mitigates the deliverability constraints, no other solution was found to be needed.

Control–Inyokern/Haiwee Tap 115 kV and Control Silver Peak 55 kV Constraint

Control–Inyokern/Haiwee Tap 115 kV and Control- Silver Peak 55 kV corridor deliverability constraint described in Table F.14-5 affects deliverability of capacity resources in the NOL area due to single and double circuit outage of Control–Coso–Inyokern 115 kV lines. Up to 33 MW of capacity resources in the base portfolio will be undeliverable without mitigation. Table F.14-6 provides a summary of the constraint including affected resources and mitigation solutions.

Table F.14-5: Control–Inyokern/Haiwee Tap 115 kV on-peak deliverability constraint

Overloaded Facility	**Contingency**	**Loading (%)**	
		HSN	**SSN**
Control–Inyokern/Haiwee Tap 115 kV	Control–Coso–Inyokern 115 kV line	109	105
Control – Silver Peak C 55kV	Control–Coso–Haiwee-Inyokern 115 kV line & Control–Haiwee–Inyokern 115 kV line	138	157

Table F.14-6: On-peak Control–Inyokern/Haiwee Tap 115 kV and Control Silver Peak 55 kV constraint summary

Affected transmission zones	North of Inyokern Area
	Base (HSN)
Portfolio MW behind constraint	55 MW
Portfolio battery storage MW behind constraint	0 MW
Deliverable portfolio MW w/o mitigation	22 MW

Total undeliverable baseline and portfolio MW		33 MW
Mitigation Options	RAS	Existing Bishop RAS
	Reduce generic battery storage (MW)	N/A
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Existing Bishop RAS

RAS and transmission upgrades were considered to address the constraint. Since the existing Bishop RAS adequately mitigates the deliverability constraint, no further mitigation solution was found to be needed.

The constraint was found to impact MIC expansion requests in the area as indicated in Table F.14-7.

Table F.14-7: MIC expansion requests impacted by the Control–Inyokern/Haiwee Tap and Silver Peak constraint

Affected interties	SILVERPK_BG
	Base
MIC expansion request MW behind constraint	13 MW
Deliverable MIC expansion request MW with mitigation	0 MW

Lugo–Victor 230 kV Corridor Constraint

The overloading of the Lugo–Victor #3 and #4 230 kV lines under the contingency conditions indicated in Table F.14-8 affect deliverability of capacity resources in the NOL area. Up to 1086 MW of capacity resources in the base portfolio will be undeliverable without mitigation. Table F.14-9 provides a summary of Lugo–Victor 230 kV line Constraint.

Table F.14-8: Lugo–Victor 230 kV corridor on-peak deliverability constraint

Overloaded Facility	**Contingency**	**Base Portfolio Loading (%)**	
		HSN	**SSN**
Lugo- Victor #3 and #4 230 kV lines	Lugo- Victor #1 and #2 230 kV lines	102	124

Table F.14-9: On-peak Lugo–Victor 230 kV corridor constraint summary

Affected transmission zones	NOL area
	Base (SSN)

Portfolio MW behind constraint		3006 MW
Portfolio battery storage MW behind constraint		1229 MW
Deliverable portfolio MW w/o mitigation		2262 MW
Total undeliverable baseline and portfolio MW		1086 MW
Mitigation Options	RAS	HDPP RAS
	Reduce generic battery storage (MW)	Not needed
	Transmission upgrade including cost	Not needed
Recommended Mitigation		HDPP RAS

Since the existing High Desert Power Project RAS adequately mitigates the deliverability constraint, no further mitigation solution was found to be needed.

The Lugo–Victor 230 kV corridor constraint was found to impact MIC expansion requests as shown in Table F.14-10.

Table F.14-10: MIC expansion requests impacted by the Lugo–Victor 230 kV corridor constraint

Affected interties	SILVERPK_BG
	Base
MIC expansion request MW behind constraint	13 MW
Deliverable MIC expansion request MW with mitigation	0 MW

F.14.2 2034 Off-peak results

Coolwater–Kramer Corridor Constraint

Wind and solar resources in the Kramer-Coolwater area are subject to curtailment due to loading limitations on 230 and 115 kV facilities in the area under contingency conditions as shown in Table F.14-11. Table F.14-12 provides a summary of the constraints including mitigation alternatives considered. The constraints can be mitigated by Mojave Desert RAS or dispatching portfolio battery storage in charging mode.

Table F.14-11: Coolwater–Kramer 230/115 kV corridor off-peak deliverability constraints

Overloaded Facility	Contingency	Base Loading (%)
Coolwater–Kramer 115 kV	Kramer–Coolwater & Kramer–Sandlot 230 kV lines	182
Coolwater 230/115 kV Tr.		183
Coolwater-Dunnside 115 kV		184
Kramer 230/115 kV #1 & #2 Tr.		161

Tortilla–Kramer 115 kV		159
Kramer–Sandlot #1 230 kV line	Kramer–Coolwater #2 230 kV line	140
Kramer–Coolwater #2 230 kV line	Kramer–Sandlot #1 230 kV line	133

Table F.14-12: Coolwater–Kramer off-peak deliverability constraint summary

Affected renewable transmission zones		Sandlot-Coolwater area
		Base Portfolio
Portfolio solar and wind MW behind the constraint		1062 MW
Energy storage portfolio MW behind the constraint		645 MW
Renewable curtailment without mitigation (MW)		364 MW
Mitigation Options:	Portfolio ES (in charging mode) (MW)[22]	0 MW
	RAS	Mojave desert RAS
	Transmission upgrades	Not needed
Recommended Mitigation		Mojave desert RAS

Lugo–Victor 230 kV Corridor Constraint

The overloading of the Lugo–Victor #3 and #4 230 kV lines under the contingency conditions indicated in Table F.14-13.

[22] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

Table F.14-14 provides a summary of the constraint including mitigation alternatives considered. The constraints can be mitigated by High Desert Power Plant RAS.

Table F.14-13: Lugo-Victor 230 kV corridor off-peak deliverability constraints

Overloaded Facility	Contingency	Base Loading (%)
Lugo- Victor #3 and #4 230 kV lines	Lugo- Victor #1 and #2 230 kV lines	119

Table F.14-14: Lugo–Victor 230 kV corridor off-peak deliverability constraint summary

Affected renewable transmission zones		NOL area
		Base Portfolio
Portfolio solar and wind MW behind the constraint		2,406 MW
Energy storage portfolio MW behind the constraint		1,480 MW
Renewable curtailment without mitigation (MW)		449 MW
Mitigation Options:	Portfolio ES (in charging mode) (MW)[23]	0 MW
	RAS	HDPP RAS
	Transmission upgrades	Not needed
Recommended Mitigation		HDPP RAS

Lugo–Calcite–Pisgah 230 kV Corridor Constraint

Resources at Calcite and Pisgah will be subject to curtailment due to loading limitations on the Calcite–Pisgah 230 kV line under contingency conditions as shown in Table F.14-15. Table F.14-16 provides summary of the constraints including mitigation alternatives considered. The constraints can be mitigated by the planned Calcite CRAS or dispatching generic portfolio battery storage in charging mode.

Table F.14-15: Lugo–Calcite–Pisgah 230 kV corridor off-peak deliverability constraint

Overloaded Facility	**Contingency**	**Base Loading (%)**
Calcite–Pisgah 230 kV	Calcite–Lugo 230 kV	128

Table F.14-16: Lugo–Calcite–Pisgah 230 kV corridor off-peak deliverability constraint summary

Affected renewable transmission zones	Calcite and Pisgah Substations
	Base Portfolio
Portfolio solar and wind MW behind the constraint	550 MW

[23] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

Energy storage portfolio MW behind the constraint		200 MW
Renewable curtailment without mitigation (MW)		86 MW
Mitigation Options	Portfolio ES (in charging mode) (MW)[24]	0 MW
	RAS	Planned Calcite CRAS
	Transmission upgrades	Not needed
Recommended Mitigation		Planned Calcite CRAS

F.14.3 2039 On-peak results

Coolwater–Kramer Corridor Constraint

The Coolwater–Kramer corridor deliverability constraint, which is comprised of the constraints included in Table F.14-17, affect deliverability of capacity resources in the NOL area due to thermal overloading of the planned 230/115 kV transformer and 115 kV lines in the area under contingency conditions as shown in the table. Up to 151 MW of capacity resources in the base portfolio will be undeliverable without mitigation.

Table F.14-3: On-peak Coolwater–Kramer corridor constraint summary provides the constraint summary for the more limiting constraints.

Table F.14-17: Coolwater–Kramer corridor on-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Coolwater–Kramer 115 kV	Kramer–Coolwater & Kramer–Sandlot 230 kV	129	123
Coolwater 230/115 kV Tr.		157	153
Tortilla–Coolwater 115 kV		126	115
Kramer 230/115 kV #1 & #2 Tr.		126	194
Tortilla–Kramer 115 kV		110	106

[24] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

Kramer- Inyokern 115kV	BLM West - Kramer 220kV & Kramer- Inyokern- Randsburg 115kV	N/A	103

Table F.14-18: Coolwater–Kramer corridor on-peak constraint summary

Affected transmission zones		NOL area	
		Base	Sensitivity
Portfolio resources behind the constraint		916 MW	916 MW
Portfolio battery storage behind the constraint		417 MW	417 MW
Deliverable portfolio resources w/o mitigation		765 MW	765 MW
Total undeliverable baseline and portfolio resources		151 MW	151 MW
Mitigation Options	RAS	Mojave Desert RAS	Mojave Desert RAS
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Not Needed	Not Needed
Recommended Mitigation		Mojave Desert RAS	Mojave Desert RAS

Remedial Action Schemes (RAS), reducing generic portfolio battery storage and transmission alternatives were considered to address the constraints. Since the existing Mohave Desert RAS adequately mitigates the deliverability constraints, no other solution was found to be needed.

The constraint was found to impact MIC expansion requests in the area as indicated in Table F.14-19.

Table F.14-19: MIC expansion requests impacted by the Coolwater–Kramer corridor constraint

Affected interties	SILVERPK_BG	
	Base	Sensitivity
MIC expansion request MW behind constraint	13 MW	N/A
Deliverable MIC expansion request MW	0 MW	N/A

Control–Inyokern/Haiwee Tap 115 kV and Control Silver Peak 55 kV Constraint

Control-Inyokern/ Haiwee Tap 115 kV and Control- Silver Peak 55 kV corridor deliverability constraint described in Table F.14-20 affects deliverability of capacity resources in the NOL area due to single and double circuit outage of Control–Coso–Inyokern 115 kV lines. Up to 452 MW of capacity resources in the sensitivity portfolio will be undeliverable without mitigation.

Table F.14-21 provides a summary of the constraint including affected resources and mitigation solutions.

Table F.14-20: Control–Inyokern/Haiwee Tap 115 kV on-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Control – Silver Peak 55kV PST	Control–Coso–Haiwee-Inyokern 115 kV line & Control–Haiwee–Inyokern 115 kV line (Loading results are based on DC solution as the AC solution diverged)	130	140
Control–Coso- Inyoern 115 kV	Base case	N/A	112
Control–Coso-Haiwee-Inyoern 115 kV		N/A	115

Table F.14-21: On-peak Control–Inyokern/Haiwee Tap 115 kV and Control Silver Peak 55 kV constraint summary

Affected transmission zones		South of Control area	
		Base	Sensitivity
Portfolio resources behind the constraint		55 MW	507 MW
Portfolio battery storage behind the constraint		0 MW	0 MW
Deliverable portfolio resources w/o mitigation		55 MW	55 MW
Total undeliverable baseline and portfolio resources		0 MW	452 MW
Mitigation Options	RAS	Bishop RAS	Bishop RAS
	Reduce generic battery storage (MW)	N/A	N/A
	Transmission upgrade including cost	Not Needed	Control-Inyokern-Kramer 220 kV upgrade (~$2B)
Recommended Mitigation		Bishop RAS	Relocate undeliverable portfolio resource fom Control substation

RAS and transmission upgrades were considered to address the constraint. Since the existing Bishop RAS adequately mitigates the deliverability constraint for Base case, no further mitigation solution was found to be needed. Bishop RAS is not adequate for Sensistivity scenario requiring transmission upgrade or relocation of undeliverable portfolio.

The constraint was found to impact MIC expansion requests in the area as indicated in Table F.14-22.

Table F.14-22: MIC expansion requests impacted by the Control–Inyokern/Haiwee Tap and Silver Peak constraint

Affected interties	SILVERPK_BG	
	Base	Sensitivity
MIC expansion request MW behind constraint	13 MW	N/A
Deliverable MIC expansion request MW	0 MW	N/A

Lugo–Calcite 230 kV Constraint

Resources at Calcite will be subject to curtailment due to loading limitations on the Calcite–Lugo 230 kV line under contingency conditions as shown in Table F.14-23. Table F.14-24 provides summary of the constraints including mitigation alternatives considered. The constraints can be mitigated by the planned upgrades and dispatching generic portfolio battery storage in charging mode or reducing/relocating the undeliverable portfolio resource.

Table F.14-23: Lugo–Calcite 230 kV corridor on-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Lugo- Calcite 230 kV	Base Case	101	105
Calcite- Lugo 230 kV	BLM West - Kramer 220kV & Kramer-Inyokern-Randsburg 115kV	102	106

Table F.14-24: Lugo–Calcite 230 kV corridor on-peak deliverability constraint summary

Affected transmission zones		Calcite and Lugo Substations	
		Base	Sensitivity
Portfolio resources behind the constraint		1145 MW	1725 MW
Portfolio battery storage behind the constraint		315 MW	295 MW
Deliverable portfolio resources w/o mitigation		1115 MW	1663 MW
Total undeliverable baseline and portfolio resources		30 MW	62 MW
Mitigation Options	RAS	N/A as it is a P0 contingency	N/A as it is a P0 contingency
	Reduce generic battery storage (MW)	30 MW	62 MW
	Transmission upgrade including cost	Pisgah substation loop in project ($218M)	Pisgah substation loop in project ($218M)
Recommended Mitigation		Reduce 30 MW of generic battery storage	Reduce 62 MW of generic battery storage

The constraint was not found to impact MIC expansion requests in the area as indicated in Table F.14-25.

Table F.14-25: MIC expansion requests impacted by the Control–Inyokern/Haiwee Tap and Silver Peak constraint

Affected interties	SILVERPK_BG	
	Base	Sensitivity
MIC expansion request MW behind constraint	13 MW	N/A
Deliverable MIC expansion request MW	13 MW	N/A

F.14.4 Conclusion and recommendation

The following conclusion can be made based on the North of Lugo Area deliverability assessment:

- All portfolio resources in the NOL area are deliverable with existing or expanded Remedial Action Schemes (RAS) except for the 2039 Base and Sensitivity portfolio due to Lugo- Calcite overload (P0). Off-peak deliverability constraints can be addressed using RAS or dispatching portfolio battery storage in charging mode;
- Out of the 13 MW of California Community Power's SILVERPK_BG MIC expansion request, 0 MW is deliverable as the MIC expansion request contributes to constraints in the North of Lugo area.

F.15 SCE Metro Area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the SCE Metro interconnection area, are listed in Table F.15-1. The portfolios in the interconnection area are comprised of battery storage and biomass/biogas resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.15-1: SCE Metro Interconnection Area – Base and Sensitivity Portfolios by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	0	0	**0**	0	0	**0**	0	0	**0**
Wind – In State	0	0	**0**	0	0	**0**	0	0	**0**
Wind – Out-of-State	0	0	**0**	0	0	**0**	0	0	**0**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	1,879	0	**1,879**	1,929	0	**1,929**	979	0	**979**
Li Battery – 8 hr	167	0	**167**	447	0	**447**	1,292	0	**1,292**
Long Duration Energy Storage (LDES)	0	0	**0**	0	0	**0**	0	0	**0**
Geothermal	0	0	**0**	0	0	**0**	0	0	**0**
Biomass/Biogas	6	0	**6**	6	0	**6**	6	0	**6**
Distributed Solar	27	0	**27**	34	0	**34**	40	0	**40**
Total	**2,078**	**0**	**2,078**	**2,415**	**0**	**2,415**	**2,316**	**0**	**2,316**

Figure F.15-1: SCE Metro Interconnection Area – 2034 Base Portfolio

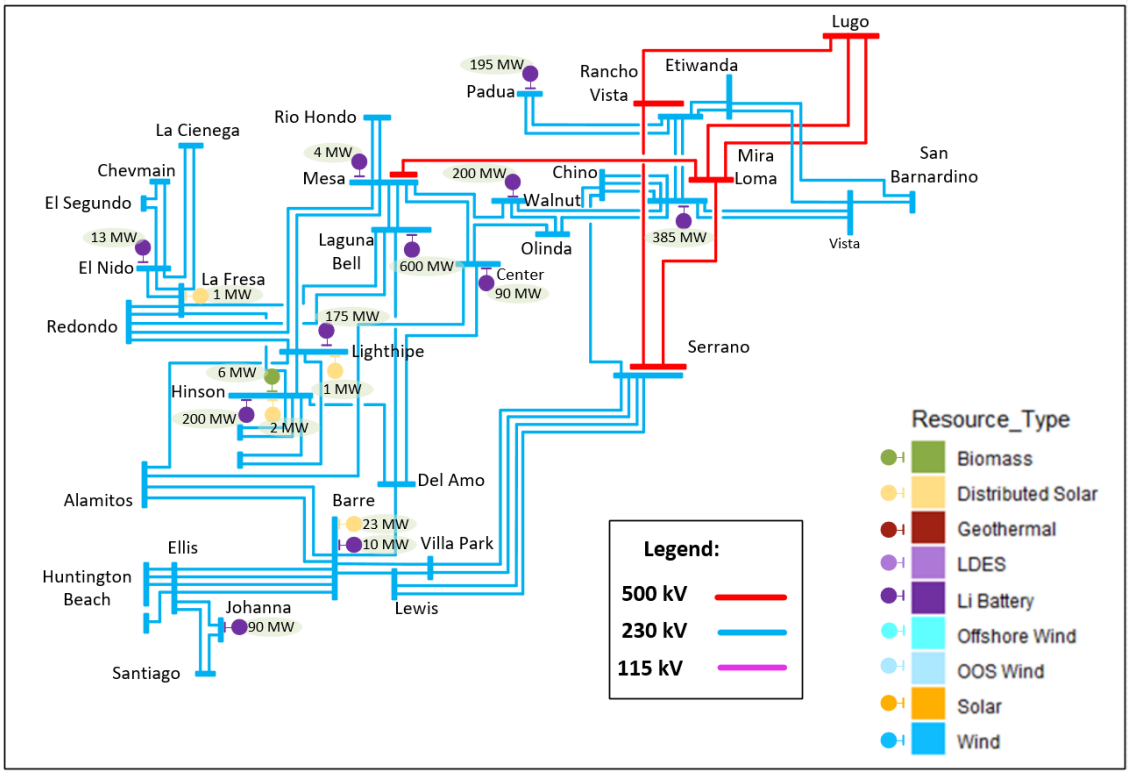
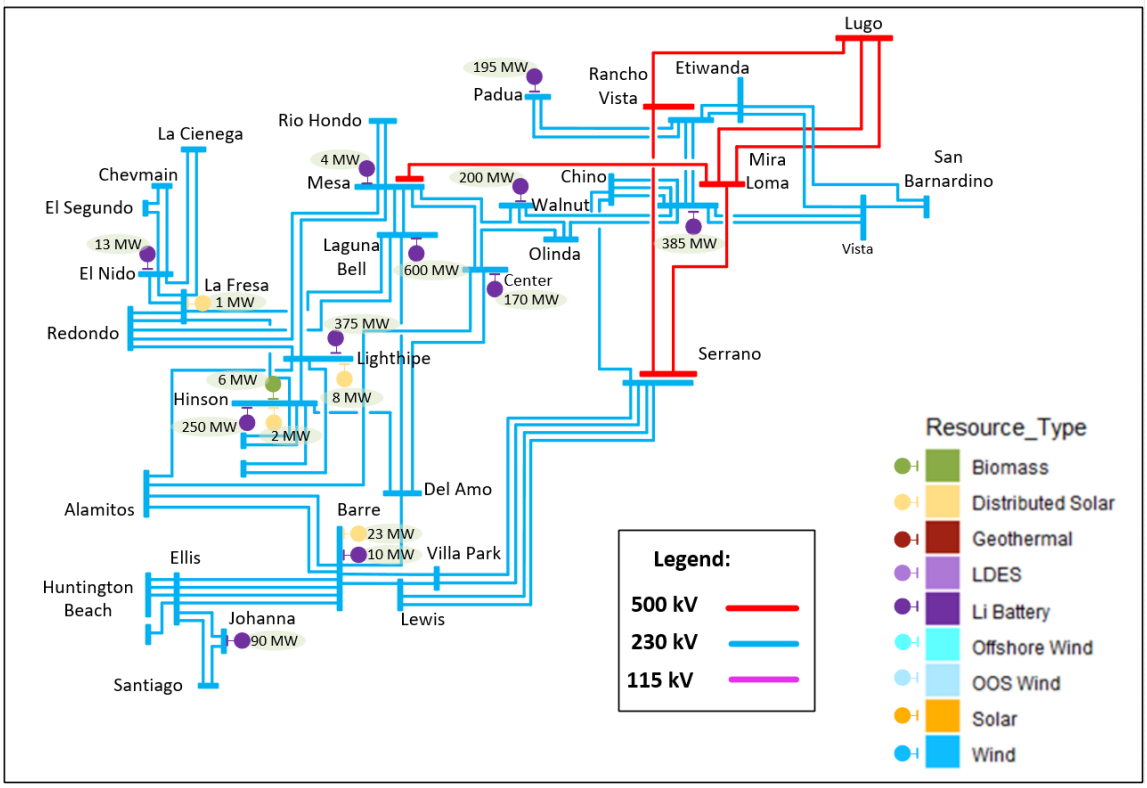


Figure F.15-2: SCE Metro Interconnection Area – 2039 Base Portfolio



F.15.1 2034 On-peak results

The SCE Metro area deliverability assessment did not identify any base portfolio 2034 on-peak deliverability constraints that require transmission upgrades.

F.15.2 2034 Off-peak results

The SCE Metro area deliverability assessment did not identify any base portfolio off-peak deliverability constraints that require transmission upgrades.

F.15.3 2039 On-peak results

The SCE Metro area deliverability assessment did not identify any base portfolio 2039 on-peak deliverability constraints that require transmission upgrades.

F.15.4 Conclusion and recommendation

The SCE Metro area deliverability assessment did not identify any base portfolio (on-peak or off-peak) deliverability constraints that require transmission upgrades.

F.16 SCE Eastern

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the SCE Eastern interconnection area are listed in Table F.16-1. The portfolios are comprised of solar, wind (in-state and out-of-state), battery storage and biomass/biogas resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.16-1: SCE Eastern Interconnection Area – Base and Sensitivity Portfolio by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	810	2,649	**3,459**	1,610	4,224	**5,834**	3,410	5,674	**8,784**
Wind – In State	224	100	**324**	224	100	**324**	224	100	**324**
Wind – Out-of-State	2,131	0	**2,131**	3,536	0	**3,536**	3,006	0	**3,006**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	3,770	468	**4,238**	3,270	468	**3,738**	3,179	468	**3,647**
Li Battery – 8 hr	270	0	**270**	1,070	0	**1,070**	1,875	0	**1,875**
Long Duration Energy Storage (LDES)	0	0	**0**	0	0	**0**	1,190	0	**1,190**
Geothermal	790	0	**790**	790	0	**790**	1,380	0	**1,380**
Biomass/Biogas	3	0	**3**	3	0	**3**	3	0	**3**
Distributed Solar	0	0	**0**	0	0	**0**	0	0	**0**
Total	**7,997**	**3,217**	**11,214**	**10,502**	**4,792**	**15,294**	**14,266**	**6,242**	**20,508**

The resources as identified in the CPUC busbar mapping for the SCE Eastern interconnection area are illustrated on the single-line diagram in Figure F.16-1 and Figure F.16-2.

Figure F.16-1: SCE Eastern Interconnection Area – Mapped 2034 Base Portfolio

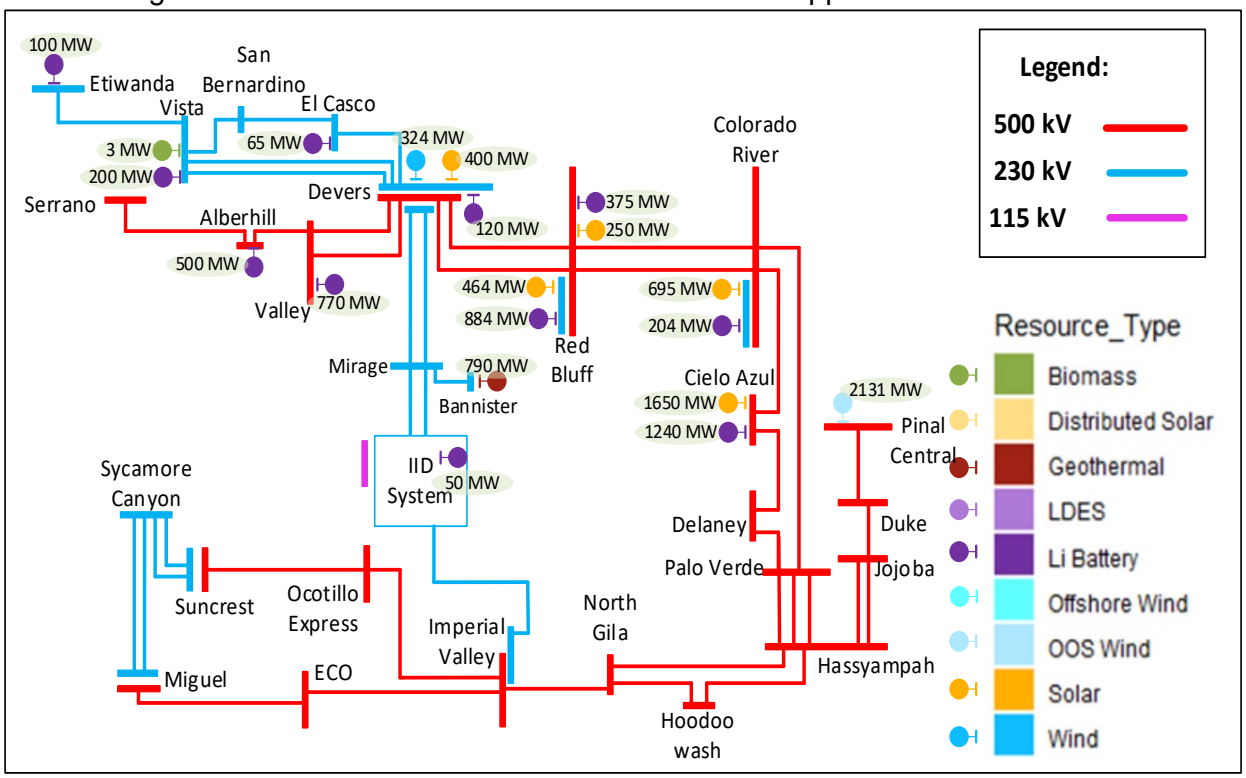
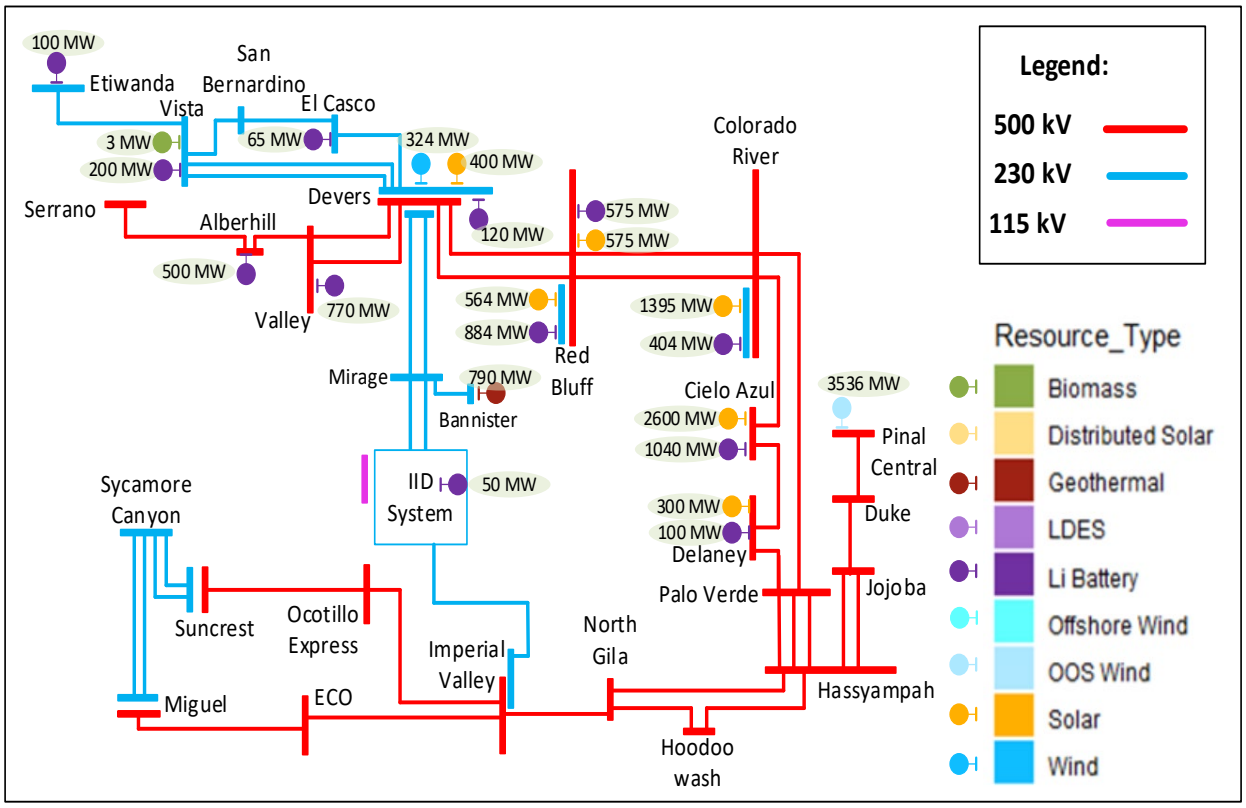


Figure F.16-2: SCE Eastern Interconnection Area – Mapped 2039 Base Portfolio



F.16.1 2034 On-peak results

Colorado River 500/230 kV constraint

The deliverability of FC resources interconnecting at the Colorado River 230 kV bus is limited by thermal overloading of the 500/230 kV transformers under Category P1 conditions as shown in Table F.16-2. The constraint was observed under both the HSN and SSN scenarios. Table F.16-3 shows the amount of generation that would be undeliverable without mitigation. The constraint can be mitigated by the existing West of Colorado River CRAS.

Table F.16-2: Colorado River 500/230 kV deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		HSN	SSN
Colorado River 500/230 kV Transformer No.1	Colorado River 500/230 kV Transformer No.2	121	121
Colorado River 500/230 kV Transformer No.2	Colorado River 500/230 kV Transformer No.1	121	121

Table F.16-3: Colorado River 500/230 kV deliverability constraint summary

Affected transmission zones		Colorado River 230 kV
Portfolio resources behind the constraint (Installed FCDS capacity)		455 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		160 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		556 MW
Mitigation Options	RAS	Existing West of Colorado River CRAS
	Reduce generic battery storage (MW)	Not needed
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Existing West of Colorado River CRAS

Affected interties	N/A
MIC expansion request MW behind constraint	N/A
Deliverable MIC expansion request MW	N/A

F.16.2 2034 Off-peak results

Colorado River 500/230 kV off-peak deliverability constraint

Wind and solar resources interconnecting at the Colorado River 230 kV bus are subject to curtailment in the base portfolio due to loading limitations on the transformers under Category P1 conditions, as shown in Table F.16-4. Pre-contingency curtailment can be avoided by dispatching battery storage in charging mode and/or utilizing the existing West of Colorado River CRAS.

Table F.16-4: Colorado River 500/230 kV off-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)
Colorado River 500/230 kV Transformer No.1	Colorado River 500/230 kV Transformer No.2	131
Colorado River 500/230 kV Transformer No.2	Colorado River 500/230 kV Transformer No.1	131

Table F.16-5: Colorado River 500/230 kV off-peak deliverability constraint summary

Affected renewable transmission zones		Colorado River 230 kV
Portfolio solar and wind resources behind the constraint		651 MW
Portfolio energy storage behind the constraint		160 MW
Renewable curtailment without mitigation		615 MW
Mitigation Options:	Portfolio ES (in charging mode)[25]	0 MW
	RAS	Existing West of Colorado River CRAS
	Transmission upgrades	Not needed
Recommended Mitigation		Existing West of Colorado River CRAS and/or baseline battery storage in charging mode

Red Bluff 500/230 kV off-peak deliverability constraint

Wind and solar resources interconnecting at the Red Bluff 230 kV bus are subject to curtailment in the base portfolio due to loading limitations on the transformers under Category P1 conditions, as shown in Table F.16-6. Pre-contingency curtailment can be avoided by

[25] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

dispatching battery storage in charging mode and/orutilizing the existing West of Colorado River CRAS.

Table F.16-6: Red Bluff 500/230 kV off-peak deliverability constraint

Overloaded Facility	Contingency	Loading (%)
Red Bluff 500/230 kV Transformer No.1	Red Bluff 500/230 kV Transformer No.2	118
Red Bluff 500/230 kV Transformer No.2	Red Bluff 500/230 kV Transformer No.1	118

Table F.16-7: Red Bluff 500/230 kV off-peak deliverability constraint summary

Affected renewable transmission zones		Red Bluff 230 kV
Portfolio solar and wind resources behind the constraint		471 MW
Portfolio energy storage behind the constraint		924 MW
Renewable curtailment without mitigation		370 MW
Mitigation Options:	Portfolio ES (in charging mode)[26]	0 MW
	RAS	Existing West of Colorado River CRAS
	Transmission upgrades	Not needed
Recommended Mitigation		Existing West of Colorado River CRAS and/or baseline battery storage in charging mode

[26] The Portfolio energy storage (in charging mode) amount is the amount needed to mitigate the constraint after baseline battery storage is fully utilized.

F.16.3 2039 On-peak results

Colorado River 500/230 kV constraint

The deliverability of FC resources interconnecting at the Colorado River 230 kV bus is limited by thermal overloading of the 500/230 kV transformers under Category P1 conditions as shown in Table F.16-8. The constraint was observed in both the base and sensitivity portiolios. Table F.16-9 shows the amount of generation that would be undeliverable without mitigation.

For the base portfolio, the constraint can be mitigated by the existing West of Colorado River CRAS. However, the CRAS alone is not sufficient for the sensitivity portfolio since the amount of generation tripping needed exceeds the 1150 MW limit for a P1 contingency. Reducing generic battery storage is also not considered to be a viable solution. To fully mitigate the constraint in the sensitivity portfolio, transmission upgrades are required. The transmission upgrade considered is to install another 500/230 kV transformer at Colorado River.

Table F.16-8: Colorado River 500/230 kV deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Colorado River 500/230 kV Transformer No.1	Colorado River 500/230 kV Transformer No.2	138	154
Colorado River 500/230 kV Transformer No.2	Colorado River 500/230 kV Transformer No.1	138	154

Table F.16-9: Colorado River 500/230 kV deliverability constraint summary

Affected transmission zones		Colorado River 230 kV	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		857 MW	1500 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		360 MW	500 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0 MW	0 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		958 MW	1609 MW
Mitigation Options	RAS	Existing West of Colorado River CRAS	Existing West of Colorado River CRAS alone not sufficient

	Reduce generic battery storage (MW)	Not needed	Not sufficient
	Transmission upgrade including cost	Not needed	New Colorado River No.3 500/230 kV transformer ($67M)
Recommended Mitigation		Existing West of Colorado River CRAS	Transmission upgrades only needed for sensitivity case

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

Devers-Red Bluff constraint

The deliverability of FC resources in the SCE Eastern and SDG&E areas is limited by thermal overloading of the Devers-Red Bluff 500 kV lines under Category P1 conditions as shown in Table F.16-10. The constraint was observed in both the base and sensitivity portiolios. Table F.16-11 shows the amount of generation that would be undeliverable without mitigation.

For the base portfolio, the constraint can be mitigated by the existing West of Colorado River CRAS. However, the CRAS alone is not sufficient for the sensitivity portfolio since the amount of generation tripping needed exceeds the 1150 MW limit for a P1 contingency. Reducing generic battery storage is also not considered to be a viable solution. To fully mitigate the constraint in the sensitivity portfolio, transmission upgrades are required. The transmission upgrade package considered is to build another Devers-Red Bluff 500 kV transmission line along with a new Devers-Mira Loma 500 kV transmission line.

Table F.16-10: Devers-Red Bluff deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Devers – Red Bluff 500 kV No.1	Devers – Red Bluff 500 kV No.2	101	118
Devers – Red Bluff 500 kV No.2	Devers – Red Bluff 500 kV No.1	101	118

Table F.16-11: Devers-Red Bluff deliverability constraint summary

Affected transmission zones		SCE Eastern (east of Red Bluff) and SDG&E	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		8038 MW	10419 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)		2456 MW	2969 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		7860 MW	8591 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		178 MW	1828 MW
Mitigation Options	RAS	Existing West of Colorado River CRAS	Existing West of Colorado River CRAS alone not sufficient
	Reduce generic battery storage (MW)	Not needed	Not sufficient
	Transmission upgrade including cost	Not needed	New Devers-Red Bluff 500 kV transmission line ($875M) and New Devers-Mira Loma 500 kV transmission line ($1.1B)
Recommended Mitigation		Existing West of Colorado River CRAS	Transmission upgrades only needed for sensitivity case

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

WECC Path 42 constraint

The deliverability of FC resources in the IID area is limited by thermal overloading of 230 kV lines related to WECC Path 42 as shown in Table F.16-12. The constraint was only observed in the sensitivity portiolio. Table F.16-13 shows the amount of generation that would be undeliverable without mitigation. The constraint can be mitigated by the Path 42 RAS.

Table F.16-12: WECC Path 42 deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Coachella Valley – Ramon 230 kV No.1	Coachella Valley – Mirage 230 kV No.1	<100	113
Ramon – Mirage 230 kV No.1		<100	103
Coachella Valley – Mirage 230 kV No.1	Coachella Valley – Ramon 230 kV No.1	<100	108

Table F.16-13: WECC Path 42 deliverability constraint summary

Affected transmission zones		IID	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		N/A	1608 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)			0 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)			1355 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)			253 MW
Mitigation Options	RAS		Path 42 RAS expansion
	Reduce generic battery storage (MW)		Not needed
	Transmission upgrade including cost		Not needed
Recommended Mitigation			Path 42 RAS expansion only needed for sensitivity case

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

Serrano-Alberhill-Valley constraint

The deliverability of FC resources in the SCE Eastern, SDG&E, and IID areas is limited by thermal overloading of lines and transformers as shown in Table F.16-14. The constraint was only observed in the sensitivity portiolio. Table F.16-15 shows the amount of generation that would be undeliverable without mitigation.

RAS is not allowed to address a base case overload, therefore, it is not a valid solution for the Serrano-Alberhill-Valley constraint. Reducing generic battery storage is also not considered to be a viable solution. To fully mitigate the constraint in the sensitivity portfolio, transmission upgrades are required. The transmission upgrade package considered is to build another Devers-Red Bluff 500 kV transmission line along with a new Devers-Mira Loma 500 kV transmission line.

Table F.16-14: Serrano-Alberhill-Valley deliverability constraint

Overloaded Facility	Contingency	Loading (%)	
		Base	Sensitivity
Devers 500/230 kV Transformer No. 1	Serrano-Alberhill-Valley 500 kV No.1	<100	108
Serrano-Alberhill-Valley 500 kV No.1	Base Case	<100	102

Table F.16-15: Serrano-Alberhill-Valley deliverability constraint summary

Affected transmission zones		SCE Eastern, SDG&E, IID	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		N/A	11725 MW
Portfolio battery storage behind the constraint (Installed FCDS capacity)			3775 MW
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)			11250 MW
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)			475 MW
Mitigation Options	RAS		RAS not allowed to address Base Case overload
	Reduce generic battery storage (MW)		Not sufficient
	Transmission upgrade including cost		New Devers-Mira Loma 500 kV transmission line ($1.1B) and

			New Devers-Red Bluff 500 kV transmission line ($875M)
Recommended Mitigation			Transmission upgrades only needed for sensitivity case

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

F.16.4 Conclusion and recommendation

The SCE Eastern area base and sensitivity portfolios deliverability assessment identified on-peak and off-peak deliverability constraints. RAS can be used to mitigate several of these constraints. The off-peak deliverability constraints can also be mitigated by dispatching battery storage in charging mode. And while transmission upgrades were considered, none of those upgrades are being recommended for approval in this planning cycle given that they are only needed for the 2039 sensitivity portfolio.

Vista-Etiwanda 230 kV 1 Line Upgrade scope change

The ISO approved the Vista-Etiwanda 230 kV 1 Line Upgrade project in the 2022-2023 Transmission Plan to increase the rating of the Vista-Etiwanda No. 1 230 kV line from 797 / 876 MVA (normal/emergency) to 988 / 1331 MVA (normal/emergency). The scope of this project requires ground clearance violations on the line to be mitigated, and by doing so, it allows the line to achieve the full conductor rating.

SCE has begun the execution of this project and recommends the following scope modification:

- The Etiwanda-Vista 230 kV line and Etiwanda-San Bernardino 230 kV line share double circuit structures along a 10-mile corridor. The Etiwanda – San Bernardino 230 kV line is to be reconductord with HTLS as part of a separate project approved in the 2022-2023 Transmission Plan. Complexities in execution arise with two separate projects on the same tower/structure. Thus, SCE recommends modifying the original scope from mitigating ground clearance with structure raises to, mitigating ground clearance by reconductoring 10 miles of the Etiwanda- Vista 230 kV line with HTLS (along the double circuit corridor) and raising four structures resulting in the requested 988/1331 MVA (normal/emergency) rating. The estimated cost is $19 million.

The ISO concurs with the scope modifications recommended by SCE.

F.17 SDG&E area

The total capacity of resources, by resource type, selected with Full Capacity Deliverability Status (FCDS) as well as those selected as Energy Only (EO) in the SDG&E interconnection area are listed in Table F.17-1. The portfolios in the interconnection area are comprised of solar, wind (instate), battery storage, geothermal, and long duration energy storage resources. All portfolio resources are modeled in policy-driven assessments except in the on-peak deliverability assessment in which only FCDS resources are modeled.

Table F.17-1: SDG&E Interconnection Area – Base and Sensitivity Portfolio by Resource Types (FCDS, EO and Total)

Resource Type	2034 Base Portfolio			2039 Base Portfolio			2039 Sensitivity Portfolio		
	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)	FCDS (MW)	EO (MW)	Total (MW)
Solar	700	882	**1,582**	700	1,219	**1,919**	1,950	2,544	**4,494**
Wind – In State	1,325	239	**1,564**	1,325	239	**1,564**	1,295	289	**1,584**
Wind – Out-of-State	0	0	**0**	0	0	**0**	0	0	**0**
Wind - Offshore	0	0	**0**	0	0	**0**	0	0	**0**
Li Battery – 4 hr	1,390	0	**1,390**	1,390	0	**1,390**	1,100	0	**1,100**
Li Battery – 8 hr	100	0	**100**	305	0	**305**	985	0	**985**
Long Duration Energy Storage (LDES)	437	0	**437**	487	0	**487**	500	0	**500**
Geothermal	160	0	**160**	160	0	**160**	866	0	**866**
Biomass/Biogas	0	0	**0**	0	0	**0**	0	0	**0**
Distributed Solar	1	0	**1**	1	0	**1**	1	0	**1**
Total	**4,113**	**1,121**	**5,234**	**4,368**	**1,458**	**5,826**	**6,697**	**2,833**	**9,530**

The resources as identified in the CPUC busbar mapping for the SDG&E interconnection area are illustrated on the single-line diagram in Figure F.17-1 and Figure F.17-2.

Figure F.17-1: SDG&E Interconnection Area – Mapped 2034 Base Portfolio

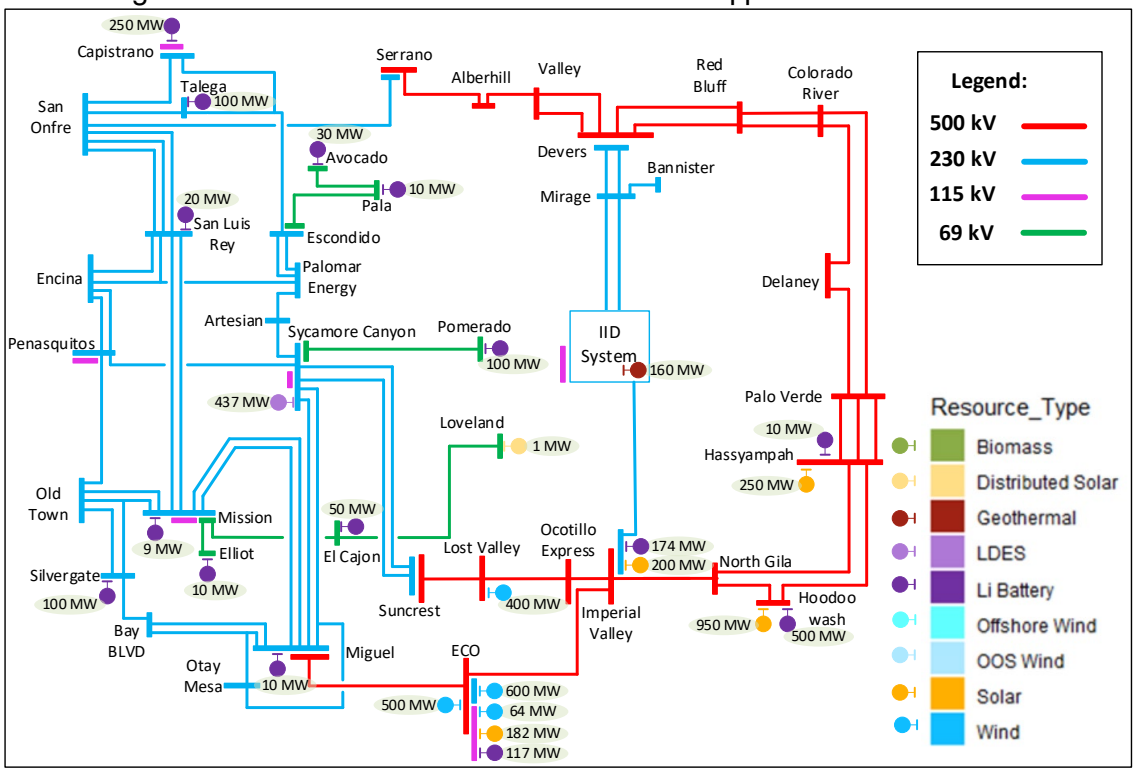
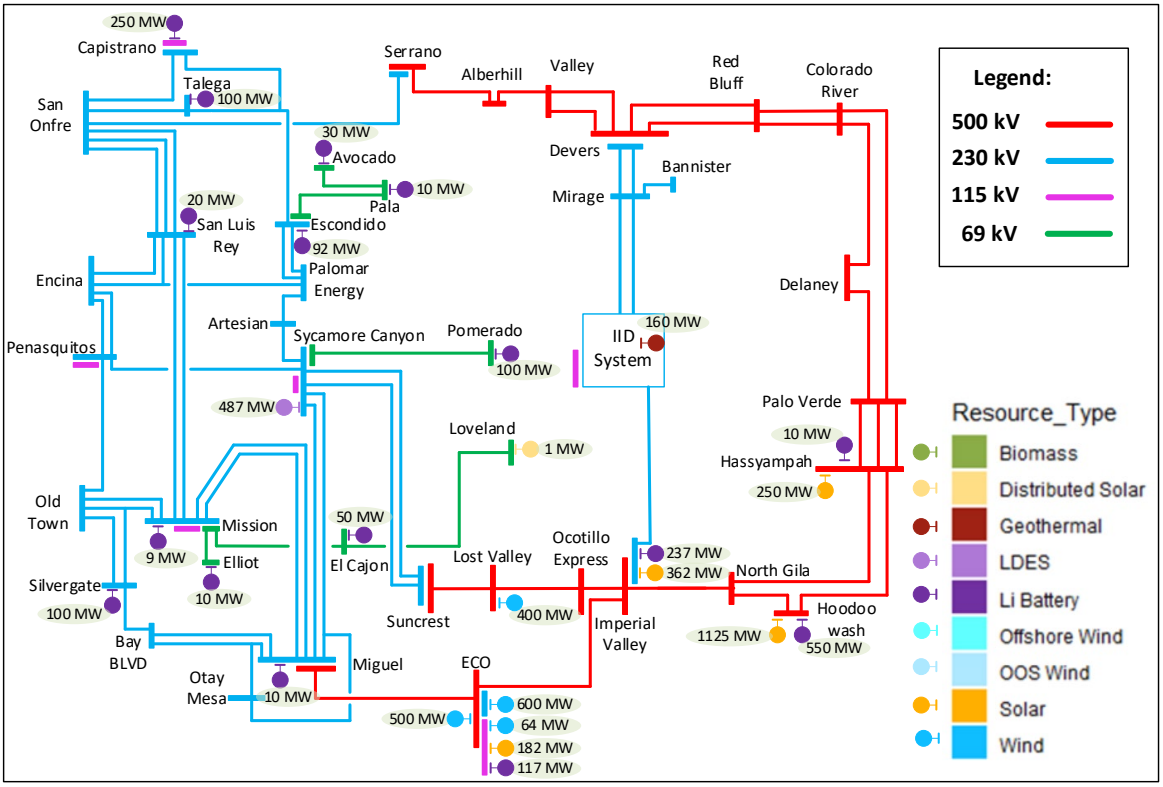


Figure F.17-2: SDG&E Interconnection Area – Mapped 2039 Base Portfolio



F.17.1 2034 On-peak results

Bay Boulevard-Silvergate constraint

The deliverability of portfolio resources in the Bay Boulevard-Silvergate area is limited by thermal overloading of the Bay Boulevard-Silvergate 230 kV line as shown in Table F.17-2. The constraint was seen in both the HSN and SSN scenarios, with the higher loadings being in the HSN scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the 2-hour emergency rating of the Bay Boulevard-Silvergate 230 kV line.

Table F.17-2: Bay Boulevard-Silvergate deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**HSN**	**SSN**
Bay Boulevard-Silvergate 230 kV	Imperial Valley-NSONGS 500 kV	106	100
Bay Boulevard-Silvergate 230 kV	Miguel-Mission 230 kV #1 and #2	108	<100

Table F.17-3: Bay Boulevard-Silvergate deliverability constraint summary

Affected transmission zones		Imperial Valley, ECO/BUE, SDGE Internal
Portfolio resources behind the constraint (Installed FCDS capacity)		746
Portfolio battery storage behind the constraint (Installed FCDS capacity)		121
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		0
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		971
Mitigation Options	RAS	None
	Reduce generic battery storage (MW)	None
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Use 2 hour emergency rating

Affected interties	IID-SDGE_ITC
MIC expansion request MW behind constraint	35
Deliverable MIC expansion request MW	35 (Use 2 hour emergency rating)

Silvergate-Old Town constraint

The deliverability of portfolio resources in the Silvergate-Old Town area is limited by thermal overloading of the Silvergate-Old Town 230 kV lines as shown in Table F.17-4. The constraint was seen in both the HSN and SSN scenarios, with the higher loadings being in the HSN scenario.

Table F.17-5: Silvergate-Old Town deliverability constraint summary shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the 30 minute rating of the overloaded lines.

Table F.17-4: Silvergate-Old Town deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**HSN**	**SSN**
Silvergate-Old Town 230 kV	Silvergate-Mission-Old Town 230 kV	108	103
Silvergate-Old Town Tap 230 kV	Silvergate-Old Town 230 kV	107	104
Silvergate-Old Town Tap 230 kV	Silvergate-Mission-Old Town 230 kV and Old Town-Mission 230 kV	103	<100

Table F.17-5: Silvergate-Old Town deliverability constraint summary

Affected transmission zones		Imperial Valley, ECO/BUE, SDGE Internal
Portfolio resources behind the constraint (Installed FCDS capacity)		501
Portfolio battery storage behind the constraint (Installed FCDS capacity)		184
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		136
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		365
Mitigation Options	RAS	None
	Reduce generic battery storage (MW)	None
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Use 30 minute emergency rating

Affected interties	IID-SDGE_ITC
MIC expansion request MW behind constraint	35

Deliverable MIC expansion request MW	35 (Use 30 minute emergency rating)

Encina-San Luis Rey constraint

The deliverability of portfolio resources in the Encina-San Luis Rey area is limited by thermal overloading of the Encina Tap-San Luis Rey 230 kV line as shown in Table F.17-4. The constraint was seen in the SSN scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS.

Table F.17-6: Encina-San Luis Rey deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**HSN**	**SSN**
Encina Tap-San Luis Rey 230 kV	San Luis Rey-Encina 230 kV	<100	110

Table F.17-7: Encina-San Luis Rey deliverability constraint summary

Affected transmission zones		Imperial Valley, ECO/BUE, SDGE Internal
Portfolio resources behind the constraint (Installed FCDS capacity)		2990
Portfolio battery storage behind the constraint (Installed FCDS capacity)		448
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		1783
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		1207
Mitigation Options	RAS	Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS
	Reduce generic battery storage (MW)	None
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS

Affected interties	IID-SDGE_ITC

MIC expansion request MW behind constraint	35
Deliverable MIC expansion request MW	35 (Use existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS)

San Luis Rey-San Onofre constraint

The deliverability of portfolio resources in the San Luis Rey-San Onofre area is limited by thermal overloading of the San Luis Rey-San Onofre 230 kV #1 line as shown in Table F.17-8. The constraint was seen in the SSN scenario. Table F.17-9 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the existing 230kV TL 23006 San Luis Rey-San Onofre RAS.

Table F.17-8: San Luis Rey-San Onofre deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**HSN**	**SSN**
San Luis Rey-San Onofre 230 kV #1	San Luis Rey-San Onofre 230 kV #2 and #3	<100	106

Table F.17-9: San Luis Rey-San Onofre deliverability constraint summary

Affected transmission zones		Imperial Valley, ECO/BUE, SDGE Internal, Arizona
Portfolio resources behind the constraint (Installed FCDS capacity)		3800
Portfolio battery storage behind the constraint (Installed FCDS capacity)		726
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		3325
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		475
Mitigation Options	RAS	Existing 230kV TL 23006 San Luis Rey-San Onofre RAS
	Reduce generic battery storage (MW)	Not sufficient
	Transmission upgrade including cost	Not needed
Recommended Mitigation		Existing 230kV TL 23006 San Luis Rey-San Onofre RAS

Affected interties	IID-SDGE_ITC
MIC expansion request MW behind constraint	35
Deliverable MIC expansion request MW	35 (Use existing 230kV TL 23006 San Luis Rey-San Onofre RAS)

F.17.2 2034 Off-peak results

The Off-peak deliverability assessment did not identify any constraints in the SDG&E area.

F.17.3 2039 On-peak results

Old Town constraint

The deliverability of portfolio resources in the Old Town area is limited by thermal overloading of the Old Town 230/69 kV transformers as shown in Table F.17-2. The constraint was seen in the 2039 Base scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

These overloads were also observed in the reliability study, and the proposed Downtown Reliability Reinforcement project that was identified in that analysis also mitigates the overloads in in the deliveabilty assessment.

Table F.17-10: Old Town deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Old Town 230/69 kV #1	Old Town 230/69 kV #2	101	<100
Old Town 230/69 kV #2	Old Town 230/69 kV #1	101	<100

Table F.17-11: Old Town deliverability constraint summary

Affected transmission zones	N/A	
	Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)	No generation in 5% DFAX circle	
Portfolio battery storage behind the constraint (Installed FCDS capacity)		
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		

Mitigation Options	RAS	Downtown Reliability Reinforcement project (identified in reliability study)
	Reduce generic battery storage (MW)	
	Transmission upgrade including cost	
Recommended Mitigation		

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

Sycamore-Scripps constraint

The deliverability of portfolio resources in the Sycamore-Scripps area is limited by thermal overloading of the Sycamore-Scripps 69 kV line as shown in Table F.17-2. The constraint was seen in the 2039 Base and Sensitivity scenarios. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the 30 minute emergency rating of the Sycamore-Scripps 69 kV line.

Table F.17-12: Sycamore-Scripps deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Sycamore-Scripps 69 kV	Sycamore-Penasquitos 230 kV	113	117
Sycamore-Scripps 69 kV	Miramar GT-Miramar 69 kV	102	103
Sycamore-Scripps 69 kV	Sycamore-Penasquitos 230 kV and Mira Sorrento-Penasquitos 69 kV	113	117

Table F.17-13: Sycamore-Scripps constraint summary

Affected transmission zones	SDGE Internal	
	Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)	591	601
Portfolio battery storage behind the constraint (Installed FCDS capacity)	101	101

Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		479	489
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		113	113
Mitigation Options	RAS	None	
	Reduce generic battery storage (MW)	None	
	Transmission upgrade including cost	Not needed	
Recommended Mitigation		Use 30 minute emergency rating	

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

Bay Boulevard-Silvergate constraint

The deliverability of portfolio resources in the Bay Boulevard-Silvergate area is limited by thermal overloading of the Bay Boulevard-Silvergate 230 kV line as shown in Table F.17-2. The constraint was seen in the 2039 Sensitivity scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the 2-hour emergency rating of the Bay Boulevard-Silvergate 230 kV line.

Table F.17-14: Bay Boulevard-Silvergate deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Bay Boulevard-Silvergate 230 kV	Imperial Valley-NSONGS 500 kV	<100	104
Bay Boulevard-Silvergate 230 kV	Miguel-Mission 230 kV #1 and #2	<100	103

Table F.17-15: Bay Boulevard-Silvergate deliverability constraint summary

Affected transmission zones	Imperial Valley, ECO/BUE, SDGE Internal	
	Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)	1579	3064

Portfolio battery storage behind the constraint (Installed FCDS capacity)		342	562
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		1579	2699
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		0	364
Mitigation Options	RAS	None	
	Reduce generic battery storage (MW)	None	
	Transmission upgrade including cost	Not needed	
Recommended Mitigation		Use 2 hour emergency rating	

Affected interties	IID-SDGE_ITC	
	Base	Sensitivity
MIC expansion request MW behind constraint	35	N/A
Deliverable MIC expansion request MW	35 (Use 2 hour emergency rating)	N/A

Silvergate-Old Town constraint

The deliverability of portfolio resources in the Silvergate-Old Town area is limited by thermal overloading of the Silvergate-Old Town 230 kV lines as shown in Table F.17-2. The constraint was seen in the 2039 Sensitivity scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the 30 minute rating of the overloaded lines.

Table F.17-16: Silvergate-Old Town deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Silvergate-Old Town 230 kV	Old Town-Mission 230 kV and Silvergate-Mission-Old Town 230 kV	<100	101

Table F.17-17: Silvergate-Old Town deliverability constraint summary

Affected transmission zones	Imperial Valley, ECO/BUE, SDGE Internal	
	Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)	1303	1971

Portfolio battery storage behind the constraint (Installed FCDS capacity)		236	236
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		1303	1862
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		0	109
Mitigation Options	RAS	None	
	Reduce generic battery storage (MW)	None	
	Transmission upgrade including cost	Not needed	
Recommended Mitigation		Use 30 minute emergency rating	

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

Encina-San Luis Rey constraint

The deliverability of portfolio resources in the Encina-San Luis Rey area is limited by thermal overloading of the Encina Tap-San Luis Rey 230 kV line as shown in Table F.17-2. The constraint was seen in the 2039 Sensitivity scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS.

Table F.17-18: Encina-San Luis Rey deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Encina Tap-San Luis Rey 230 kV	San Luis Rey-Encina 230 kV	<100	103
Encina Tap-San Luis Rey 230 kV	Imperial Valley-North of SONGS 500 kV	<100	102

Table F.17-19: Encina-San Luis Rey deliverability constraint summary

Affected transmission zones	Imperial Valley, ECO/BUE, SDGE Internal	
	Base	Sensitivity

Portfolio resources behind the constraint (Installed FCDS capacity)		3196	4646
Portfolio battery storage behind the constraint (Installed FCDS capacity)		1052	1271
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		3196	4348
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		0	298
Mitigation Options	RAS	Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS	
	Reduce generic battery storage (MW)	Not sufficient	
	Transmission upgrade including cost	Not needed	
Recommended Mitigation		Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS	

Affected interties	IID-SDGE_ITC	
	Base	Sensitivity
MIC expansion request MW behind constraint	35	N/A
Deliverable MIC expansion request MW	35 (Use existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS)	N/A

Escondido-San Marcos constraint

The deliverability of portfolio resources in the Escondido-San Marcos area is limited by thermal overloading of the Escondido-San Marcos 69 kV line as shown in Table F.17-20. The constraint was seen in the 2039 Sensitivity scenario. Table F.17-3 shows the amount of portfolio generation that would be deliverable without any transmission upgrades.

The constraint can be mitigated by using the existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS.

Table F.17-20: Encina-San Luis Rey deliverability constraint

		Highest Loading (%)	
Overloaded Facility	**Contingency**	**Base**	**Sensitivity**
Escondido-San Marcos 69 kV	San Luis Rey-Encina 230 kV and San Luis Rey-Encina-Palomar 230 kV	<100	106

Table F.17-21: Encina-San Luis Rey deliverability constraint summary

Affected transmission zones		Imperial Valley, ECO/BUE, SDGE Internal	
		Base	Sensitivity
Portfolio resources behind the constraint (Installed FCDS capacity)		634	643
Portfolio battery storage behind the constraint (Installed FCDS capacity)		143	143
Deliverable portfolio resources w/o mitigation (Installed FCDS capacity)		634	521
Total undeliverable baseline and portfolio resources (Installed FCDS capacity)		0	122
Mitigation Options	RAS	Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS	
	Reduce generic battery storage (MW)	None	
	Transmission upgrade including cost	Not needed	
Recommended Mitigation		Existing 230kV TL 23003 Encina-San Luis Rey/ TL 23011 Encina-San Luis Rey-Palomar RAS	

Affected interties	N/A	
	Base	Sensitivity
MIC expansion request MW behind constraint	N/A	N/A
Deliverable MIC expansion request MW	N/A	N/A

F.17.4 Conclusion and recommendation

The SDG&E area base and sensitivity portfolios deliverability assessment identified on peak constraints. These constraints can be mitigated by using existing RAS and emergency ratings of

the overloaded lines. The off-peak deliverability assessment did not identify any constraints. Transmission upgrades in the SDG&E area are not found to be needed in this planning cycle.

F.18 Out-of-State Wind

In the CPUC submitted portfolios for Out of State wind (OOS) resources for the 2024-2025 TPP, there is a total of approximately 6 GW for 2034 and 9 GW for 2039 in the base portfolios. For 2034, the base portfolio includes 1,060 MW from Idaho, 2,905 MW from Wyoming, and 2,131 MW from New Mexico. For 2039, in the base portfolio, in addition to these amounts, there is an additional 1,500 MW from Wyoming and an additional 1,405 MW from New Mexico. All the required MW amounts require developing new transmission as well as transmission upgrades within the ISO footprint.

Based on transmission projects approved in the 2022-2023 TPP, the three transmission projects namely SWIP-North, TWE, and SunZia combined help in integrating 5,700 MW of OOS resources from Idaho, Wyoming, and New Mexico. It should also be noted that the scheduling rights for Sunzia from Pinal Central to Palo Verde is about 2,131 MW. The 2039 base portfolio has 3,536 MW New Mexico wind which equals 2,369 MW study amount. After taking into account 5% lost factor on HVDC line, there is still not enough scheduling right from Pinal Central to Palo Verde. The ISO needs to determine additional transmission projects that would be needed to integrate the additional amounts of wind resources from Wyoming and New Mexico. The ISO is not proposing the approval of any transmission project or upgrade in the 2024-2025 TPP for integrating additional OOS resources from Wyoming and New Mexico. This is also consistent with the CPUC Decision 25-02-026[27] issued on February 20, 2025 not to trigger upgrades related to the additional OOS wind amounts in the portfolio that are beyond the amounts that can be accommodated on the already-identified and in-development transmission upgrades.

The ISO will undertake a special study of the various routes and combinations for the OOS wind amounts to learn more information about the details of potential routes. This will allow for analysis of alternative locations for injecting the resources onto the CAISO grid and the potential transmission solutions. Moreover, the ISO will coordinate with CPUC staff as it pursues additional modeling with new OOS wind profiles and cost estimates to confirm the need for the high level of OOS wind. Engagement with utilities in the West to seek mutually beneficial transmission solutions and results from the WestTEC studies will also help inform the ISO as it works towards developing transmission solutions to integrate additional OOS resources.

While the ISO is working on transmission solutions to integrate additional OOS wind resources, it must be noted that in order to support the 1500 MW of Wyoming wind interconnecting to Tesla 500 kV in 2039, the ISO is relying on a Tesla substation expansion project identified through the generator interconnection process. Additional analysis will be performed in future cycles to evaluate if additional updates to this project are required.

[27] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M557/K879/557879249.PDF

Northern California Wind was evaluated as part of the 2024-2025 TPP. The amount of generation currently mapped (900 MW) will be able to be supported through existing transmission however significant increases to the generation may require additional transmission to deliver the generation to CAISO system. This will be evaluated in future cycles.

F.19 Transmission Plan Deliverability with Approved Transmission Upgrades

As part of the coordination with other ISO processes and as set out in Appendix DD (GIDAP) of the ISO tariff, the ISO monitors the available transmission plan deliverability (TPD) in areas where the amount of generation in the interconnection queue exceeds the available deliverability, as identified in the generator interconnection cluster studies. In areas where the amount of generation in the interconnection queue is less than the available deliverability, the transmission plan deliverability is sufficient. An estimate of the generation deliverability supported by the existing system and approved upgrades is provided in the transmission capability estimates white paper the ISO published in August 2024[28]. The white paper considered queue clusters up to and including queue cluster 14. The transmission plan deliverability is estimated based on the area deliverability constraints identified in recent generation interconnection studies without considering local deliverability constraints.

F.20 Production cost model (PCM) results

The CPUC IRP portfoliosdescribed in section F.4 were used to develop planning PCM cases that were used for both policy and economic assessments. Transmission congestion and renewable curtailment were assessed in the PCM studies. Details of PCM development and study results can be found in Chapter 4 and Appendix G.

[28] https://www.caiso.com/library/transmission-capability-estimate-inputs-for-cpuc-integrated-resource-plan-aug-29-2024