Modeling Assumptions for the 2024-2025 Transmission Planning Process

CPUC Staff Report

February 2024

Contents

1. Document Purpose

Resource-to-busbar mapping ("busbar mapping") is the process of refining the geographically coarse electricity resource portfolios produced in the California Public Utilities Commission's (CPUC) Integrated Resource Planning (IRP) proceeding, into plausible transmission network modeling locations (i.e., busbars) for transmission analysis in the California Independent System Operator's (CAISO) annual Transmission Planning Process (TPP).

The purpose of this Report is to memorialize and communicate the results of the busbar mapping process, performed by the CPUC, CAISO and California Energy Commission (CEC) staff and transmitted to the CAISO for input into the 2024-2025 TPP by the CPUC Decision (D.) 24-02-047.[1] The key output of busbar mapping is the locations of the resources in the portfolio and this Report summarizes those mapping results and the analysis perform to obtain those results. While transmission constraint information and analysis are incorporated into this analysis, busbar mapping and the CPUC do not identify and trigger transmission upgrades. The transmission information utilized and summarized in this Report only helps to inform the mapping locations and identifies where potential upgrades may be needed. It is the CAISO's role through the full transmission analysis in the TPP to identify whether transmission upgrades would be necessary to accommodate the resources mapped in this analysis.

The CPUC has traditionally provided a document describing planning and modeling assumptions to accompany the portfolios transmitted for study in the TPP annually. It was originally called the "Long-Term Procurement Plan Assumptions and Scenarios" and later the "Unified Inputs and Assumptions". Starting with the 2020-2021 TPP, the CPUC has provided "Modeling Assumptions" documentation similar to what is in this Report describing guidance on the mapping results for previous TPP studies. Thus, this Report supersedes earlier guidance and documents.[2]

The approach taken in this Report serves to provide detailed documentation to accompany several Excel workbooks that identify the locations for future generation and storage resources that are expected to be necessary to support the California electric grid. Please see Section 10: Appendices for links to these workbooks along with the previously released busbar mapping methodology document.

[1] Decision 24-02-047. "Decision Adopting 2023 Preferred System Plan and Related Matters, and Addressing two petitions for modification." 02/15/24.
https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=525918033

[2] Previous busbar mapping Reports for earlier TPP cycles are posted to the IRP webpage. The previous Report for the 23-24 TPP is at the Assumptions for the 23-24 TPP webpage: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials/portfolios-and-modeling-assumptions-for-the-2023-2024-transmission-planning-process

2. Scope

This Report addresses the busbar mapping and other modeling assumptions for the portfolios being transmitted by the CPUC to the CAISO for the 2024-2025 TPP, as outlined in Table 1 below.

Table 1: Modeling assumptions reported in this document.

IRP Portfolio	**2023-2024 TPP Portfolio Use Case(s)**	**Modeling Assumptions**
2023 PSP portfolio (25 MMT GHG target by 2035 Core portfolio using the 2022 CEC IEPR Planning Forecast) —base case portfolio	• Reliability base case • Policy-driven base case assessment • Economic assessments	• Busbar allocations of non-battery resources and battery resources for 2034 and 2039 model years • Baseline reconciliation between the new 2022-23 IRP baseline and the CAISO's 2023 White Paper baseline. • Thermal units not retained assumptions
25 MMT high gas retirement sensitivity portfolio using the 2022 CEC IEPR Planning Forecast (includes 15.9 GW of gas retirements by 2039 — high gas retirement sensitivity portfolio	• Policy-driven sensitivity assessment	• Busbar allocations of non-battery resources and battery resources for 2034 and 2039 model years • Baseline reconciliation between the new 2022-23 IRP baseline and the CAISO's 2023 White Paper baseline. • Thermal units not retained assumptions

3. Report Summary

The October 10, 2023, Ruling Seeking Comments on Proposed 2023 Preferred System Plan and Transmission Planning Process Portfolios[3] proposed the 2023 PSP Portfolio, the 25 MMT GHG target by 2035 Core portfolio using the 2022 CEC Integrated Energy Policy Report (IEPR) Planning forecast and including LSEs' 2022 individual IRP resources, as the reliability and policy-driven base case portfolio for the 2024-2025 TPP. The ruling proposed mapping and transmitting two study years: 2034 and 2039 for this base case portfolio in compliance with the requirements of SB 887 (Stats. 2022, Ch. 358).[4] The ruling also proposed transmitting a high gas retirement policy-driven sensitivity portfolio, portfolio, which includes a total of 9.1 GW of gas retirements in 2034 and a total of 15.9 GW in 2039. These portfolios were confirmed as the portfolios for the 2024-25 TPP by the February 15, 2024, Decision (D.) 24-02-047.

The base case portfolio includes over 37,200 MW of renewable resources and 17,600 MW of storage in the 2034 model year. The portfolio's 2039 model year includes over 53,400 MW of renewables, including 1,970 MW of geothermal, 9,000 MW of out-of-state wind on new out-of-state transmission, and 4,500 MW of offshore wind, as well as 23,900 MW of storage, including 1,000 MW of long duration storage. These new resources are incremental to the resources included in the 2023 IRP modeling baseline, which includes both existing resources and new resources not yet online.

Figure 1 below, includes a graph and map which provide a geographic overview of the mapped results for base case portfolio's 2034 model year. The map provides an overview of the locations, amounts, and type of resources mapped through the implementation of the busbar mapping process, while the chart summarizes the amount map by general region. Figure 2, shows the same overview for the base case portfolio's 2039 model year mapping results.

The high gas retirement sensitivity portfolio's 2039 mapping results are comprised of 70,000 MW of renewable resources and 28,600 MW of storage. The sensitivity portfolio also includes 15,900 MW of gas capacity not retained in 2039, which incorporates ~12,200 MW of non-OTC (once-through cooling) gas plants. Figure 3 depicts a map showing the general locations and amounts by resource type of the 2039 mapping results for the gas retirement sensitivity and chart summarizes the mapped resources by resource type and region.

[3] https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=520522241

[4] SB 887 established PUC § 454.57 which requires, amongst other things, the CPUC to transmit to the CAISSO for its TPP resource portfolios for at least 15 years into the future to ensure adequate lead time for transmission planning and development.

Figure 1: Final busbar mapping results of the 24-25 TPP base case portfolio 2034 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region.

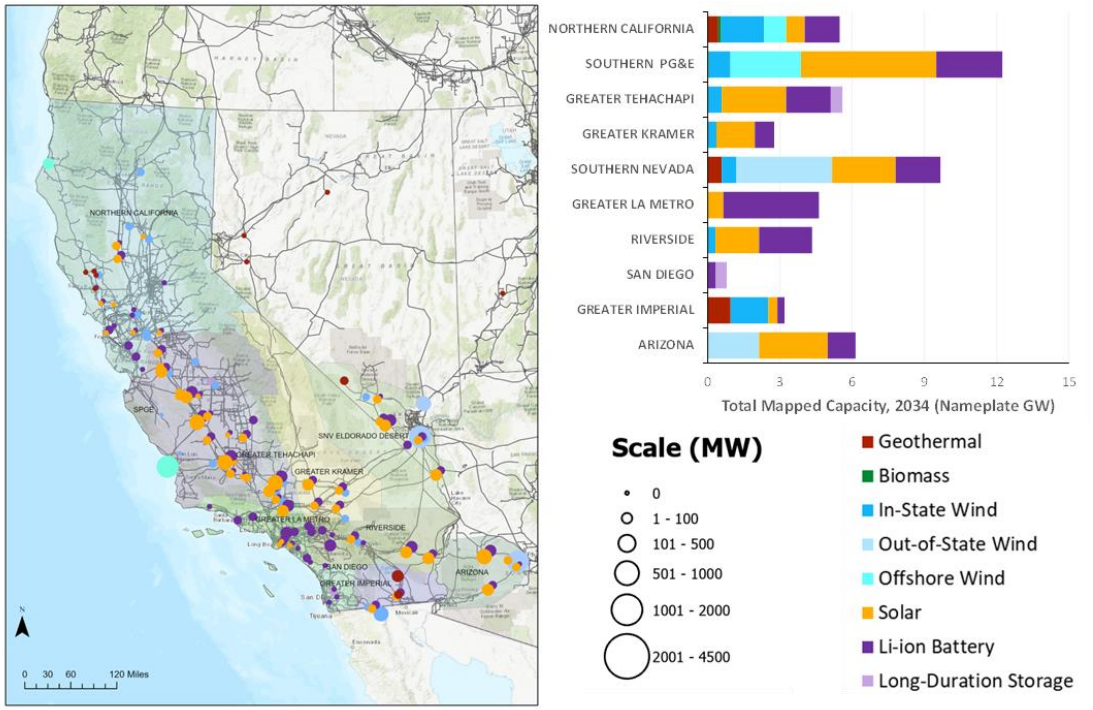


Figure 2: Final busbar mapping results of the 24-25 TPP base case portfolio 2039 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region.

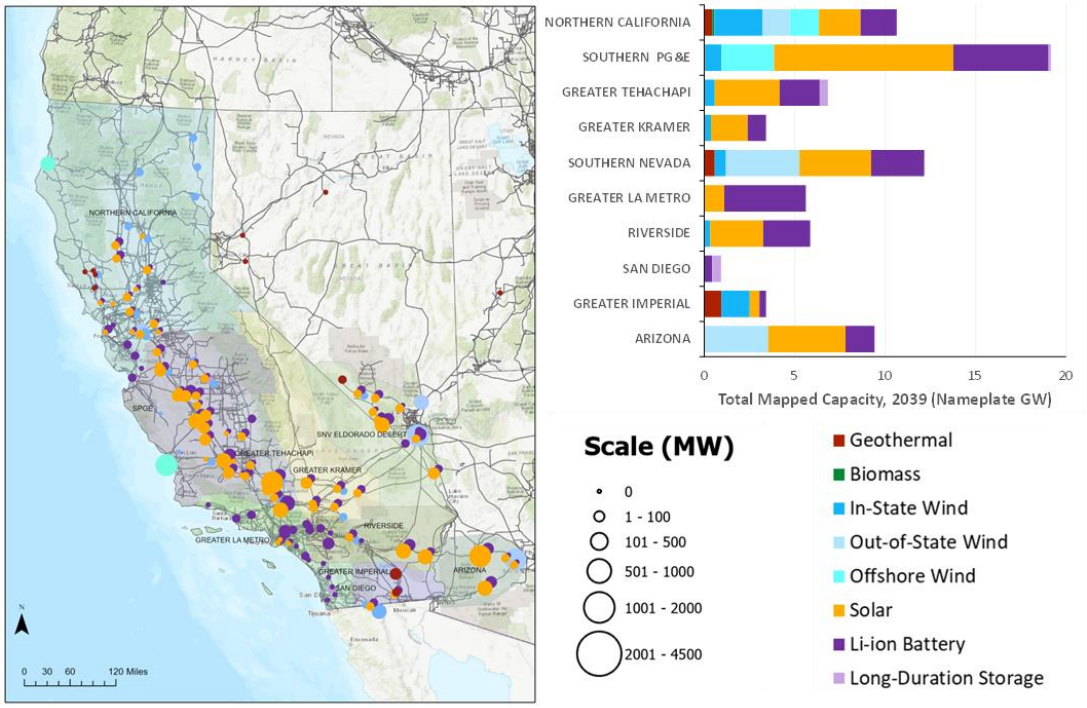
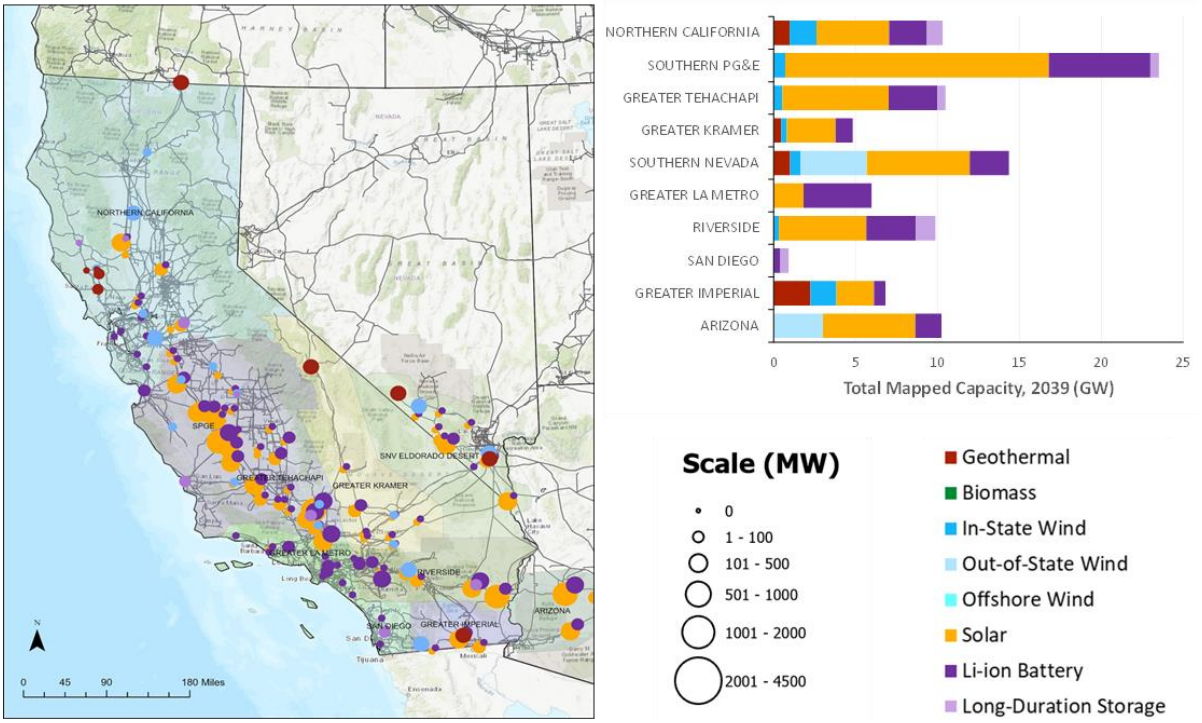


Figure 3: Final busbar mapping results of the 24-25 TPP high gas retirement sensitivity portfolio 2039 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region.



This Report describes the base case portfolio, its mapping to specific busbars, as well as additional inputs and assumptions including gas capacity not retained assumptions needed for the CAISO's 2024-2025 TPP. This report also describes the high gas retirement sensitivity portfolio and summarizes its key mapping results. The busbar mapping work was conducted by staff taking into consideration parties' comments in both the October 2023 Ruling and the January 2024 Proposed Decision[5]

This Report is structured as follows:

> **Section 4** states the objectives of studying the base case and sensitivity portfolio, summarizes the portfolios themselves, and details the RESOLVE modeling outputs for the portfolios.
>
> **Section 5** summarizes the updates made to the mapping methodology[6] used by CPUC, CAISO and CEC staff to conduct busbar mapping and produce other inputs and assumptions for the 2024-2025 TPP.

[5] January 10, 2024, Proposed Decision Adopting 2023 Preferred System Plan and Related Matters, and Addressing Two Petitions for Modification: https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=523201875.
[6] Referring to the version attached to the October 2023 Ruling. Available at: 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/mapping_methodology_v10_05_23_ruling.pdf

Section 6 details the busbar mapping criteria analysis and remapping steps taken by staff to improve the mapping allocations to meet the criteria.

Section 7 summarizes the results of the mapping process and potential transmission implications.

Section 8 presents other information about the portfolios required for TPP modeling including gas capacity not retained assumptions.

Section 9 draws conclusions regarding mapping the portfolios for the 2024-2025 TPP and provides guidance to the CAISO.

Section 10 lists the appendices for this report including, the busbar mapping methodology document, the mapping dashboards that identify the locations for future generation and storage resources and the resulting busbar mapping analysis of those locations, and several other supporting workbooks.

4. Inputs

In order to complete the busbar mapping, the following input is needed: Portfolios of selected resources for 2034 and 2039 by RESOLVE resource area, with Fully Deliverable (FD) and Energy-Only (EO) megawatt (MW) amounts specified. This section provides an overview of the base case portfolio (Section 4.1) and the high gas retirement sensitivity (Section 4.2) as developed through the IRP modeling efforts using the RESOLVE capacity expansion model and other assumptions. Additionally, Section 4.3 outlines the baseline reconciliation process to align mapping assumptions between the new IRP resource baseline used for portfolio development, the new baseline used for CAISO's transmission constraint assumptions, and the previous 23-24 TPP portfolio.

The base case portfolio described in Section 4.1 was developed using similar modeling assumptions as the portfolio released with the October 5, 2023, TPP Ruling (R.20-05-003). The following additional updates were made since the release of the Ruling:

- Updated to the CAISO transmission constraints representation based on guidance from CAISO staff,
- Updates to resource potential limits for in-state wind and out-of-state wind,
- Updates to existing pumped hydro storage round-trip efficiency from 81% to 69%,
- Updates to BTM PV generation to align to IEPR annual forecast more closely,
- Updates to RESOLVE code to fix FCDS and EODS deliverability consistency through the entire modeling horizon,
- Updates to non-modeled costs for BTM PV to align with NREL 2023 ATB, and
- Operating reserves and thermal ramp rates are now included in model parameters.

4.1 25 MMT Core (with 11/1 LSE Plan Filing) Portfolio

Objective and Rationale

The objective of transmitting this portfolio to the CAISO for the TPP base case studies is to ensure that transmission planning and development aligns with resource planning and development. The design of this portfolio achieves this objective by reflecting a possible lowest-cost achievement of the state's greenhouse gas reduction goals as informed by individual LSE planning efforts, staff aggregation of these plans, and IRP capacity expansion modeling. This 25 MMT Core portfolio is designed around a 25 million metric ton (MMT) annual GHG emissions target by 2035 for the electric sector and is named based on the convention of referring to that target. However, because the resource planning horizon needed specifically for the 2024-2025 TPP extends to 2039, the emissions of the portfolio in 2039 are lower than 25 MMT. This is described in more detail under the Description of Portfolio section below. The 2022 IEPR planning load scenario utilized in the portfolio is designed to reflect a higher electrification future, centered on CARB electrification regulations on vehicles, and it assesses the potential transmission impacts and transmission upgrade needs of new policy drivers pointing to higher electrification loads.

To improve the degree of accuracy of the transmission upgrade information that comes out of the RESOLVE analysis, the CPUC updated the modeling of transmission deliverability using data from the CAISO's 2023 Transmission White Paper and supplementing it with data from CAISO's 2022-2023 TPP results. This update further improved the locational information for all solar, wind, battery, geothermal, and pumped hydro storage resources modeled in RESOLVE to be consistent

with CAISO's available capacity at a substation-level. Ultimately, this resulted in improved information as inputs for the busbar mapping process for assigning all of the locational-specific resources.

However, one of the challenges that persisted with the updated transmission information from the CAISO is a disconnect with the transmission information that was used in developing the LSE plans. To incorporate both the LSE plans and the new transmission deliverability data, some modifications were made to assumptions of resources that could be selected to levels contained in the LSEs' plans. For instance, although offshore wind from the Humboldt area is included in the LSE plans, the RESOLVE portfolio was allowed to use offshore wind from Morro Bay as a replacement option. This was done to enable the model to solve, because the amount of available transmission deliverability at Humboldt was less than the amount of resource contained in the LSE plans.

Relationship Between RESOLVE Selected Resources and the CAISO TPP

RESOLVE is a system level capacity expansion model with simplified transmission capability and cost assumptions. As an input to the busbar mapping process the resources selected by RESOLVE and their locations get evaluated based on interconnection feasibility, potential required transmission upgrades, and other criteria. The RESOLVE portfolio for this 2024-2025 TPP indicates the need for 16,936 MW of partial or full transmission upgrades by 2034 and 19,300 MW by 2039 to accommodate the full number of resources selected in 2035 and 2039 that could not be accommodated by the existing transmission system.

However, CPUC staff cannot know for certain the transmission implications until they are studied by the CAISO in the TPP at actual busbar locations. For this reason, the CPUC will transmit this portfolio to the CAISO to conduct detailed transmission planning to assess the exact transmission needs. CAISO TPP results will indicate whether any reliability or policy-driven transmission upgrades are found necessary, and if so, those transmission upgrades may be recommended to the CAISO Board of Governors for approval. If any of the approved transmission upgrades are investments made specifically to accommodate the resource development future reflected by the CPUC in this portfolio, this portfolio will have helped ensure that transmission and generation resources are developed concurrently. This should minimize the risk of stranded generation assets later being discovered to be undeliverable to load due to a lack of available transmission capability.

To ensure this is a bidirectional minimization of ratepayer costs, the CPUC expects to receive information from the CAISO regarding which approved transmission projects are developed to accommodate policy-driven resource planning. (Typically, the CAISO Transmission Plan clearly identifies the policy-driven projects). The CPUC can then act accordingly to encourage the development of those resources that can utilize the transmission capacity to avoid stranded transmission assets. Further, the CPUC's transmittal cannot be assumed to prejudge the outcome of a future siting application for a specific transmission line (e.g. a Certificate of Public Convenience and Necessity Proceeding). However, the CPUC's transmittal of resource planning assumptions can be considered in the need determination phase of the CPUC's consideration of any specifically proposed transmission project.

Description of Portfolio

For the planning year 2034, the portfolio comprises 16,671 MW of new battery storage (14,958 MW of 4-hr storage, 1,713 MW of 8-hr storage), 935 MW of long-duration storage (477 MW of pumped hydro storage, 458 MW of compressed-air storage), 32,007 MW of new in-state renewable resources (which includes 3,855 MW of offshore wind), and 5,328 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources. For the planning year 2039, the portfolio comprises 22,917 MW of new battery storage (15,707 MW of 4-hr storage, 7,210 MW of 8-hr storage), 985 MW of long-duration storage (485 MW of pumped hydro storage, 508 MW of compressed-air storage), 45,277 MW of new in-state renewable resources (which includes 4,531 MW of offshore wind), and 8,328 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources.[7]

Table 2 summarizes the resource build out in 2034 and 2039, the resource planning years needed specifically for the 2024-2025 TPP. The GHG targets modeled in 2034 and 2039 were 26 MMT and 18 MMT respectively.[8]

Table 2. Cumulative Capacity Additions in 2034 and 2039 in the 25 MMT Core Portfolio for the Ruling and Proposed Decision

25 MMT Core Portfolio (2034 and 2039 Results) - Ruling and Proposed Decision Vintages					
		10/05 Ruling Vintage	Proposed Decision Vintage	10/05 Ruling Vintage	Proposed Decision Vintage
Resource Type	**Unit**	**2034**	**2034**	**2039**	**2039**
Natural Gas	MW	-	-	-	-
Geothermal	MW	1,600	1,969	1,700	1,969
Biomass	MW	200	171	200	171
In-State Wind	MW	8,100	7,023	8,200	7,923
Out-of-State Wind	MW	5,300	5,328	11,600	8,328
Offshore Wind	MW	3,900	3,855	4,500	4,531
Solar	MW	16,400	18,988	26,100	30,682
Customer Solar	MW	-	-	-	-
Li-ion Battery (BTM)	MW	-	-	6,100	-
Li-ion Battery (4-hr)	MW	15,000	14,958	15,700	15,707
Li-ion Battery (8-hr)	MW	1,700	1,713	5,700	7,210
Pumped Hydro Storage	MW	500	477	500	477
Long Duration Storage	MW	500	458	500	508
Shed DR	MW	-	-	-	-
Gas Capacity Not Retained	MW	-	-	-	-
In-State Renewables	**MW**	***30,200***	***32,007***	***40,700***	***45,277***
Out-of-State Renewables	**MW**	***5,300***	***5,328***	***11,600***	***8,328***

[7] Full RESOLVE results can be found on the CPUC's Portfolios and Modeling Assumptions for the 2023-2024 Transmission Planning Process website: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials/portfolios-and-modeling-assumptions-for-the-2023-2024-transmission-planning-process

[8] This represents the CAISO contribution extrapolated from a 25 MMT by 2030 target to the 8 MMT by 2045 target adopted in the 2023 CARB Scoping Plan.

This portfolio meets the RESOLVE Planning Reserve Margin (PRM) constraint which includes the adjustments made to incorporate the mid-term reliability decisions (D.21-06-035 and D.23-02-040). The loss of load expectation (LOLE) study results include a 0.015 LOLE in 2026, a 0.001 LOLE in 2030, a 0.012 LOLE in 2034, a 0.021 LOLE in 2035, and a 0.130 LOLE in 2039 indicating that this is generally a reliable portfolio. The resource inputs to the mapping process for this portfolio are summarized in Table 3 below.

In addition to the resource selection information from RESOLVE, transmission upgrade results are also used to inform the mapping analysis. Figure 4, Figure 5, and Figure 6 summarize the selected upgrades triggered in RESOLVE, showing that there are few upgrades selected by 2034, 2039, and 2045, these include upgrades already approved by the CAISO board, as well as new upgrades. This is partly due to the construction times associated with the upgrades as provided in the CAISO's 2023 White Paper. For the TPP years under consideration, a total of 16,936 MW by 2034 and 19,300 MW by 2039 of partial and full transmission upgrades are selected by the portfolio.

Table 3: All resources selected in the 25 MMT Core portfolio (2034 and 2039 cumulative)

Pre Round 1 - RESOLVE Selections		2034 Selected Resource, MW			2039 Selected Resource, MW		
Technology	Resource	FCDS	EODS	Total	FCDS	EODS	Total
Biomass	InState_Biomass	171	-	171	171	-	171
Geothermal	Central_Nevada_Geothermal	40	-	40	40	-	40
	Greater_Imperial_Geothermal	1,345	-	1,345	1,345	-	1,345
	Inyokern_North_Kramer_Geothermal	7	-	7	7	-	7
	Northern_California_Geothermal	544	-	544	544	-	544
	Northern_Nevada_Geothermal	-	-	-	-	-	-
	Pacific_Northwest_Geothermal	33	-	33	33	-	33
	Utah_Geothermal	-	-	-	-	-	-
Solar	Arizona_Solar	1,158	1,829	2,987	4,042	1,829	5,870
	Greater_Imperial_Solar	39	-	39	39	-	39
	Greater_Kramer_Solar	1,012	-	1,012	4,438	-	4,438
	Greater_LA_Solar	-	-	-	-	-	-
	Northern_California_Solar	26	100	126	26	100	126
	Riverside_Solar	659	-	659	818	-	818
	Southern_NV_Eldorado_Solar	7,372	330	7,702	7,372	330	7,702
	Southern_PGAE_Solar	247	-	247	1,226	-	1,226
	Tehachapi_Solar	6,216	-	6,216	10,463	-	10,463
Wind	Baja_California_Wind	-	1,573	1,573	-	2,473	2,473
	Central_Valley_North_Los_Banos_Wind	-	241	241	-	241	241
	Greater_Imperial_Wind	133	-	133	133	-	133
	Idaho_Wind	300	-	300	300	-	300
	New_Mexico_Wind	2,028	-	2,028	2,028	-	2,028
	Northern_California_Wind	-	2,259	2,259	-	2,259	2,259
	Solano_Wind	-	375	375	-	375	375
	Southern_NV_Eldorado_Wind	711	-	711	711	-	711
	Tehachapi_Wind	1,732	-	1,732	1,732	-	1,732
	Utah_Wind	-	-	-	-	-	-
	Wyoming_Wind	3,000	-	3,000	6,000	-	6,000
	Cape_Mendocino_Offshore_Wind	-	-	-	-	-	-
	Del_Norte_Offshore_Wind	-	-	-	-	-	-
	Humboldt_Bay_Offshore_Wind	-	-	-	-	-	-
	Morro_Bay_Offshore_Wind	3,855	-	3,855	4,531	-	4,531
Subtotal - Renewables		**30,629**	**6,706**	**37,335**	**45,999**	**7,606**	**53,605**
Li-ion Battery	Arizona_Li_Battery_4hr	1,059	-	1,059	1,059	-	1,059
	Arizona_Li_Battery_8hr	-	-	-	-	-	-
	Greater_Imperial_Li_Battery_4hr	613	-	613	613	-	613
	Greater_Imperial_Li_Battery_8hr	6	-	6	6	-	6
	Greater_Kramer_Li_Battery_4hr	313	-	313	797	-	797
	Greater_Kramer_Li_Battery_8hr	100	-	100	100	-	100
	Greater_LA_Li_Battery_4hr	-	-	-	-	-	-
	Greater_LA_Li_Battery_8hr	-	-	-	4,300	-	4,300
	Northern_California_Li_Battery_4hr	2,924	-	2,924	2,924	-	2,924
	Northern_California_Li_Battery_8hr	1,075	-	1,075	1,544	-	1,544
	Riverside_Li_Battery_4hr	732	-	732	1,019	-	1,019
	Riverside_Li_Battery_8hr	-	-	-	-	-	-
	Southern_NV_Eldorado_Li_Battery_4hr	2,644	-	2,644	2,644	-	2,644
	Southern_NV_Eldorado_Li_Battery_8hr	532	-	532	532	-	532
	Southern_PGAE_Li_Battery_4hr	4,186	-	4,186	4,186	-	4,186
	Southern_PGAE_Li_Battery_8hr	-	-	-	128	-	128
	Tehachapi_Li_Battery_4hr	2,427	-	2,427	2,466	-	2,466
	Tehachapi_Li_Battery_8hr	-	-	-	-	-	-
Flow Battery	Arizona_Flow_Battery	-	-	-	-	-	-
	Greater_Imperial_Flow_Battery	50	-	50	50	-	50
	Greater_Kramer_Flow_Battery	-	-	-	-	-	-
	Greater_LA_Flow_Battery	50	-	50	50	-	50
	Northern_California_Flow_Battery	50	-	50	100	-	100
	Riverside_Flow_Battery	108	-	108	108	-	108
	Southern_NV_Eldorado_Flow_Battery	-	-	-	-	-	-
	Southern_PGAE_Flow_Battery	-	-	-	-	-	-
	Tehachapi_Flow_Battery	-	-	-	-	-	-
Pumped Storage	Northern_California_Pumped_Storage	173	-	173	173	-	173
	Riverside_East_Pumped_Storage	125	-	125	125	-	125
	Riverside_West_Pumped_Storage	-	-	-	-	-	-
	San_Diego_Pumped_Storage	-	-	-	-	-	-
	Tehachapi_Pumped_Storage	178	-	178	178	-	178
Adiabatic CAES	Southern_PGAE_Adiabatic_CAES	-	-	-	-	-	-
	Tehachapi_Adiabatic_CAES	200	-	200	200	-	200
Subtotal - Storage		**17,606**	**-**	**17,606**	**23,902**	**-**	**23,902**
Total		**48,235**	**6,706**	**54,941**	**69,900**	**7,606**	**77,507**

Figure 4. 25 MMT Core Portfolio - Summary of RESOLVE triggered transmission expansion by 2034 and 2039, by transmission constraint.

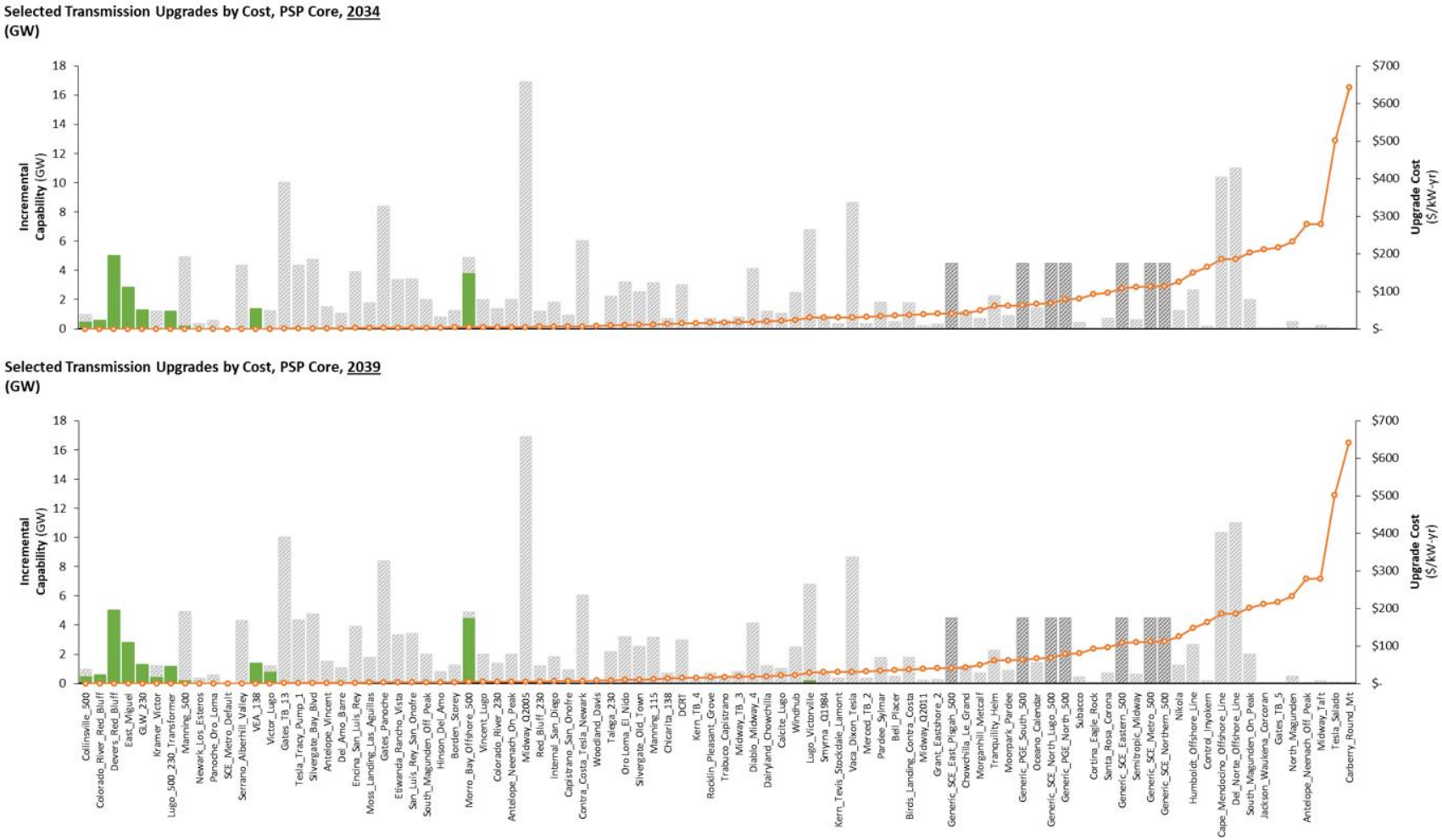


Figure 5. 25 MMT Core Portfolio - Summary of RESOLVE triggered transmission expansion by 2045, by study area.

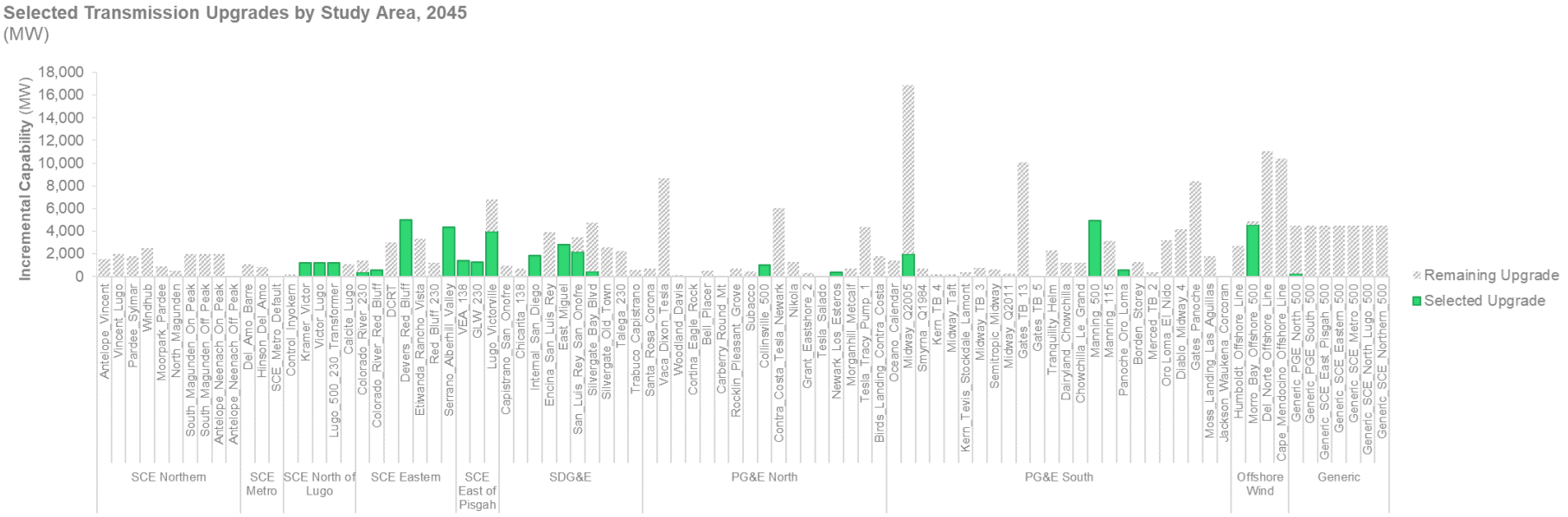
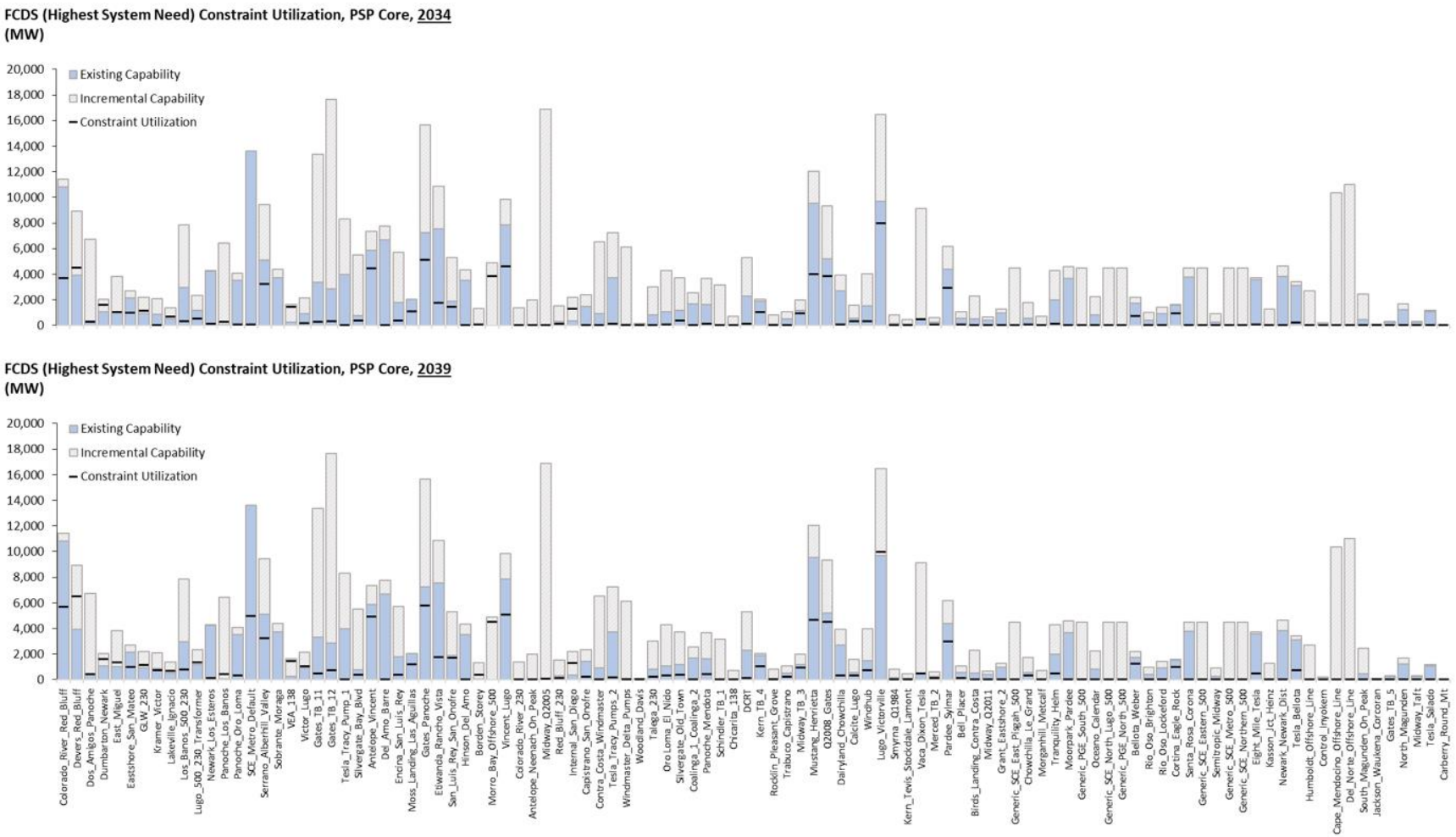


Figure 6. 25 MMT Core Portfolio - Summary of FCDS Highest System Need transmission capacity utilization by 2034 and 2039.



4.2 High Gas Retirement Portfolio

Objective and Rationale

The objective of transmitting the high gas retirement portfolio to the CAISO for the 2024-2025 TPP as a policy-driven sensitivity is to collect planning information about the impacts and transmission requirements of potential large-scale gas plant retirements, about 9.3 GW by 2035 and 15 GW by 2039, roughly half the current in-CAISO capacity. The energy planning agencies have limited detail regarding potential transmission needs for retiring gas units and this portfolio is a step in expanding the set of information that can be used in planning and potential procurement in the future. This portfolio utilizes the same GHG trajectory as the 25 MMT Core portfolio with 2035 and 2039 targets of 25 MMT and the 18 MMT respectively. However, the portfolio does not include the 11/01/2023 LSE Plans, relying entirely on the RESOLVE model optimization for resource selection without any LSE plan consideration. All other assumptions remain constant.

Description of Portfolio

For the planning years 2035, the portfolio comprises 10,321 MW of new battery storage (5,586 MW of 4-hr storage, 4,735 MW of 8-hr storage), 3,280 MW of long-duration storage (2,780 MW of pumped hydro storage, 500 MW of compressed-air storage), 30,281 MW of new in-state renewable resources, and 6,066 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources. For the planning years 2039, the portfolio comprises 23,058 MW of new battery storage (5,586 MW of 4-hr storage, 17,472 MW of 8-hr storage), 3,680 MW of long-duration storage (2,780 MW of pumped hydro storage, 900 MW of compressed-air storage), 63,036 MW of new in-state renewable resources, and 7,066 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources.[9]

Table 4 summarizes the resource build out in 2034 and 2039, the resource planning years needed specifically for the 2024-2025 TPP. As previously mentioned, the GHG targets modeled in 2035 and 2039 were 25 MMT and 18 MMT respectively.

[9] Full RESOLVE results can be found on the CPUC's Portfolios and Modelling Assumptions for the 2024-2025 Transmission Planning Process website: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials/portfolios-and-modeling-assumptions-for-the-2024-2025-transmission-planning-process

Table 4. Capacity Additions in 2034 and 2039 in the High Gas Retirement Sensitivity Portfolio for the Ruling and Proposed Decision

High Gas Retirement Portfolio (2034 and 2039 Results) - Ruling and Proposed Decision Vintages					
		10/05 Ruling Vintage	Proposed Decision Vintage	10/05 Ruling Vintage	Proposed Decision Vintage
Resource Type	**Unit**	**2034**	**2034**	**2039**	**2039**
Natural Gas	MW	-	-	-	-
Geothermal	MW	3,500	3,984	5,000	5,111
Biomass	MW	-	-	200	-
In-State Wind	MW	7,000	5,739	7,000	5,739
Out-of-State Wind	MW	5,400	6,066	5,400	7,066
Offshore Wind	MW	-	-	-	-
Solar	MW	20,000	20,559	53,300	52,186
Customer Solar	MW	-	-	-	-
Li-ion Battery (BTM)	MW	-	-	-	-
Li-ion Battery (4-hr)	MW	5,100	5,586	5,100	5,586
Li-ion Battery (8-hr)	MW	5,400	4,735	18,300	17,472
Pumped Hydro Storage	MW	2,800	2,780	2,800	2,780
Long Duration Storage	MW	500	500	900	900
Shed DR	MW	300	250	-	-
Gas Capacity Not Retained	MW	-	-	-	-
In-State Renewables	**MW**	***30,500***	***30,281***	***65,500***	***63,036***
Out-of-State Renewables	**MW**	***5,400***	***6,066***	***5,400***	***7,066***

This portfolio also meets the RESOLVE Planning Reserve Margin (PRM) constraint which includes the adjustments made to incorporate the mid-term reliability decisions (D.21-06-035 and D.23-02-040) requirements. The resource inputs to the mapping process for this portfolio are summarized in Table 5 below.

In addition to the resource selection information from RESOLVE, transmission upgrade results are also used to inform the mapping analysis. Figure 7, Figure 8, and Figure 9 summarize the selected upgrades triggered in RESOLVE for the high gas retirement scenario, showing that there are few upgrades selected by 2034, 2039, and 2045. These include upgrades already approved by the CAISO board, as well as new upgrades. This is partly due to the construction times associated with the upgrades as provided in the CAISO's 2023 White Paper. For the TPP years under consideration, a total of 22,678 MW by 2034 and 32,714 MW by 2039 of partial and full transmission upgrades are utilized by the portfolio, but most of these are already approved in previous TPPs.

Table 5. All resources selected in the High Gas Retirement sensitivity portfolio (2034 and 2039 cumulative)

Pre Round 1 - RESOLVE Selections		2034 Selected Resource, MW			2039 Selected Resource, MW		
Technology	Resource	FCDS	EODS	Total	FCDS	EODS	Total
Biomass	InState_Biomass	-	-	-	-	-	-
Geothermal	Central_Nevada_Geothermal	536	-	536	536	-	536
	Greater_Imperial_Geothermal	2,460	-	2,460	2,460	-	2,460
	Inyokern_North_Kramer_Geothermal	7	-	7	7	-	7
	Northern_California_Geothermal	314	-	314	848	-	848
	Northern_Nevada_Geothermal	170	-	170	764	-	764
	Pacific_Northwest_Geothermal	436	-	436	436	-	436
	Utah_Geothermal	-	-	-	-	-	-
Solar	Arizona_Solar	1,586	-	1,586	10,354	-	10,354
	Greater_Imperial_Solar	-	-	-	4,818	-	4,818
	Greater_Kramer_Solar	1,012	-	1,012	4,438	-	4,438
	Greater_LA_Solar	-	-	-	375	-	375
	Northern_California_Solar	-	-	-	-	-	-
	Riverside_Solar	-	-	-	8,688	-	8,688
	Southern_NV_Eldorado_Solar	8,569	-	8,569	8,569	-	8,569
	Southern_PGAE_Solar	-	-	-	4,501	-	4,501
	Tehachapi_Solar	3,392	-	3,392	10,443	-	10,443
Wind	Baja_California_Wind	-	1,265	1,265	-	1,265	1,265
	Central_Valley_North_Los_Banos_Wind	146	-	146	146	-	146
	Greater_Imperial_Wind	133	-	133	133	-	133
	Idaho_Wind	-	-	-	-	-	-
	New_Mexico_Wind	3,066	-	3,066	3,066	-	3,066
	Northern_California_Wind	-	1,377	1,377	-	1,377	1,377
	Solano_Wind	-	375	375	-	375	375
	Southern_NV_Eldorado_Wind	711	-	711	711	-	711
	Tehachapi_Wind	1,732	-	1,732	1,732	-	1,732
	Utah_Wind	-	-	-	-	-	-
	Wyoming_Wind	3,000	-	3,000	4,000	-	4,000
	Cape_Mendocino_Offshore_Wind	-	-	-	-	-	-
	Del_Norte_Offshore_Wind	-	-	-	-	-	-
	Humboldt_Bay_Offshore_Wind	-	-	-	-	-	-
	Morro_Bay_Offshore_Wind	-	-	-	-	-	-
Subtotal - Renewables		**33,330**	**3,016**	**36,347**	**67,085**	**3,016**	**70,102**
Li-ion Battery	Arizona_Li_Battery_4hr	632	-	632	632	-	632
	Arizona_Li_Battery_8hr	-	-	-	833	-	833
	Greater_Imperial_Li_Battery_4hr	21	-	21	21	-	21
	Greater_Imperial_Li_Battery_8hr	436	-	436	1,030	-	1,030
	Greater_Kramer_Li_Battery_4hr	231	-	231	231	-	231
	Greater_Kramer_Li_Battery_8hr	-	-	-	665	-	665
	Greater_LA_Li_Battery_4hr	32	-	32	32	-	32
	Greater_LA_Li_Battery_8hr	-	-	-	1,448	-	1,448
	Northern_California_Li_Battery_4hr	29	-	29	29	-	29
	Northern_California_Li_Battery_8hr	-	-	-	3,562	-	3,562
	Riverside_Li_Battery_4hr	-	-	-	-	-	-
	Riverside_Li_Battery_8hr	-	-	-	149	-	149
	Southern_NV_Eldorado_Li_Battery_4hr	3,308	-	3,308	3,308	-	3,308
	Southern_NV_Eldorado_Li_Battery_8hr	-	-	-	-	-	-
	Southern_PGAE_Li_Battery_4hr	862	-	862	862	-	862
	Southern_PGAE_Li_Battery_8hr	2,245	-	2,245	7,730	-	7,730
	Tehachapi_Li_Battery_4hr	411	-	411	411	-	411
	Tehachapi_Li_Battery_8hr	2,055	-	2,055	2,055	-	2,055
Flow Battery	Arizona_Flow_Battery	-	-	-	-	-	-
	Greater_Imperial_Flow_Battery	-	-	-	-	-	-
	Greater_Kramer_Flow_Battery	-	-	-	-	-	-
	Greater_LA_Flow_Battery	-	-	-	-	-	-
	Northern_California_Flow_Battery	-	-	-	-	-	-
	Riverside_Flow_Battery	-	-	-	-	-	-
	Southern_NV_Eldorado_Flow_Battery	-	-	-	-	-	-
	Southern_PGAE_Flow_Battery	-	-	-	-	-	-
	Tehachapi_Flow_Battery	-	-	-	-	-	-
Pumped Storage	Northern_California_Pumped_Storage	-	-	-	-	-	-
	Riverside_East_Pumped_Storage	1,300	-	1,300	1,300	-	1,300
	Riverside_West_Pumped_Storage	500	-	500	500	-	500
	San_Diego_Pumped_Storage	500	-	500	500	-	500
	Tehachapi_Pumped_Storage	480	-	480	480	-	480
Adiabatic CAES	Southern_PGAE_Adiabatic_CAES	-	-	-	400	-	400
	Tehachapi_Adiabatic_CAES	500	-	500	500	-	500
Subtotal - Storage		**13,601**	**-**	**13,601**	**26,738**	**-**	**26,738**
Total		**46,932**	**3,016**	**49,948**	**93,823**	**3,016**	**96,839**

Figure 7. High Gas Retirement Sensitivity - Summary of RESOLVE triggered transmission expansion by 2034 and 2039; by transmission constraint.

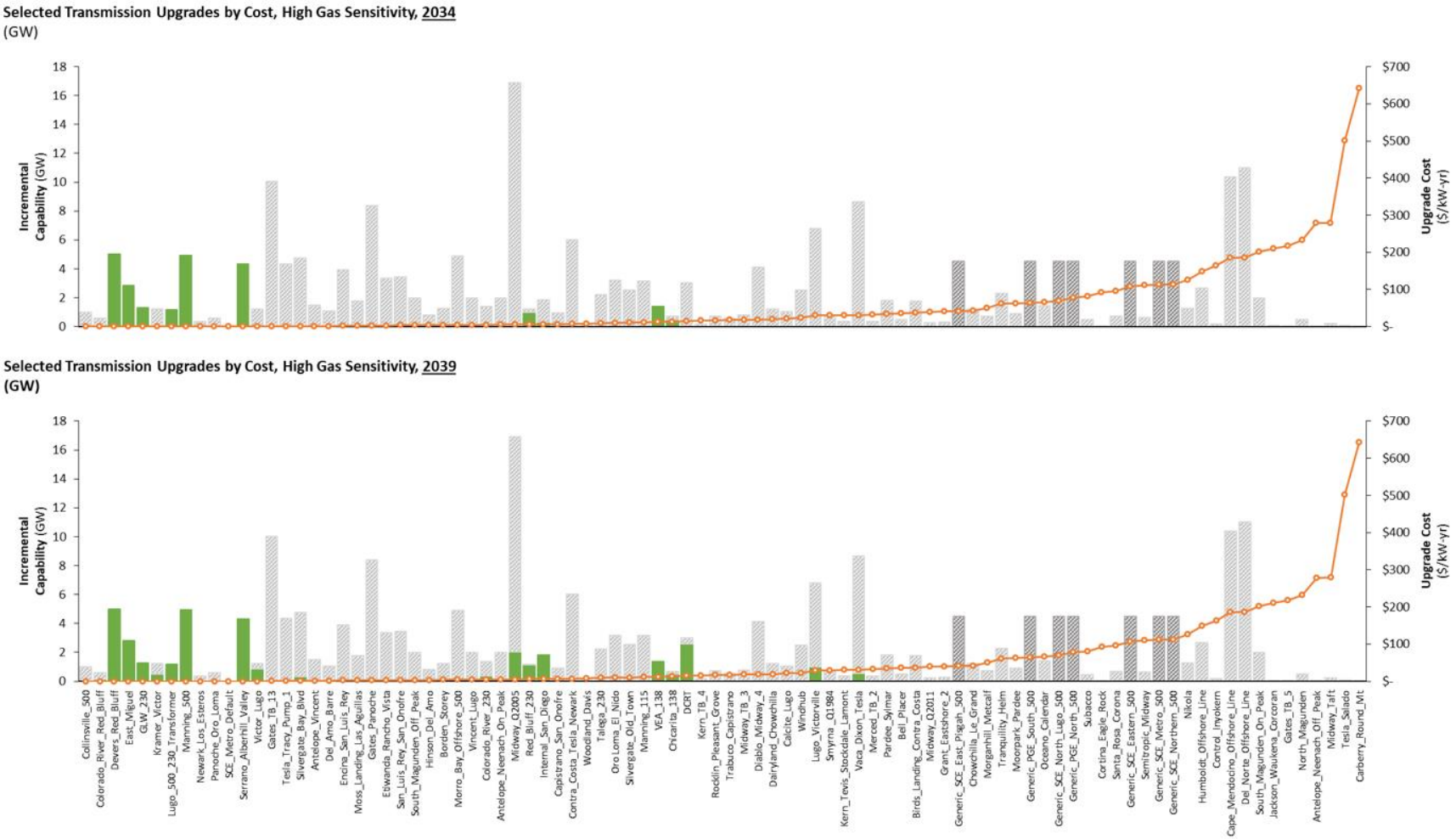


Figure 8. High Gas Retirement Sensitivity - Summary of RESOLVE triggered transmission expansion by 2045; by study area.

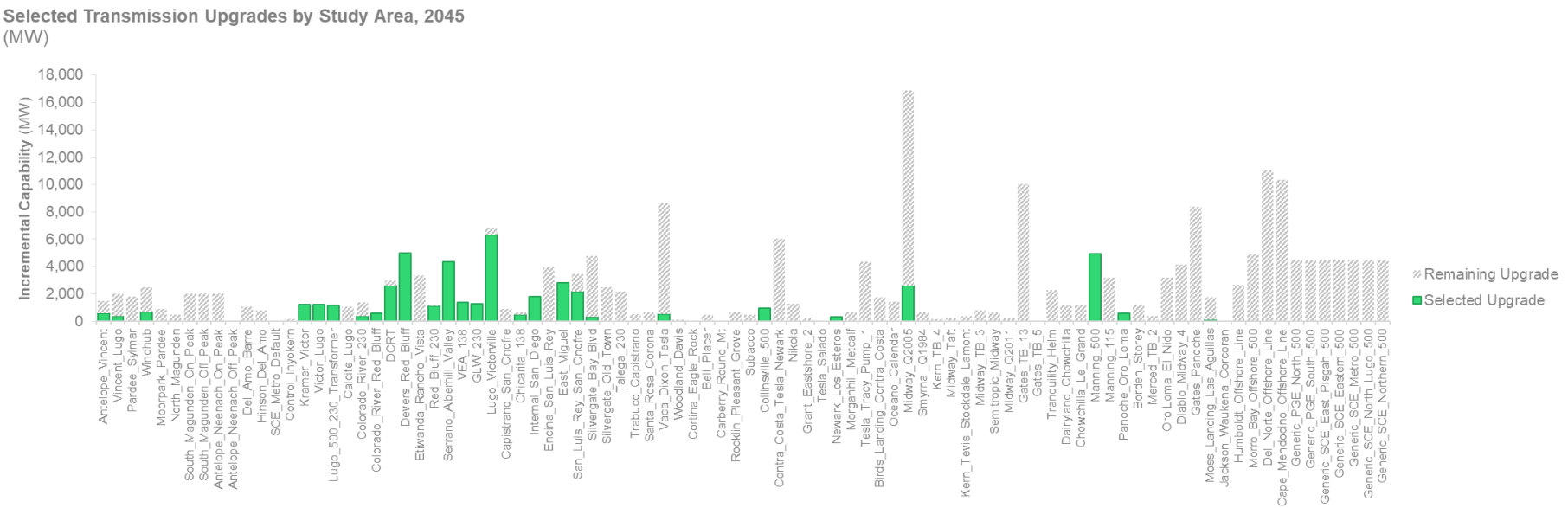
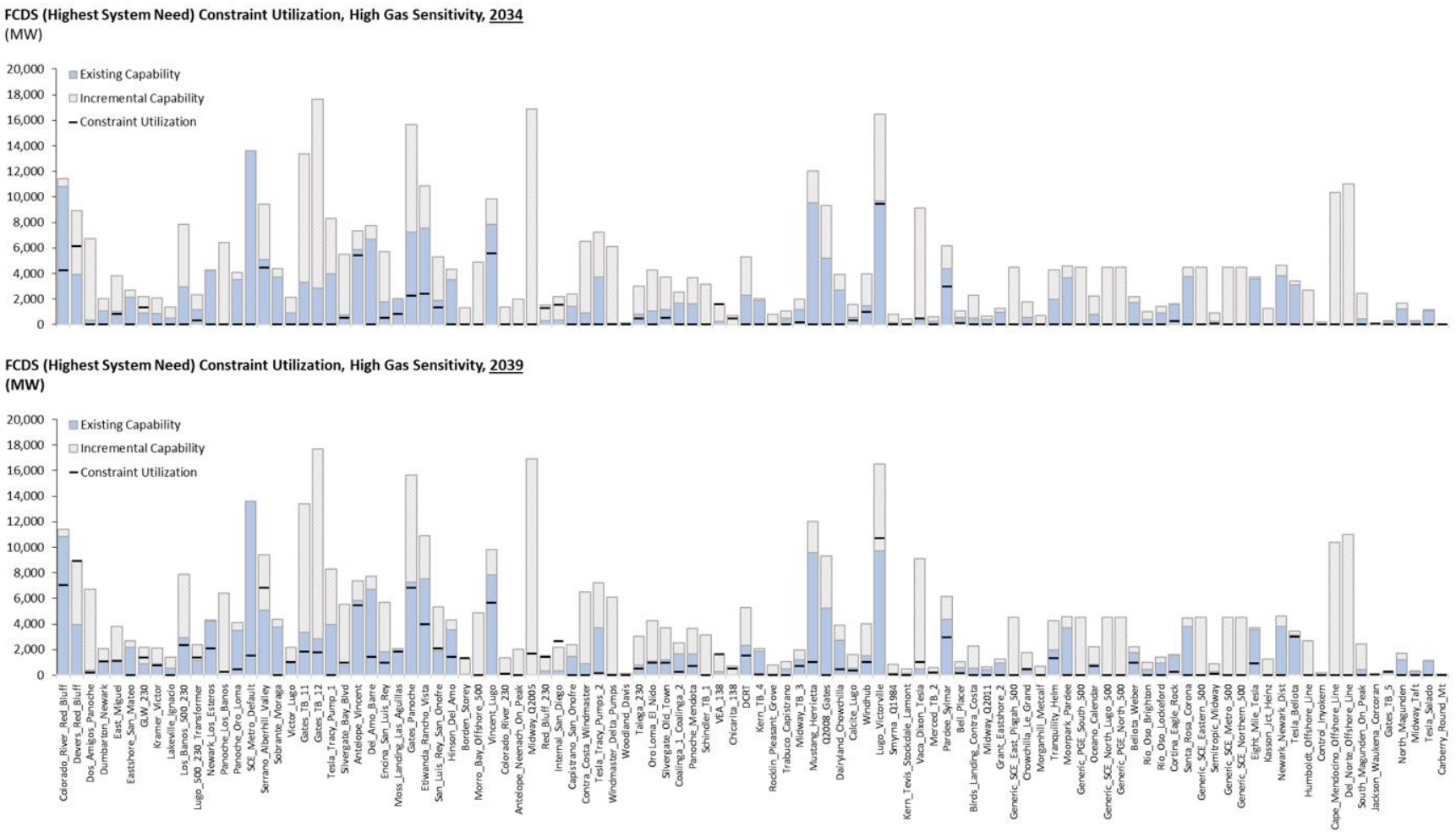


Figure 9. High Gas Retirement Sensitivity - Summary of FCDS Highest System Need transmission capacity utilization by 2034 and 2039.



4.3 Baseline Reconciliation

As part of the 2023 IRP Inputs and Assumptions,[10] the list of baseline resources assumed in IRP modeling was updated to include new resources operational in the CAISO Master Generating Capability List as of January 2023, future generators contracted to CPUC jurisdictional Load Serving Entities (LSEs), not yet online and identified through various IRP filings, as well as generators outside of the CAISO through the WECC's 2023 Anchor Data Set. The modeling for the base case portfolio and sensitivity for the 24-25 TPP used this updated 2023 IRP resource baseline. Thus, the baseline for the 24-25 TPP portfolios have significantly more resources than the baseline used for the 23-24 TPP, which relied on the 2020 IRP baseline. Resources not in that baseline were included in the 23-24 TPP portfolios and mapped as online and in-development resources. Staff included these resources in the 23-24 TPP portfolio to align with the CAISO's 2021 Transmission Capability Estimates White Paper,[11] which used a similar baseline in calculating transmission capacity and upgrade needs. In addition to the updated IRP baseline, the CAISO released an updated 2023 White Paper on "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2023 White Paper)[12] using a baseline that included resources online by January 1, 2022. IRP staff conducted baseline reconciliation both between the new CAISO 2023 White Paper assumptions and the new IRP baseline to ensure accurate representations of resources impacts on transmission constraints calculation and between the new IRP baseline and the previous 23-24 TPP portfolio to enable accurate comparison between the portfolios.

To reconcile between the 2023 White Paper baseline and the 2023 IRP baseline, staff identified all resources in the new IRP baseline with online dates after 01/01/2022. These baseline resources are not part of the published 24-25 TPP portfolio resources amounts and are not busbar mapped, but they still need to be accounted for in the busbar mapping transmission calculations which uses the older 01/01/2022 baseline cutoff. Additionally, staff identified in-CAISO resources not yet online but contracted by out-of-CAISO LSE. These too are not included in the 24-25 TPP portfolio but need to be captured in the transmission calculations. The full list of resources needing to be included in the transmission calculations can be seen in the Baseline Reconciliation workbook (Appendix F). Table 6 below summarizes these resources by CAISO study area. These not yet online resources included in the baseline will also need to be captured in the CAISO's TPP analysis.

Contracted by in-CAISO LSEs and other in-development resources not included in the updated baseline are included in the 24-25 TPP portfolio and accounted for in the busbar mapping of the portfolio. These resources are classified as "in-development" resources in busbar mapping and are discussed in the commercial interest mapping alignment criteria discussion in Section 6.1.D.

[10] "Inputs & Assumptions — 2022-2023 Integrated Resource Planning." October 2023. 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/inputs-assumptions-2022-2023_final_document_10052023.pdf

[11] "2021 Transmission Capability Estimates for use in the CPUC's Resource Planning Process." CAISO Revised White Paper. 10/28/2021. https://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=79BEBAD0-E696-4E04-A958-1AAF53A12248.

[12] "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2023). CAISO White Paper. https://www.caiso.com/Documents/PresentationUpdatedTransmissionCapabilityEstimates-use-CPUCsResourcePlanningProcess-Jul5-2023.pdf

Table 6: Summary by CAISO study area of in-baseline resources with COD after 01/01/2022 that need to be included in Tx constraint calculations.

In-Baseline Resources (COD > 1/1/2022) for Tx Calculations by CAISO Study Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total by Area
PG&E North of Greater Bay	61	2.8	90	-	-	-	438	-	**592**
PG&E Greater Bay	-	-	45	-	-	25	1,290	-	**1,360**
PG&E Fresno	-	1.9	76	-	-	250	125	-	**453**
PG&E Kern	-	-	91	-	-	225	173	-	**489**
SCE Northern Area	-	1.9	-	-	-	1,700	1,536	-	**3,237**
SCE Metro	-	-	-	-	-	-	170	-	**170**
SCE North of Lugo	54	-	-	-	-	637	318	-	**1,008**
East of Pisgah	88	-	350	-	-	125	65	-	**628**
SCE Eastern	45	-	94	-	-	1,220	1,856	-	**3,214**
SDG&E	50	-	105	-	-	173	950	-	**1,277**
Total by Type	**298**	**7**	**851**	**-**	**-**	**4,354**	**6,919**	**-**	**12,429**

To allow comparison between the current portfolios and the previous 23-24 TPP base case portfolio, IRP staff sought to identify what resources included in the 23-24 TPP are now represented in the updated baseline. To do that, CPUC staff assumed all resources identified as online in the 23-24 TPP portfolio mapping results with an online date before 01/01/2022 were captured in the new baseline; this includes ~4,100 MW of resources in the 23-24 TPP portfolio. Staff then also assumed that resources in the new 2023 IRP baseline with online dates after 01/01/2022 were represented by mapped resources included in the 23-24 TPP portfolio. Thus, any comparison will either add these resources to the 24-25 TPP portfolios or subtract them from the 23-24 TPP portfolio. Table 7 below shows the 23-24 TPP portfolio (2035 model year) by CAISO study area after the new baseline resources have been subtracted. The 23-24 TPP base case included ~85,000 MW of resources (generation and storage); with the updated baseline accounted for, the new total is ~68,500 MW.

Table 7: The 23-24 TPP base case portfolio (2035) updated to remove resources now included in the new 2023 IRP baseline.

23-24 TPP Base Case (2035) by CAISO Study Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total by Area
PG&E North of Greater Bay	118	80.0	384	-	1,607	1,249	393	-	**3,830**
PG&E Greater Bay	-	22.4	567	-	-	512	905	-	**2,006**
PG&E Fresno	-	7.6	74	-	-	4,885	2,345	-	**7,312**
PG&E Kern	-	2.0	263	-	3,100	2,993	1,468	300	**8,125**
SCE Northern Area	-	6.4	127	-	-	6,894	4,058	500	**11,585**
SCE Metro	-	3.8	-	-	-	20	1,765	-	**1,789**
SCE North of Lugo	-	2.7	-	-	-	1,930	1,036	-	**2,969**
East of Pisgah	817	-	353	2,500	-	4,818	2,624	-	**11,112**
SCE Eastern	805	2.6	-	2,328	-	7,441	3,820	700	**15,097**
SDG&E	-	-	495	-	-	2,188	1,503	500	**4,686**
Total by Type	**1,740**	**127**	**2,261**	**4,828**	**4,707**	**32,930**	**19,918**	**2,000**	**68,512**

5. Busbar Mapping Methodology Updates and Adjustments

Working Group staff from the two agencies and the CAISO completed the busbar mapping effort described in the Methodology for Resource-to-Busbar Mapping & Assumptions for the Annual TPP. The full, updated Methodology is available as a separate document (see Appendix A).

Figure 10: Flowchart overviewing the busbar mapping process for the TPP.

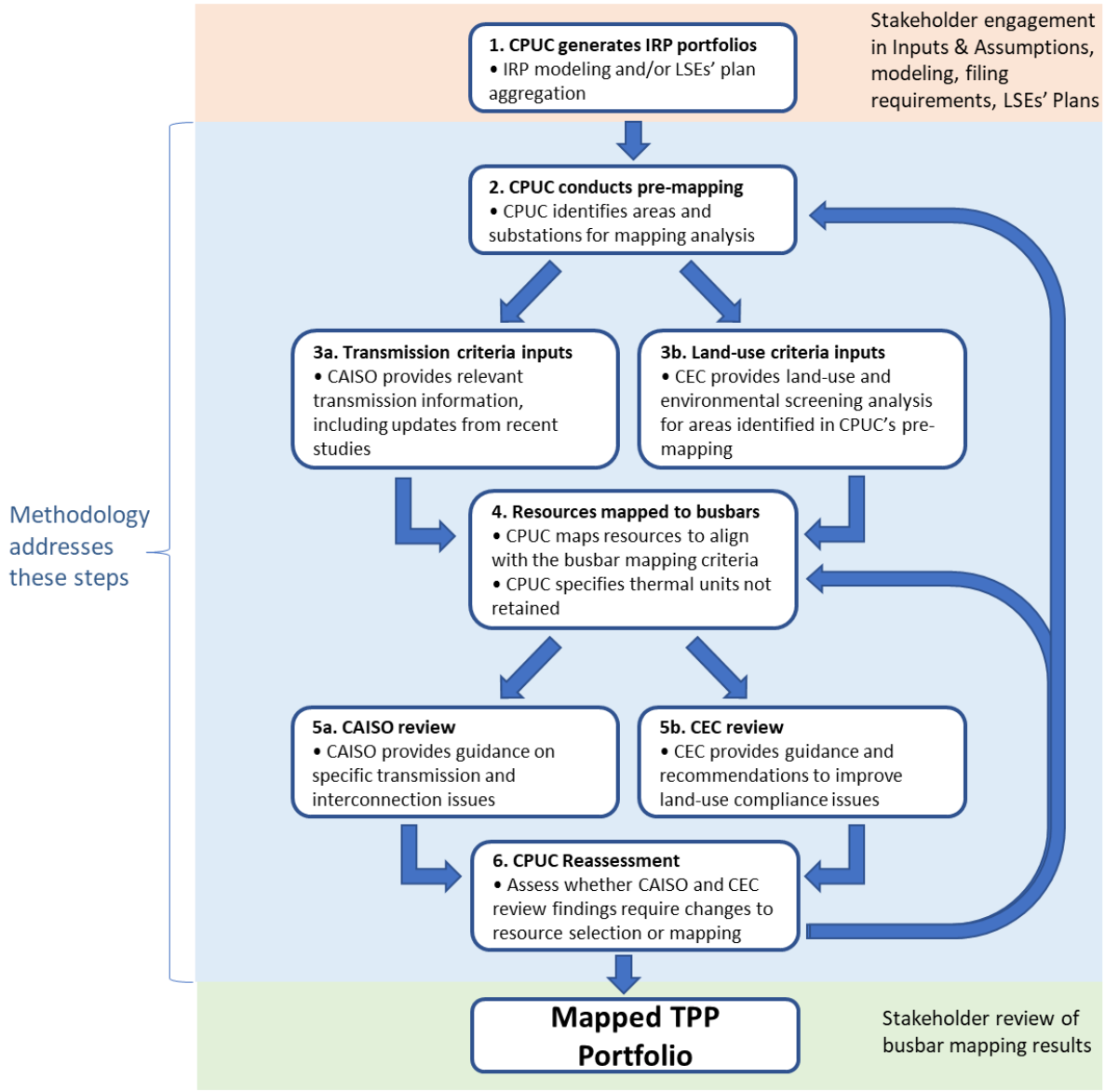


Figure 10 outlines the busbar mapping process, which underwent revisions prior to the October 2023 Ruling to refine the process and criteria alignment analysis and incorporate new and updated datasets for the mapping analysis. Additional minor changes to the Methodology were made based on stakeholder feedback through Ruling and Proposed Decision comments and replies, recommendations from CEC and CAISO staff, and staff's experience during implementation of the busbar mapping process, discussed below. Staff also updated and finalized selection criteria to map

gas capacity not retained include in the portfolios to specific gas units for the CAISO to model as offline in the TPP analysis. Details of the selection criteria and mapping results are in Section 8.1.

For busbar mapping, staff implemented two main mapping methodology changes after the October 2023 Ruling:

- Identification of commercial interest projects that were likely repowers and exclusion of resources mapped in line with those identified MWs from the land-use and environmental analysis calculations. Since existing project footprints are generally excluded from the resource potentials, this exclusion avoids double counting the potential impacts of these resources.

- Incorporating land-use and environmental analysis using a base resource potential derived from a 20% capacity factor (CF) minimum threshold for onshore in-state wind. Staff initially only used an onshore wind base resource potential layer with a minimum threshold of 28% CF. Staff updated to incorporating land-use and environmental criteria analysis derived from both the 28% CF threshold data and the 20% threshold data. Working Group staff included a new resource potential base layer and applied the same criteria analysis. Staff did not relax the land-use and environmental impacts criteria.

Between the October 2023 Ruling and the January 2024 Proposed Decision, staff corrected several errors identified in the land-use feasibility and environmental impacts criteria mapping analysis and data used. These changes are corrections to fix the existing data and criteria analysis and are not changes to what data is being used or the methodology being applied. These corrections include:

- Staff corrected the double counting of newly online resources in the land-use and environmental screens analysis. Working Group staff were initially including resources that had come online after January 1, 2022, in the MW totals of resources at a substation used to assess the land-use and environmental criteria compliance. CEC staff had also excluded the footprints of many of these online resources from the available resource potential layer used for this analysis. In the updated analysis, staff only included online resources in the land-use analysis MW totals if they had online dates after 08/31/23, as projects with early online dates were likely captured by the CEC's existing resources footprint screens.

- CEC staff identified and corrected several issues with the application of the land-use and environmental impacts screens:

    - Staff updated the protected areas exclusion layer to allow for gaps to remain between the components of the protected area layer. Previously, the gaps were merged into the protected area layer, incorrectly adding areas as protected in the Riverside area and impacting both solar and wind potentials.

    - Staff included wind potential in certain Bureau of Land Management areas where development is not prohibited by the Desert Renewable Energy Conservation Plan (i.e., certain DFA/VPL/GPLs areas) in the base total resource potential for application of the land-use and environmental impacts screens. These areas were unintentionally excluded from initial calculations.

    - Staff updated the results of applying several of the land-use and environmental impacts screens to exclude the footprints for some existing wind resources. These

existing wind footprints had been excluded from some but not all the environmental and land-use screens.

After the release of the January 2024 Proposed Decision, staff made several other minor corrections to transmission and land-use criteria data and data analysis. These corrections included:

- Updating the on-peak deliverability output factors for offshore wind to new values developed by the CAISO.
- Further adjustments to constraint membership for some substations, per CAISO staff review and feedback.
- Correcting an error in the dashboard's transmission exceedance calculator that undercounted EODS solar resources for off-peak exceedance calculations.
- Additional minor adjustments to the land-use and environmental screens to correct for missing existing projects and to fix the protected layer screen to allow for gaps of a certain size between protected areas throughout California.

These adjustments and their impacts on the mapping and criteria analysis are discussed in more detail in Section 6.2.

In implementing the new busbar mapping methodology, staff were unable to perform some portions of the prescribed analysis for certain criteria categories due to time, information, and staffing constraints. For the system level transmission capability criteria, staff did not implement the full Local Capacity Requirement (LCR) areas analysis. Staff also did not fully implement the substation level interconnection viability criteria analysis, specifically:

- Staff did not conduct substation level analysis of the potential interconnection accessibility impacts from a perspective of potential land-use conflicts or environmental impacts around the substation.
- Staff also did not incorporate substation level interconnection infrastructure availability and potential costs of substation level upgrades needed to interconnect. Timing constraints and staff limitations as well as the need to coordinate and engage with the participating transmission owners for pertinent information limited the viability of the analysis for this mapping cycle.

In lieu of that analysis, staff implemented a simplified distance from interconnection analysis based on the environmental and land-use criteria's radial distance from substation analysis. This criterion is comparable to the distance to transmission of appropriate voltage analysis done in prior busbar mapping efforts. Staff were also able to incorporate some interconnection viability information from existing, publicly available PTO sources. Staff utilized the list of substations with fault duty limitations and space limitation as identified in the PG&E Transmission Interconnection Handbook[13] and sought to limit mapping at those substations to amounts already identified in the interconnection queues.

[13] "PG&E Transmission Interconnection Handbook." 06/13/2023. https://www.pge.com/en/about/doing-business-with-pge/interconnections/handbooks.html

6. Analysis

This section outlines the results of the mapping process and notes mapping adjustments made after the initial mapping released for the October 5, 2023, Ruling[14] base case portfolio. For the portfolio resources, staff use a "dashboard" to assess how well busbar allocations comply with the mapping criteria described in the Methodology (see Appendix A.). This informs whether changes to the mapping allocations may be required.

Section 6.1 summarizes the results of the initial mapping effort the busbar Working Group staff performed to map all resources to substations for the base case portfolio included in the October 2023 ruling. Full results for both the 2034 and 2039 mapped years at a substation level and the mapped resources compliance with the busbar mapping criteria are detailed in the Mapping Dashboards for both portfolio years. This initial mapping dashboard is included as Appendix C.

Section 6.2 presents the adjustments made to the mapping post-ruling. Working Group staff made these adjustments to improve compliance with the busbar mapping criteria, to account for updated information on transmission, commercial interest, and in-development resources, and to incorporate feedback stakeholders provided through comments and replies on the October 2023 Ruling and the January 11, 2024, Proposed Decision.[15] These mapping adjustments are summarized by resource area in this section.

Section 6.3 summarizes the final busbar mapping analysis and criteria analysis following the mapping changes outline in Section 6.2. A full accounting of the adjustments by resource type and substation is in the final Mapping Dashboards released with this report as Appendix D.

6.1 Initial Mapping Results for 24-25 TPP Base Case Portfolio

This section summarizes the criteria alignment of the mapping results following initial rounds of mapping that the busbar mapping Working Group, comprised of CPUC, CEC, and CAISO staff, conducted for the base case portfolio included in the October 2023 Ruling. These mapping results summarize the full initial mapping information included in the two preliminary mapping Dashboards released for the base case portfolio: the Dashboard for Preliminary Mapping of Proposed 24-25 TPP Base Case, released October 26, 2023, (Appendix B) and the Updated Dashboard for Preliminary mapping, released December 13, 2023 (Appendix C).

Table 8 and Table 9 below show, by RESOLVE resource area and resource type, a comparison of the October 2023 Ruling RESOLVE selected base case portfolio and the initial mapping result with the 23-24 TPP base case 2035 portfolio for model years 2034 and 2039 respectively. The 23-24 TPP base case portfolio summary included in Table 8 and Table 9 have been adjusted to account for the updated baseline use for the 24-25 TPP portfolios as discussed in Section 4.3 through the baseline reconciliation process. Additionally, the 23-24 TPP portfolio did not have separate 4-hour and 8-hour Li-battery resource categories, it had a single Li-battery resource which for the 2035 portfolio had a RESOLVE model average duration of roughly six hours.

[14] October 5, 2023, Administrative Law Judge's Ruling Seeking Comment on Proposed 2023 Preferred System Plan and Transmission Planning Process Portfolio: https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=520522241.

[15] January 10, 2024, Proposed Decision Adopting 2023 Preferred System Plan and Related Matters, and Addressing Two Petitions for Modification: https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=523201875.

Table 8: Summary of the October 2023 Ruling proposed base case portfolio (2034 model year) and initial mapping results by RESOLVE resource area compared to the previous 23-24 TPP base case.

2034 Initial Base Case Portfolio	Initial RESOLVE Modeled Portfolio	Initial Mapping Total (2034)			23-24 TPP (2035) Mapped Total (Subtracting New Baseline)		
RESOLVE Resource Name	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**
InState Biomass	**171**	171	-	**171**	127		**127**
Central_Nevada_Geothermal	**40**	450	-	**450**	500		**500**
Greater_Imperial_Geothermal	**1,239**	790	-	**790**	805		**805**
Inyokern_North_Kramer_Geothermal	**7**	-	-	**-**	-		**-**
Northern_California_Geothermal	**314**	107	-	**107**	118		**118**
Northern_Nevada_Geothermal	**-**	240	-	**240**	305		**305**
Pacific_Northwest_Geothermal	**13**	-	-	**-**	-		**-**
Utah_Geothermal	**-**	26	-	**26**	12		**12**
Distributed Solar	-	194	-	**194**	86		**86**
Arizona_Solar	**3,243**	610	2,240	**2,850**	1,498	2,947	**4,445**
Greater_Imperial_Solar	**39**	-	182	**182**	-	711	**711**
Greater_Kramer_Solar	**1,012**	672	910	**1,582**	611	1,317	**1,928**
Greater_LA_Solar	**-**	-	23	**23**	125	625	**750**
Northern_California_Solar	**126**	105	290	**395**	679	1,047	**1,726**
Riverside_Solar	**659**	400	1,009	**1,409**	1,026	3,448	**4,473**
Southern_NV_Eldorado_Solar	**4,665**	1,075	1,365	**2,440**	2,032	2,786	**4,818**
Southern_PGAE_Solar	**1,586**	2,129	2,116	**4,245**	3,093	4,733	**7,826**
Tehachapi_Solar	**5,064**	1,561	1,518	**3,079**	1,837	4,331	**6,167**
Baja_California_Wind	**1,573**	900	600	**1,500**	-	360	**360**
Central_Valley_North_Los_Banos_Wind	**32**	360	5	**365**	74	-	**74**
Greater_Imperial_Wind	**133**	460	100	**560**	135	-	**135**
Greater_Kramer_Wind		550	100	**650**	-	-	**-**
Kern_Greater_Carrizo_Wind		275	10	**285**	263	-	**263**
Northern_California_Wind	**849**	552	210	**761**	230	109	**339**
Riverside_Palm_Springs_Wind		499	100	**599**	-	-	**-**
Solano_Wind	**375**	785	200	**985**	537	75	**612**
Southern_NV_Eldorado_Wind	**5,011**	1,610	200	**1,810**	353	-	**353**
Tehachapi_Wind	**156**	564	50	**614**	127	-	**127**
Idaho_Wind	**300**	1,000	-	**1,000**	1,000	-	**1,000**
New_Mexico_Wind	**1,968**	2,000	-	**2,000**	2,328	-	**2,328**
Wyoming_Wind	**3,000**	2,268	-	**2,268**	1,500	-	**1,500**
Humboldt_Bay_Offshore_Wind	**-**	-	-	**-**	1,446	161	**1,607**
Morro_Bay_Offshore_Wind	**3,855**	3,855	-	**3,855**	3,100	-	**3,100**
Renewable Resource Total	**35,431**	**24,208**	**11,226**	**35,434**	**23,852**	**22,669**	**46,521**
Arizona_Li_Battery_4hr	**972**	910		**910**	1,554		**1,554**
Arizona_Li_Battery_8hr	**190**	250		**250**			**-**
Greater_Imperial_Li_Battery_4hr	-	341		**341**	332		**332**
Greater_Imperial_Li_Battery_8hr	-	-		**-**			**-**
Greater_Kramer_Li_Battery_4hr	**445**	716		**716**	1,036		**1,036**
Greater_Kramer_Li_Battery_8hr	**165**	90		**90**			**-**
Greater_LA_Li_Battery_4hr	**3,471**	3,218		**3,218**	2,883		**2,883**
Greater_LA_Li_Battery_8hr	**587**	167		**167**			**-**
Northern_California_Li_Battery_4hr	**875**	1,122		**1,122**	1,298		**1,298**
Northern_California_Li_Battery_8hr	-	300		**300**			**-**
Riverside_Li_Battery_4hr	**708**	2,130		**2,130**	2,728		**2,728**
Riverside_Li_Battery_8hr	-	120		**120**			**-**
Southern_NV_Eldorado_Li_Battery_4hr	**1,145**	1,684		**1,684**	2,624		**2,624**
Southern_NV_Eldorado_Li_Battery_8hr	**439**	180		**180**			**-**
Southern_PGAE_Li_Battery_4hr	**5,638**	2,331		**2,331**	3,813		**3,813**
Southern_PGAE_Li_Battery_8hr	**332**	437		**437**			**-**
Tehachapi_Li_Battery_4hr	**1,703**	2,505		**2,505**	3,526		**3,526**
Tehachapi_Li_Battery_8hr	-	170		**170**			**-**
LI_Battery Total	**16,671**	**16,671**		**16,671**	**19,794**		**19,794**
Riverside_East_Pumped_Storage	**299**	-		**-**	700		**700**
San_Diego_Pumped_Storage	**-**	449		**449**	500		**500**
Tehachapi_Pumped_Storage	**178**	-		**-**			**-**
Southern_PGAE_Adiabatic_CAES	-	-		**-**	300		**300**
Tehachapi_Adiabatic_CAES	**200**	481		**481**	500		**500**
Greater_Imperial_Flow_Battery	**29**	-		**-**			**-**
Greater_LA_Flow_Battery	**50**	-		**-**			**-**
Northern_California_Flow_Battery	**71**	5		**5**			**-**
Southern_PGAE_Flow_Battery	**108**	-		**-**			**-**
Other Storage Total	**935**	**935**		**935**	**2,000**		**2,000**
Storage Total	**17,606**	**17,606**		**17,606**	**21,794**		**21,794**
Total Storage+Resources	**53,037**	**41,814**	**11,226**	**53,040**	**45,646**	**22,669**	**68,315**

Table 9: Summary of the October 2023 Ruling proposed base case portfolio (2039 model year) and initial mapping results by RESOLVE resource area compared to the previous 23-24 TPP base case.

2039 Initial Base Case Portfolio	Initial RESOLVE Modeled Portfolio	Initial Mapping Total (2039)			23-24 TPP (2035) Mapped Total (Subtracting New Baseline)		
RESOLVE Resource Name	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**	**FCDS (MW)**	**EODS (MW)**	**Total (MW)**
InState Biomass	**171**	171	-	**171**	127		**127**
Central_Nevada_Geothermal	**40**	500	-	**500**	500		**500**
Greater_Imperial_Geothermal	**1,356**	790	-	**790**	805		**805**
Inyokern_North_Kramer_Geothermal	**7**	-	-	**-**	-		**-**
Northern_California_Geothermal	**314**	124	-	**124**	118		**118**
Northern_Nevada_Geothermal	**-**	240	-	**240**	305		**305**
Pacific_Northwest_Geothermal	**13**	-	-	**-**	-		**-**
Utah_Geothermal	**-**	76	-	**76**	12		**12**
Distributed Solar	**-**	225	-	**225**	86		**86**
Arizona_Solar	**3,243**	1,210	2,890	**4,100**	1,498	2,947	**4,445**
Greater_Imperial_Solar	**39**	-	182	**182**	-	711	**711**
Greater_Kramer_Solar	**4,066**	752	1,258	**2,010**	611	1,317	**1,928**
Greater_LA_Solar	**-**	125	148	**273**	125	625	**750**
Northern_California_Solar	**126**	605	590	**1,195**	679	1,047	**1,726**
Riverside_Solar	**659**	600	1,909	**2,509**	1,026	3,448	**4,473**
Southern_NV_Eldorado_Solar	**4,665**	1,125	1,715	**2,840**	2,032	2,786	**4,818**
Southern_PGAE_Solar	**1,586**	2,994	4,475	**7,469**	3,093	4,733	**7,826**
Tehachapi_Solar	**10,796**	1,561	2,818	**4,379**	1,837	4,331	**6,167**
Baja_California_Wind	**2,473**	1,300	1,000	**2,300**	-	360	**360**
Central_Valley_North_Los_Banos_Wind	**32**	360	5	**365**	74	-	**74**
Greater_Imperial_Wind	**133**	460	100	**560**	135	-	**135**
Greater_Kramer_Wind		550	100	**650**	-	-	**-**
Kern_Greater_Carrizo_Wind		275	10	**285**	263	-	**263**
Northern_California_Wind	**849**	1,685	210	**1,894**	230	109	**339**
Riverside_Palm_Springs_Wind		499	100	**599**	-	-	**-**
Solano_Wind	**375**	785	200	**985**	537	75	**612**
Southern_NV_Eldorado_Wind	**5,011**	1,610	300	**1,910**	353	-	**353**
Tehachapi_Wind	**1,489**	764	50	**814**	127	-	**127**
Idaho_Wind	**300**	1,204	-	**1,204**	1,000	-	**1,000**
New_Mexico_Wind	**1,968**	4,500	-	**4,500**	2,328	-	**2,328**
Wyoming_Wind	**7,936**	4,500	-	**4,500**	1,500	-	**1,500**
Humboldt_Bay_Offshore_Wind	**-**	-	-	**-**	1,446	161	**1,607**
Morro_Bay_Offshore_Wind	**4,531**	4,531	-	**4,531**	3,100	-	**3,100**
Renewable Resource Total	**52,180**	**34,121**	**18,058**	**52,179**	**23,852**	**22,669**	**46,521**
Arizona_Li_Battery_4hr	**972**	910		**910**	1,554		**1,554**
Arizona_Li_Battery_8hr	**190**	650		**650**			**-**
Greater_Imperial_Li_Battery_4hr	**-**	341		**341**	332		**332**
Greater_Imperial_Li_Battery_8hr	**-**	-		**-**			**-**
Greater_Kramer_Li_Battery_4hr	**445**	746		**746**	1,036		**1,036**
Greater_Kramer_Li_Battery_8hr	**165**	265		**265**			**-**
Greater_LA_Li_Battery_4hr	**4,020**	3,318		**3,318**	2,883		**2,883**
Greater_LA_Li_Battery_8hr	**587**	539		**539**			**-**
Northern_California_Li_Battery_4hr	**875**	1,172		**1,172**	1,298		**1,298**
Northern_California_Li_Battery_8hr	**2,697**	770		**770**			**-**
Riverside_Li_Battery_4hr	**708**	2,130		**2,130**	2,728		**2,728**
Riverside_Li_Battery_8hr	**-**	520		**520**			**-**
Southern_NV_Eldorado_Li_Battery_4hr	**1,145**	2,084		**2,084**	2,624		**2,624**
Southern_NV_Eldorado_Li_Battery_8hr	**439**	530		**530**			**-**
Southern_PGAE_Li_Battery_4hr	**5,837**	2,500		**2,500**	3,813		**3,813**
Southern_PGAE_Li_Battery_8hr	**815**	1,699		**1,699**			**-**
Tehachapi_Li_Battery_4hr	**1,703**	2,505		**2,505**	3,526		**3,526**
Tehachapi_Li_Battery_8hr	**763**	684		**684**			**-**
LI_Battery Total	**21,364**	**21,364**		**21,364**	**19,794**		**19,794**
Riverside_East_Pumped_Storage	**299**	-		**-**	700		**700**
San_Diego_Pumped_Storage	**-**	499		**499**	500		**500**
Tehachapi_Pumped_Storage	**178**	-		**-**			**-**
Southern_PGAE_Adiabatic_CAES	**-**	-		**-**	300		**300**
Tehachapi_Adiabatic_CAES	**200**	481		**481**	500		**500**
Greater_Imperial_Flow_Battery	**29**	-		**-**			**-**
Greater_LA_Flow_Battery	**50**	-		**-**			**-**
Northern_California_Flow_Battery	**71**	5		**5**			**-**
Southern_PGAE_Flow_Battery	**158**	-		**-**			**-**
Other Storage Total	**985**	**985**		**985**	**2,000**		**2,000**
Storage Total	**22,349**	**22,349**		**22,349**	**21,794**		**21,794**
Total Storage+Resources	**74,528**	**56,470**	**18,058**	**74,528**	**45,646**	**22,669**	**68,315**

The initial rounds of mapping by the Working Group resulted in some significant shifts of where the resources in the 24-25 TPP base case portfolio were mapped when compared to the mapped results of the 23-24 TPP base case. These changes were driven by two main factors: 1) The portfolios themselves differ in resource composition and size, even after adjusting for the updated baseline; 2) as noted in Section 5, the mapping process implements several new and updated criteria including new land-use screens and updated transmission constraint information. Section 6.1.E discusses the initial mapping's alignment with the previous base case in more detail.

The following subsections summarize and discuss the initial mapping's alignment with the busbar mapping criteria by category for the base case portfolio. The transmission constraint criteria alignment, the commercial development interest criteria alignment, and previous TPP base case criteria alignment are discussed with respect to both the 2034 and 2039 portfolio mapping results. The land-use feasibility, environmental impacts, and community impacts criteria alignment sections focus on only the 2039 portfolios, as they are the larger portfolios with more resources mapped.

6.1.A Initial System Level Transmission Criteria Alignment

The system level transmission criteria focus on mapped resources utilizing transmission capabilities in the existing CAISO system. The analysis relies on transmission constraints and identified upgrades from the CAISO's new 2023 White Paper on "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2023 White Paper)[16] with adjustments identified by CAISO staff feedback through the Working Group. The new 2023 White Paper significantly expanded the number of constraints and substations considered compared to the previous 2021 White Paper[17] and provided additional upgrade information. The Working Group incorporated feedback from CAISO staff to identify and include upgrade information from upgrades already approved in previous TPP cycles.

Table 10 below shows the initial mapping of resources for the 2034 portfolio. Resources are summarized by resource type and the transmission status of the buses the resources are mapped to. The table summarizes whether the resources are mapped to buses that are in transmission constraints which have capability exceedances due to the full mapped portfolio based on the 2023 White Paper constraint information. Table 11 shows the same analysis for the initial mapping of the 2039 portfolio. Note, the MW amounts in Table 10 and Table 11 differ by 210 MW from the total initial portfolio, as that amount of in-development resources CAISO staff identified as already being included in the transmission constraint capability baselines.

[16] "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2023). CAISO White Paper. https://www.caiso.com/Documents/PresentationUpdatedTransmissionCapabilityEstimates-use-CPUCsResourcePlanningProcess-Jul5-2023.pdf

[17] "2021 Transmission Capability Estimates for use in the CPUC's Resource Planning Process." CAISO Revised White Paper. 10/28/2021. https://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=79BEBAD0-E696-4E04-A958-1AAF53A12248.

Table 10: Initial mapping (2034 Portfolio) alignment with existing transmission capability availability by resource type.

2034 Ruling Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedancess	Actual Constraint Exceedances
Geothermal (MW)	-	740	841
Biomass (MW)	47	-	124
OnshoreWind (MW)	3,478	-	4,652
OOS Wind (MW)	-	-	5,268
Offshore Wind (MW)	3,855	-	-
Solar (MW)	12,507	110	3,658
Li_Battery (MW)	8,235	700	7,681
LDES (MW)	481	-	454
Total by Status (MW)	**28,602**	**1,550**	**22,677**

Table 11: Initial mapping (2039 Portfolio) alignment with existing transmission capability availability by resource type.

2039 Ruling Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	-	740	958
Biomass (MW)	37	3	130
OnshoreWind (MW)	3,519	499	6,345
OOS Wind (MW)	-	-	10,204
Offshore Wind (MW)	4,531	-	-
Solar (MW)	18,376	712	5,970
Li_Battery (MW)	7,646	2,524	11,138
LDES (MW)	481	-	504
Total by Status (MW)	**34,590**	**4,477**	**35,249**

Overall, initial mapping of the base case portfolio resulted in 16 exceedances in transmission constraints from CAISO's 2023 White Paper in the 2034 model year, per Working Group staff calculations, and 27 exceedances in the 2039 model year. In both 2034 and 2039 mapping years, all exceedances were for the on-peak (Highest System Need or HSN) constraints. Table 12 shows the number of constraint exceedances by CAISO zone and whether the constraints exceeded are actual values or default values per the information provided in the CAISO White Paper. The table does not reflect additional transmission upgrade needs beyond the current CAISO transmission system including upgrades or new transmission for out-of-CAISO resources to reach the CAISO system or new transmission likely needed to interconnect resources in new areas of California such as offshore wind.

Table 12: Number of transmission constraint exceedances for the inital mapping results by CAISO study area for the 2034 and 2039 portfolios.

Tx Constraint Exceedances	2034		2039	
	Actual	Default	Actual	Default
PG&E North of Greater Bay	2	0	2	0
PG&E Greater Bay	3	0	3	0
PG&E Fresno	2	0	4	1
PG&E Kern	2	0	3	0
SCE Northern Area	1	0	1	0
SCE Metro	0	0	0	0
SCE North of Lugo	0	0	0	0
East of Pisgah	1	0	1	1
SCE Eastern	0	1	1	3
SDG&E	4	0	4	3
Total	15	1	19	8

A calculated exceedance does not determine if the identified upgrade in the 2023 White Paper will necessarily occur; only the CAISO's full TPP analysis determines what upgrades may be needed. Busbar mapping calculated exceedances only highlight locations of potential need for transmission upgrades within the CAISO system due to the mapped resources to help guide the mapping.

The initial mapping constraint exceedances and additional transmission implications are discussed in more detail by area and CAISO study area below.

Northern California – PG&E North of Greater Bay and PG&E Greater Bay

In both 2034 and 2039 mapping years, five actual on-peak constraints are identified as exceeded in the mapping transmission calculations: two located in PG&E North of Greater Bay and three in PG&E Greater Bay study areas. The mapped resources behind the exceedances in both areas are onshore wind, co-located battery storage, and to a lesser extent geothermal resources.

In the PG&E North of Greater Bay study area, the two exceeded constraints are the Vaca Dixon-Tesla 500 kV Line and the Carberry-Round Mountain 230kV Line. In 2034, the Vaca Dixon-Tesla 500 kV Line Constraint has an on-peak exceedance of ~700 MW, which increases to over 1,900 MW in the 2039 mapping. The exceedance could be alleviated by the identified White Paper upgrade, costing ~$2.9 billion and providing over 8,600 MW of additional capability. The previous TPP portfolio did not find the identified upgrade as necessary even though resources mapped to the area results in a similar exceedance; however, the current exceedance is larger and new full TPP analysis may find the upgrade necessary. In 2039 with the large exceedance, IRP staff assess that the upgrade would likely be necessary. The Carberry-Round Mountain 230kV Line Constraint has an on-peak exceedance of ~120 MW in both 2034 and 2039 that would likely trigger an upgrade. The 2039 mapping includes 1,000 MW of onshore wind mapped to locations around three Nevada Energy (NVE) substations in northeastern California in Lassen and Modoc counties, which lie outside of the current CAISO system. These resources are modeled as interconnecting to the CAISO system in the Malin-Round Mountain area and would likely need long gen-ties to interconnect to the CAISO system or a major new transmission line to the NVE system in Northern California. Finally, the initial mapping has no offshore wind mapped to the North Coast, so no North Coast transmission is identified as needed.

In the PG&E Greater Bay study area, the three exceeded on-peak constraints are the Windmaster-Delta pumps 230 kV Line, the Morganhill-Metcalf 115kV Line, and the Birds Landing-Contra Costa 230kV Line Constraints. All three constraints have exceedances ranging between 200 and 500 MWs in both 2034 and 2039. CAISO staff provided feedback within the busbar mapping Working Group on the potential impacts and likelihood of these exceedances triggering the identified White Paper upgrades. CAISO staff note that for all three constraints resources are mapped to certain substations that are within the area of the constraint but are not binding to the specific constraint and small MW amounts of resources are mapped to substations with low distribution factors (DFAX) for these constraints. Resources mapped to the Tesla substation are not binding on the Windmaster-Delta pumps 230 kV Line Constraint; resources mapped to the Metcalf substations are not binding on the Morganhill-Metcalf 115kV Line Constraint. For the Birds Landing-Contra Costa 230kV Line Constraint, resources mapped to Glenn and Eagle Rock substations are not binding, while resources mapped to other substations like Lakeville and Tulucay with low DFAX values are also not likely to result in the exceedance triggering the identified transmission upgrade. These mappings therefore have a low likelihood of triggering the upgrades for the constraints but cannot be guaranteed without full analysis in the TPP.

Southern PG&E — PG&E Fresno and PG&E Kern

In 2034, initial busbar mapping results in two exceedances in each study area for on-peak, actual White Paper transmission constraints. In 2039 mapping, the amount increases to three in the PG&E Kern zone and five total, four actual and one default, in the PG&E Fresno zone. In both zones, exceedances are mostly driven by large amounts of solar and storage mapped.

In the PG&E Kern study area, the two constraints with on-peak exceedances in both 2034 and 2039 are in the Oceano-Calendar 115kV Line and the Midway-Q2005 230kV Line Constraints. In the 2034 mapping, the Oceano-Calendar 115kV Line's calculated exceedance is ~300 MW and increases to over 900 MW in 2039. The Midway-Q2005 230kV Line Constraint has a calculated exceedance of over 1,300 MW in 2034 and nearly 2,900 MW in 2039 making the identified CAISO White Paper upgrade likely needed. While the exceedance amount for the Oceano-Calendar 115kV Line may not trigger the identified upgrade in the 2034 mapping, the higher exceedance in 2039 indicates that the upgrade is likely needed for the 2039 portfolio. In 2039, the third on-peak exceedance occurs in the Midway-Q2011 230 kV Line Constraint. This exceedance is relatively minor, only 16 MW.

In the PG&E Fresno study area, the two on-peak exceedances in both 2034 and 2039 are in the Chowchilla-Le grand 115kV Line and Schindler 115/70kV TB #1 Constraints. Both constraints have exceedances ~200 MW in the 2034 mapping and ~300 MW in the 2039 mapping. CAISO staff's feedback within the busbar mapping Working Group noted that resources are mapped to several substations with low DFAX (e.g., Wilson, Helms, and Borden) in amounts that are not likely to impact the constraint and trigger the identified upgrade in either 2034 or 2039. Thus, the exceedances calculated have a low probability of resulting in triggering the identified White Paper upgrades but cannot be guaranteed without a full TPP analysis. Two additional on-peak exceedances are identified in 2039 mapping in the Gates 500/230kV TB #11 and TB#12 Constraints. Both exceedances are larger than 1 GW and likely trigger the identified upgrade, which is the same for both constraints, an estimated $35 million upgrade that increases both constraints capabilities by over 3 GW. The 2039 mapping also has an on-peak default constraint exceedance of ~400 MW in the Moss Landing-Las Aguilas 230 kV Line Off-peak Constraint. The capability value for the on-peak constraint was not found so the White Paper utilized the number of resources studied as the default capability estimate. Thus, it is not known whether this exceedance is likely to trigger a

transmission upgrade.

All 4.5 GW by 2039 of offshore wind in the portfolio is mapped to the Morro Bay wind area. Initial mapping splits the offshore wind interconnection locations between the Diablo Canyon 500 kV substation and a proposed new Morro Bay 500 kV substation that loops into the Diablo-Gates 500 kV line as identified in the offshore wind sensitivity portfolio analysis from the CAISO's 2021-22 TPP Report[18]. No constraints are exceeded by this mapping of offshore wind and no additional constraint upgrades would likely be necessary. The CPUC's IRP and TPP portfolio modeling assumes the Diablo Canyon Power Plant (DCPP) retires fully in 2025 in line with California's Public Utilities Code § 454.52 and the CAISO's 2023 White Paper available transmission capability information assumes that DCPP transmission capacity is available.

Greater Tehachapi & LA Metro — SCE Northern and SCE Metro

Resources mapped to the SCE Northern study area result in an on-peak exceedance in the South of Magunden Constraint in both 2034 and 2039 of ~600 MW. The upgrade identified in the CAISO's White Paper is estimated to cost $4.4 billion and provide an additional 2,000 MW of capability. In feedback to the busbar mapping Working Group, CAISO staff noted the previous upgrade included in the 2021 White Paper, a new 500 kV Magunden substation with an estimated cost of $1.5 billion and capability increase of 870 MW, as an alternative upgrade. Either upgrade also has the potential for reducing Path 26 congestion and addressing the Windhub Constraint. CAISO staff also noted that the resources mapped to substations in the Ventura area (e.g. Moorpark, Santa Clara, Goleta, and Mandalay) have a low probability of contributing to the need for an upgrade. These substations have low DFAX values, and the MW amounts mapped to them are unlikely to contribute to the exceedance. Additionally, the MW number of resources mapped is less than the amount of TPD allocated to projects at the constraint substations. Initial mapping resulted in no other constraint exceedances in these two areas.

Greater Kramer — SCE North of Lugo

Initial mapping resulted in no calculated transmission exceedances for either the 2034 or 2039 portfolios. The three upgrades approved in the 22-23 TPP for this study area can accommodate the resources mapped.

Southern Nevada & El Dorado — East of Pisgah

The East of Pisgah study area has one on-peak constraint exceedance in the 2034 initial mapping. The calculated on-peak exceedance in the Lugo - Victorville Area Constraint is 1,400 MW in 2034 and increases to over 6,000 MW in the 2039 mapping. The exceedance is primarily driven by OOS wind on new transmission as, particularly in 2039, when all 10 GW of OOS wind in the portfolio is mapped as interconnecting to substations within the constraint. The CAISO 2023 White Paper identified upgrade is a new 500 kV line costing an estimate $2.2 billion and providing an estimated 6,800 MW of additional capability. The level of exceedance in 2034 may not result in triggering the identified White Paper transmission upgrade as a similar number of resources were mapped to the constraint in the 23-24 TPP base case and preliminary results from the 23-24 TPP[19] initially indicate that an upgrade may not be required. However, the larger exceedance in the 2039 portfolio indicates

[18] 2021-2022 Transmission Plan. CAISO. 03/17/2022. caiso.com/Documents/ISOBoardApproved-2021-2022TransmissionPlan.pdf

[19] "2023-2024 Transmission Planning Process Stakeholder Meeting." CAISO. 11/16/23. caiso.com/InitiativeDocuments/Presentation-2023-2024-Transmission-Planning-Process-Nov16223.pdf

that the upgrade is likely necessary. The mapping in 2039 results in an on-peak default exceedance in the GLW 230kV Area Constraint as the amount mapped results in an exceedance of the estimated capability of the already approved GLW 230kV Area upgrade by ~400 MW. The amount mapped to the GLW area is comparable to the amount mapped in the 2023-24 TPP base case and likely to not require an additional upgrade but cannot be guaranteed without a full TPP analysis.

The East of Pisgah area includes the likely CAISO intertie points for the mapped out-of-state wind in Idaho and Wyoming as well as geothermal resources in Central Nevada, Northern Nevada, and Utah. Idaho wind (1,000 MW in 2034; 1,200 MW in 2039) is assumed to interconnect on the proposed SWIP-North line and thus mapped to the Harry Allen 500 kV CAISO intertie. Working Group staff mapped up to 3,000 MW of Wyoming Wind to the Eldorado 500 kV CAISO intertie assuming the resources utilize the in-development TransWest line. The remaining 1,500 MW of Wyoming wind are also mapped to the Eldorado intertie and would need an additional new transmission line to interconnect to the CAISO system. For Central Nevada geothermal, staff mapped at total of 500 MW by 2039 as interconnecting to the expanded Beatty substation. Working Group staff note that though interconnecting directly with the CAISO system this configuration would likely still require long gen-ties (>50 miles) to interconnect the known geothermal areas in Central/Southern Nevada. Northern Nevada resources are mapped as interconnecting into the CAISO at Eldorado – Harry Allen 500 kV tie-in points while Utah geothermal is modeled as interconnecting at the Eldorado 230 kV tie-in points.

Riverside & Arizona — SCE Eastern

In 2034, initial busbar mapping results in the on-peak exceedance from one default constraint. The amount mapped to substations in the Devers-Red Bluff Constraint exceeded the estimated capability of the 22-23 TPP approved upgrade by ~1,400 MW. In the 2039 mapping, the exceedance on the Devers-Red Bluff Constraint increases to almost 6,500 MW, while two additional default on-peak exceedances occur for the Colorado River-Red Bluff and Serrano-Alberhill-Valley Constraints. Like for the Devers-Red Bluff Constraint, in both constraints, the amount mapped is exceeding the estimated capability of the 22-23 TPP approved upgrades, by over 2,300 MW for the Colorado River-Red Bluff Constraint and ~500 MW for the Serrano-Alberhill-Valley Constraint. As these are default exceedances based on upgrade capability estimates, staff do not know if the exceedances will trigger additional upgrades without performing the TPP analysis. However, it is likely that the Devers-Red Bluff Constraint will require additional upgrades given how high the exceedance is, and there is potential the Colorado River-Red Bluff constraint may need an additional upgrade as well. In feedback to the Working Group, CAISO staff identified upgrades from previous studies and White Papers as potential solutions. For Devers-Red Bluff CAISO staff pointed to the CAISO's 2021 White Paper identified new Devers - Red Bluff 500kV No. 3 line, costing an estimated $1.02 billion, for the Devers-Red Bluff Constraint and a new 500 kV Colorado River-Red Bluff line, costing an estimated $357 million, for the Colorado River-Red Bluff Constraint exceedance. The 2039 mapping also resulted in a calculated exceedance in the on-peak Colorado River 500/230 kV Constraint by 220 MW, which would likely require the identified $67 million dollar CAISO's 2023 White Paper upgrade.

The SCE Eastern study area also includes 740 MW of Imperial geothermal mapped to the Imperial Irrigation District (IID) system and interconnecting to the CAISO at the Mirage substation intertie. Working Group staff note that in addition to potential in-CAISO constraint upgrades, these resources would likely require transmission upgrades in the IID system. Additionally, staff mapped the New Mexico wind in the portfolio (2,000 MW in 2034 and 4,500 MW in 2039) to the Palo Verde

CAISO boundary intertie point. In initial mapping, Working Group staff assumed that ~2,500 MW of the mapped New Mexico wind would utilize the in development SunZia line per CAISO's 20-year transmission outlook (2021-2022). The additional 2,000 MW of New Mexico wind would require additional new transmission to reach Palo Verde.

San Diego & Greater Imperial — SDG&E

Initial busbar mapping in the SDG&E area results in four on-peak exceedances in both 2034 and 2039 portfolios. The four constraints: Chicarita 138 kV, Silvergate - Bay Blvd 230 kV, Silvergate-Old Town 230 kV, and Talega 230 kV Constraints have exceedances ranging between 160-520 MWs in 2034 and 300-660 MW in 2039. In feedback to the Working Group, CAISO staff noted that even small exceedances in these constraints will likely trigger an upgrade. The 2039 initial mapping results in three additional exceedances of default on-peak capability limits for the Internal San Diego Area, Encina - San Luis Rey 230 kV, and San Luis Rey-San Onofre 230 kV Line constraints. The small default exceedances, all less than 200 MW, in these three constraints are a result of the mapping resources exceeding the estimated capability of the 22-23 TPP approved upgrades for these constraints. These small exceedances are not likely to trigger additional upgrades but cannot be guaranteed without a full TPP analysis.

6.1.B Initial Land-use Feasibility and Environmental Implications Criteria Alignment

This section summarizes the initial mapping's alignment with the land-use implications and environmental (conservation and biological) impacts criteria categories. The mapping of utility-scale solar, onshore wind, and geothermal for the initial 2039 portfolio alignment with criteria is discussed below. As 2039 portfolio results do not reduce resources mapped to locations compared with the 2034 mapping, the 2039 mapping criteria alignment reflects the largest potential implications of the portfolio. Full criteria alignment of the 2034 and 2039 mapping results for the initial base case portfolio can be found in the initial mapping dashboard (Appendix C). This analysis reflects criteria alignment with the data implemented for the initial mapping work. As noted in Section 5, the Working Group made several updates to correct the data analysis for several land-use screens, which does result in improved criteria alignment. These changes to the data analysis for the criteria are not reflected in this initial analysis summary but are discussed and reflected in the final criteria analysis summary in Section 6.3.

Utility-Scale Solar

Table 13 depicts a summary of the initial 2039 portfolio's mapped solar resources alignment with the land-use implications and environmental impacts criteria. The table summarizes by RESOLVE resource area the MW of solar mapped and their highest non-alignment flag for the various criteria. The first set of columns shows the amount of solar in each region and the amount of MWs at each level of alignment for the Core Land-use screen criteria, which uses either the CEC's Core Land-use Screen for instate resources and the WECC Environmental and Cultural Considerations Data Layer for out-of-state solar resources. The second set of columns represents the same breakdown for the highest alignment flag amongst the remaining land-use implications criteria alignment, which for solar includes the parcelization, cropland, and fire threat criteria. Solar resources are summed by the highest flag for any of those three criteria. The final set of columns depicts the highest flag amongst the environmental (conservation and biological) impacts criteria.

Table 13: Summary of initial solar mapping results alignment with the land-use implications and environmental impacts criteria for the 2039 portfolio. Criteria alignment summarized by category and RESOLVE resource area.

Intital 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Other Land-use Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	565	230	400		683	512			428	767	-	-
Southern PG&E	5,044	2,465	-	-	4,932	2,577	-	-	6,735	774	-	-
Greater Tehachapi	2,814	1,815	-	-	-	-	-	4,624	2,814	1,815	-	-
Greater Kramer	1,016	350	644		280	994	-	736	1,016	994	-	-
Riverside	-	1,395	-	1,114	-	-	1,114	1,395	1,395	1,114	-	-
Arizona	4,100	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Southern Nevada	2,540	300	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	182	-	-	-	-	182	-	-	182	-	-	-
Total:	**16,011**	**6,555**	**1,044**	**1,114**	**5,895**	**4,265**	**1,114**	**6,505**	**12,320**	**5,464**	**-**	**-**

Higher non-alignment flags for land use and environmental criteria occur in the following key areas: Northern California, Tehachapi, Greater Kramer, and Riverside. In Northern California, the Tesla substation, with 400 MW solar resources mapped, has a level-4 alignment flag for the core land use screen, while the 230 MWW of solar mapped to the Cortina substation has a level-3 alignment flag. These flags indicate the mapped resources would require a significant portion of the lower implication acreage available around each substation. The Southern PG&E has a few level-3 alignment flags for the core land-use screen at the Midway and Gates substations and level-3 for Cropland implications at Gates as well.

In Tehachapi, the Windhub, Whirlwind, and Antelope substations have level-5 non-alignment flags for parcelization, while the Vincent substation has a level-4 flag. However, stakeholders have previously noted the Tehachapi area is a unique location with regards to parcelization that industry has been able to overcome. Recent large-scale development of solar in the area provides confirmation that high-parcelization may not be a barrier to development. Additionally, Vincent and Antelope have level-5 and -4 flags for fire threat respectively.

In the Greater Kramer area, there is level-4 flag in the core land-use screen for solar resources mapped to the Kramer buses and a level-3 flag for 350 MW at Coolwater. The higher flag for the Kramer substation indicates limited area of lower-potential implications area more favorable for solar development around the substation, particularly to the South and East. However, staff note that to the North and West, lower implication land is available in larger amounts making, likely making the further interconnection distance cost-effective. There are also parcelization level-5 non-alignment flags at the Roadway, Victor, and Calcite substations, but staff note that similarly to the Tehachapi area development has and likely will be able to accommodate the higher parcelization.

In the Riverside area, solar mapped to the Red Bluff substation has a level-5 flag for the core land use screen criteria and a level-4 flag for the Cropland Index criteria, while the Colorado River substation has a level-5 alignment flag for the Cropland Index Criteria. For the core land use screen, the amount of solar resource mapped to the area would likely exceed the available lower implication area, and it uses 50-70% of the available higher implication area, even when the interconnection distance is expanded to 20-miles. For both substations, the amount of solar mapped would likely utilize an amount of land that exceeds the low value cropland acreage around both substations. Staff would consider remapping resources from Red Bluff for this level of exceedance; however, Working

Group staff corrected land-use dataset errors discussed in detail in Section 6.2 that artificially limited the amount of lower implication land-identified as available.

Onshore Wind

Table 14 depicts a summary of the initial 2039 portfolio's mapped onshore wind resources alignment with the land-use implications and environmental impacts criteria. The table summarizes by RESOLVE resource area the MW of wind mapped and their high non-alignment flag for the various criteria. The structure is the same as for solar, except that the parcelization and Cropland Index criteria are not applicable for onshore wind. This analysis is for onshore wind in California or the existing CAISO. For wind this includes Southern Nevada wind but excludes Wyoming, Idaho, and New Mexico wind. Although interconnecting directly to the CAISO, Baja California, Mexico, wind is not analyzed as the Working Group was not able to incorporate comparable data for resource potential areas in Mexico.

Table 14: Summary of initial onshore in-CAISO wind mapping results alignment with the land-use implications and environmental impacts criteria for the 2039 portfolio. Criteria alignment summarized by category and RESOLVE resource area.

Intital 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Other Land-use Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Onshore Wind	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	433	-	1,545	901	1,538	-	-	1,341	1,203	370	200	1,106
Southern PG&E	300	-	-	350	575	-	-	75	300	-	75	275
Greater Tehachapi	314	500	-	-	124	500	-	190	814	-	-	-
Greater Kramer	200	300	-	150	650	-	-	-	500	150	-	-
Riverside	-	-	-	499	-	-	-	499	-	-	200	399
Southern Nevada	1,500	410	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	60	-	-	500	-	60	-	500	60	500	-	-
Total:	**2,807**	**1,210**	**1,545**	**2,400**	**2,887**	**560**	**-**	**2,605**	**2,877**	**1,020**	**475**	**1,780**

Higher non-alignment flags for the land-use and environmental criteria occur in all areas, with the greatest occurrences in the Northern California, Southern PG&E, Riverside, and Imperial areas.

In Northern California, most mapped wind resources and most substations mapped to have level-4 or -5 alignment flags for the CEC core land-use screen. Wind mapped to Telsa, Kelso, and Eagle Rock substations, roughly 780 MW, has a level-5 non-alignment for the core screen, while 420 MW of wind mapped to Birds Landing and a proposed substation on the Cottonwood-Pit 1 line, as well as the 1,000 MW mapped to the three NVE substations in northeastern California have level-4 non-alignment flags. For these substations, the wind resources utilize all the low-potential implication wind resource potential land, and for Eagle Rock and Telsa areas, the resource additionally utilize nearly all the higher implications areas. For the fire threat criteria, wind mapped to Eagle rock, the three northeastern California locations, and the proposed substation on the Cottonwood-Pit 1 line have leve-5 flags. Both Eagle Rock and Tesla substation have multiple level-5 flags for the environmental impact criteria, while the wind resources mapped near the NVE Madeline substation has a level-5 flag for the Intactness criteria. Only the 100 MWs mapped to Coburn and 433 MW mapped to Glenn have no level-4 or -5 alignment flags across the two categories.

In Southern PG&E, three substations, Caliente, Los Banos, and Templeton, with 350 MW of wind

have level-5 flags for the core land-use screen while Los Banos and Caliente have multiple level-5 flags for the environmental implications criteria. The 210 MW of wind resources mapped to Caliente utilize more land than available from the low or high implications land combined. Similarly in the Riverside area, the resources mapped to the Devers and El Casco substation trigger multiple level-5 alignment flags and exceed the amount of available low and high implication acreage available under the core land-use screen.

In the Greater Kramer area, the 150 MW of wind mapped to a proposed substation on the Lugo – Pisgah line has a single level-5 flag for the core land-use screen criteria for the mapped resources utilizing all the lower potential implication land and a significant portion of the higher implication land. In the Greater Imperial area, the 500 MW mapped to a proposed substation on the Suncrest – Ocotillo line similarly has a level-5 flag in the core land-use screen criteria.

As noted above, at several mapping locations, there is not enough base resource potential to accommodate the amount mapped or the amount seen in the commercial development interest. Stakeholders have previously noted, including in the most recent busbar mapping methodology update process, that the wind resource potential data used is not granular enough to capture all likely areas where wind could be developed. Thus, in updated analysis for the Proposed Decision Working Group staff incorporated a lower capacity factor threshold of 20%, lowered from the initially assumed 28%, to capture additional potential resources area that wind development could likely occur, but which was potential excluded by the higher capacity factor threshold and coarse base potential data. Staff did not reduce the land-use or environmental impact criteria thresholds. Mapping results using both the 28% and 20% CF thresholds are shown for the final mapping results analysis in Section 6.3.

Geothermal

As shown for onshore wind above, Table 15 depicts a summary of the initial 2039 portfolio's mapped geothermal resources alignment with the land-use implications and environmental impacts criteria. This analysis is for geothermal resources mapped to known geothermal areas in California and does not include geothermal resources mapped to Nevada or Utah. For the geothermal mapping, the only level-5 flags are for the 124 MW of resources mapped to the Geysers area for the fire threat criteria.

Table 15: Summary of initial in-state geothermal mapping results alignment with the land-use implications and environmental impacts criteria for the 2039 portfolio. Criteria alignment summarized by category and RESOLVE resource area.

Intital 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Other Land-use Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Geothermal	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Gesyers	124	-	-	-	-	-	-	124	-	124	-	-
Salton Sea	740	-	-	-	740	-	-	-	740	-	-	-
East Brawley	50	-	-	-	50	-	-	-	50	-	-	-
Total (MW):	**914**	**-**	**-**	**-**	**790**	**-**	**-**	**124**	**790**	**124**	**-**	**-**

6.1.C Initial Community and Societal Environmental Impacts Criteria Alignment

Table 16 shows the initial mapping results for the 2039 portfolio alignment with the prioritized mapping criteria for the community and societal environmental impacts criteria summarized by CAISO study area. The table highlights the number of MWs of generation and storage in the initial 2039 portfolio mapped to areas within a PM2.5 or ozone air quality non-attainment zone, to a substation near existing and former fossil fuel plants, in an area that is identified as an Inflation Reduction Act (IRA) Energy Community, or in or near a disadvantaged community (DAC) per the SB 535 definition as identified by the CalEnviroScreen 4.0 dataset.

Table 16: Summary of initial mapping (2039 portfolio) alignment with the community environmental impacts criteria. Summarizes by CAISO study area mapped generation and storage amounts meeting prioritized criteria goals.

Inital 2039 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Thermal Plant (<1 mile)		In IRA Energy Community		In or near (<5 mi) DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	477	181	843	290	223	38	560	77
PG&E Greater Bay	1,328	876	218	961	1,305	176	1,217	826
PG&E Fresno	4,427	2,243	3,050	1,907	-	32	8,831	4,455
PG&E Kern	2,862	1,284	4,730	50	7,474	1,274	4,557	2,337
SCE Northern Area	5,448	4,385	2,853	1,372	5,446	4,230	2,705	1,695
SCE Metro	40	2,292	31	1,615	40	1,712	48	3,440
SCE North of Lugo	2,537	1,011	683	170	1,782	641	2,289	620
East of Pisgah	-	-	1,400	500	4,540	1,785	-	200
SCE Eastern	6,142	1,405	399	990	2,603	1,150	205	1,335
SDG&E	2,592	1,371	2,542	309	-	250	100	467
Total	**25,852**	**15,047**	**16,748**	**8,164**	**23,412**	**11,288**	**20,512**	**15,451**

The direct and indirect impacts of renewable buildout on air quality are not known with high certainty and further study is needed for probabilistic characterization of air quality benefits of renewable buildout. Nonetheless, the goals of aligning mapped resources with these criteria is to bolster and benefit pollution-burdened and disadvantaged communities where feasible, particularly by reducing emissions and impacts of air-pollutant emitting fossil-fuel generators.

As a result of the initial mapping efforts, over half the initial 2039 mapped portfolio occurs in air-quality non-attainment zones, primarily in the Los Angeles Basin and the San Joaquin Valley, while roughly one third of renewables and storage are mapped to substations within a mile of an existing or former fossil fuel power plant. Roughly half the resources are in an IRA energy community, and nearly 70% of storage resources and roughly 40% of generation is in or within 5 miles of a disadvantaged community.

The mapping of biomass resources receives additional emphasis due to the air quality impacts of combustion. Table 17 below shows the proximity of mapped biomass resources in both the 2034 and 2039 portfolios to disadvantaged communities. Initial mapping resulted in about 42 MW out of 171 MW allocated to substations in or near a disadvantaged community. While 17 MW are in-development and cannot be remapped, staff will seek to remap the remaining amount to locations with lower air-quality impacts. The following substations with level-4 criteria alignment flags for disadvantaged communities have between 1-5 MW biomass each: Ganso, Lamont, Mariposa, Sanger, Vista (SCE), and Wilson.

Table 17: Initial mapping of biomass resources' alignment with proximity to disadvantaged communities.

Biomass/gas in 2034 & 2039 Initial Portfolio	>5 mi from DAC	<5 miles from DAC	in DAC
In-Development (MW)	6.0	10.6	5.6
Generic (MW)	123.3	14.0	11.6
Total (MW)	**129.3**	**24.6**	**17.2**

6.1.D Initial Commercial Development Interest Criteria Alignment

For assessing commercial development interest, the Working Group utilizes the CAISO interconnection queue, the wholesale distribution tariff queues from major CAISO transmission operators such as PG&E and SCE, and other transmission operators outside of CAISO's balancing area including Imperial Irrigation District (IID), PacifiCorp, and Nevada Energy (NVE). For these out-of-CAISO interconnection queues, the Working Group focused on key resource types such as geothermal, LDES, and onshore wind.

The Working Group also incorporates development interest beyond the projects identified in the queues listed and not reflected in the commercial interest queue summaries such as interest identified through LSE IRP plans and contract information, stakeholder comments, and Working Group communications. Such information is key for identifying development resources and potential locations for long lead time resources including out-of-state wind and offshore wind. Two points of staff utilizing additional commercial interest information the initial busbar mapping of LDES are: 1) the mapping of 5 MW of LDES to Northern California in line with a project being developed under a grant through the CEC's Long-Duration Energy Storage program; and 2) the mapping of 499 MW of LDES as pumped storage to the San Diego area in line with a project that received funding in the 2021 state budget for design, permitting, and licensing.

The commercial interest criteria prioritize mapping resources in alignment with identified in-development resources first. These are resources contracted by LSE, under construction, or recently online but not in the new IRP resource baseline used for the portfolio modeling. These resources are either already online or very certain to come online in the next few years and need to be accounted for in transmission planning. In-development resources are identified through CPUC information on LSE contracts, the CAISO's new resource interconnection report, and feedback from PTOs. Detail information on the in-development resources, which is based on information available by September 2023, is found in the Baseline Reconciliation workbook (See Appendix F). Table 18 summarizes the identified in-development resources by CAISO study area and resource type. The table shows that the region with the greatest share of in-development resources is SCE East, followed by SCE North and PG&E Fresno. In the SCE East region, the in-development resource mix is dominated by solar and battery storage (1,800 and 2,300 MW respectively). The SCE North in-development resources are primarily solar, battery storage, and LDES (1,036 MW, 2,200 MW, and 200 MW respectively). The PG&E Fresno in-development resources are solar and battery storage (1,600 MW and 1,500 MW).

Table 18: Summary, by CAISO study area, of in-development resources (identified contracted, under engineering or construction, or recently online resources that are not in the IRP baseline).

In-Development Resources: Contracted, online, or under construction not in modeling baseline										
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Distributed Solar (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total In-Development (MW)
PG&E North of Greater Bay	32	6.0	-	-	-	13	40	93	-	**184**
PG&E Greater Bay	-	5.0	-	-	-	14	100	170	-	**290**
PG&E Fresno	-	3.0	-	-	-	26	1,572	1,455	-	**3,055**
PG&E Kern	-	-	-	-	-	32	472	186	-	**690**
SCE Northern Area	-	-	-	-	-	5	1,031	2,240	200	**3,476**
SCE Metro	-	5.6	-	-	-	27	-	895	-	**928**
SCE North of Lugo	-	-	-	-	-	3	532	361	-	**896**
East of Pisgah	26	-	-	-	-	-	460	624	-	**1,110**
SCE Eastern	-	2.6	-	-	-	-	1,759	2,255	-	**4,016**
SDG&E	-	-	-	-	-	1	610	1,100	-	**1,711**
Total In-Development:	**58**	**22.2**	**-**	**-**	**-**	**121**	**6,575**	**9,380**	**200**	**16,355**

After in-development resources, the commercial interest criteria prioritize higher confidence commercial interest which includes resources in queue which have been allocated Transmission Plan Deliverability, TPD, (CAISO queue only), have executed an interconnection agreement (CAISO queue and WDT queues), and have completed Phase II of interconnection studies (CAISO queue only). Lower confidence commercial interest, projects in Phase I in the CAISO interconnection process or that have not completed any interconnection studies by their respective balancing area authority or transmission owner, have the lowest alignment priority. Analysis of the CAISO interconnection queue from August 2023 for commercial interest is in the Commercial Interest Analysis of CAISO Interconnection Queue workbook (Appendix I), while summaries of commercial interest from the CAISO queue and the other queues are included in the Preliminary Mapping Dashboard (Appendix C).

Table 19 below shows commercial interest by resource type and priority category. The table values are derived from the various interconnection queues with resource amounts already in the modeling baseline or identified as in-development resources excluded.

Table 19: Summary of commercial queue interest (MW) by resource type and interconnection stage which indicates criteria priority category.

Identified Commercial Development Interest in Queues[1]						
Resource Type	**Has TPD[2]**	**Executed IA**	**Completed Phase II**	**All Queues**	**Cluster 15 Requests***	**Total Resources**
Geothermal	-	-	-	2,069	-	**2,069**
Biomass	-	22	22	38	10	**48**
Onshore Wind	631	2,046	4,536	7,287	3,611	**10,898**
OOS Wind	-	-	-	-	12,728	**12,728**
Offshore Wind	1,000	1,029	1,191	7,578	12,500	**20,078**
Distributed Solar	-	163	163	266	-	**266**
Solar	3,504	14,483	23,377	48,809	75,951	**124,760**
Battery	15,704	18,530	32,781	100,940	155,804	**256,744**
LDES	1,265	500	2,700	2,700	1,181	**3,881**
Total:	**22,104**	**36,773**	**64,770**	**169,686**	**261,785**	**431,471**

[1]Excluding identified baseline and in-development resources

[2]For queue projects w/ co-located resources, TPD first applied to storage

*incomplete inclusion of all projects in list

As can be seen in Table 19, higher confidence commercial interest represents about 15% of total commercial interest. For some resources, like solar and battery storage the amount of higher confidence commercial interest significantly exceeds the amount of MWs in the 2034 and even 2039 portfolio, while for other resources including wind and geothermal there is less higher confidence commercial interest than resources in the base case portfolio. The total commercial interest is multiple times more than the amounts of resources included in the base case portfolio, particularly for solar and storage, while there is also significant commercial interest for wind and other resources.

Table 20 and Table 21, breakdown the commercial interest calculated from the CAISO queue alone by CAISO study area for higher confidence commercial interest (Table 20) and total commercial interest (Table 21).

Table 20: Summary of higher confidence commercial queue interest (MW) from CAISO interconnection queue information summarized by CAISO study area and resource type.

Commercial Interest (Phase II Study Complete)									
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total (MW)
PG&E North of Greater Bay Stu	-	12	416	-	162	1,076	1,938	-	**3,603**
PG&E Greater Bay Study Area	-	-	787	-	-	453	3,245	-	**4,484**
PG&E Fresno Study Area	-	5	64	-	-	1,995	1,976	-	**4,041**
PG&E Kern Study Area	-	5	210	-	1,029	2,351	2,681	500	**6,776**
SCE Northern Study Area	-	-	124	-	-	3,418	5,248	300	**9,090**
SCE Metro Study Area	-	-	-	-	-	-	1,080	-	**1,080**
SCE North of Lugo Study Area	-	-	212	-	-	1,019	1,075	-	**2,306**
East of Pisgah Study Area	-	-	310	-	-	3,765	3,729	-	**7,804**
SCE Eastern Study Area	-	-	297	-	-	6,075	7,111	1,900	**15,384**
SDG&E Study Area	-	-	2,117	-	-	3,225	4,698	-	**10,039**
Total:	**0**	**22**	**4,537**	**0**	**1,191**	**23,377**	**32,781**	**2,700**	**64,607**

Table 21: Summary of total commercial queue interest (MW) from CAISO interconnection queue information including Cluster 15 applications summarized by CAISO study area and resource type.

Commercial Interest (All Queues and Cluster 15)									
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total (MW)
PG&E North of Greater Bay Stu	32	22	1,667	-	2,462	7,028	17,551	567	**29,330**
PG&E Greater Bay Study Area	-	-	1,187	-	3,825	2,705	21,656	-	**29,373**
PG&E Fresno Study Area	-	10	264	-	-	32,403	44,661	-	**77,338**
PG&E Kern Study Area	-	17	210	-	11,491	7,399	13,228	500	**32,845**
SCE Northern Study Area	-	-	229	-	2300	8327	26376	800	**38032**
SCE Metro Study Area	-	-	-	-	-	-	24,327	-	**24,327**
SCE North of Lugo Study Area	5	-	462	-	-	9,287	18,487	-	**28,241**
East of Pisgah Study Area	1,007	-	1,418	9,728	-	22,360	27,994	-	**62,506**
SCE Eastern Study Area	871	-	998	3,000	-	23,267	38,518	1,900	**68,553**
SDG&E Study Area	83	-	4,463	-	-	11,984	22,686	-	**39,216**
Total:	**1,998**	**49**	**10,898**	**12,728**	**20,078**	**124,760**	**255,484**	**3,767**	**429,761**

While mapping efforts seek to align with higher confidence commercial interest, departures will occur as the Working Group seeks to balance alignment with the other mapping criteria as well. Multiple locations with large amounts of higher confidence commercial interest have poor alignment with other mapping criteria, discouraging mapping of resources to those areas. Additionally, as noted earlier, the amount of higher confidence commercial interest for solar and storage is greater than the amount of solar and storage included in the portfolio. Generally, mapping results should not select locations without any commercial interest, for solar and storage in particular where the total amount of commercial interest in battery storage (256 GW) exceeds the 2039 portfolio amount (21 GW) by 9X, and staff will seek to relocate those resources if it does not significantly decrease alignment with the other criteria.

Table 22 and Table 23 show the initial mapping results of generic resources (resources beyond those

mapped to align with identified in-development resources) for the 2034 and 2039 portfolios compared to the amount of commercial interest identified in the interconnection queues. The initial mapping comparison summary is broken down by CAISO study area with Table 22 depicting the four study areas in the PG&E territory and Table 23 showing the six study areas in the Southern California, Nevada, and Arizona area. Overall, area wide mapping aligns well with the higher confidence commercial interest and allocated TPD, particularly by 2039 when the portfolio size is more comparable to the amount of higher confidence commercial interest. The SCE Northern and East of Pisgah study areas are the two areas where the amount of storage mapped is significantly less than the amount of storage with TPD (45% of total storage TPD in SCE Northern and 55% in East of Pisgah). In contrast, the amount of wind and geothermal mapped to study areas is generally significantly higher than the amounts of higher confidence commercial interest.

Table 22: Comparison of initial mapping results (2034 and 2039 model years) to identified commercial interest by CAISO study area and resource type for the PG&E study areas.

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E North of Greater Bay	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**	**PG&E Greater Bay**	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	75	92	-	-	32	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	92	92	-	12	22	Biomass (MW)	24	24	-	-	-
OnshoreWind (MW)	971	2,104	201	416	1,667	OnshoreWind (MW)	875	875	208	787	1,187
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	162	2,462	Offshore Wind (MW)	-	-	-	-	3,825
Distrib. Solar (MW)	24	24	-	29	30	Distrib. Solar (MW)	24	24		27	55
Solar (MW)	255	655	105	1,076	7,028	Solar (MW)	-	400	-	453	2,705
Li_Battery (MW)	238	408	308	1,938	17,551	Li_Battery (MW)	920	1,270	1,903	3,245	21,656
LDES (MW)	5	5	-	-	567	LDES (MW)	-	-	-	-	-
Total (MW)	**1,661**	**3,381**	**613**	**3,633**	**29,359**	**Total (MW)**	**1,843**	**2,593**	**2,111**	**4,512**	**29,428**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E Fresno	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**	**PG&E Kern**	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	13	13	-	5	10	Biomass (MW)	17	17	-	5	17
OnshoreWind (MW)	265	265	60	64	264	OnshoreWind (MW)	285	285	-	210	210
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	3,855	4,531	1,000	1,029	11,491
Distrib. Solar (MW)	8	8	-	42	49	Distrib. Solar (MW)	41	41	-	45	53
Solar (MW)	1,086	3,210	451	1,995	32,403	Solar (MW)	1,115	2,215	206	2,351	7,399
Li_Battery (MW)	395	1,376	1,556	1,976	44,661	Li_Battery (MW)	732	1,182	1,286	2,681	13,228
LDES (MW)	-	-	-	-	114	LDES (MW)	-	-	465	500	500
Total (MW)	**1,767**	**4,872**	**2,068**	**4,082**	**77,501**	**Total (MW)**	**6,045**	**8,271**	**2,957**	**6,821**	**32,898**

Table 23: Comparison of initial mapping results (2034 and 2039 model years) to identified commercial interest by CAISO study area and resource type for the Southern California study areas.

	Mapped Portfolio		Commercial Queue Interest		
SCE Northern Area	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	1	1	-	-	-
OnshoreWind (MW)	614	814	100	124	229
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	2,300
Distrib. Solar (MW)	-	-	-	-	9
Solar (MW)	2,048	3,598	1,191	3,418	8,327
Li_Battery (MW)	1,170	1,734	3,799	5,248	26,376
LDES (MW)	281	281	300	300	800
Total (MW)	**4,114**	**6,428**	**5,390**	**9,090**	**38,041**

	Mapped Portfolio		Commercial Queue Interest		
SCE Metro	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	-	-	-	-	-
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	7	-	4	17
Solar (MW)	-	-	-	-	-
Li_Battery (MW)	1,067	1,397	1,000	1,080	24,327
LDES (MW)	-	-	-	-	-
Total (MW)	**1,067**	**1,404**	**1,000**	**1,084**	**24,344**

	Mapped Portfolio		Commercial Queue Interest		
SCE North of Lugo	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	5
Biomass (MW)	2	2	-	-	-
OnshoreWind (MW)	650	650	-	212	462
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	24	-	13	44
Solar (MW)	1,050	1,478	213	1,019	9,287
Li_Battery (MW)	445	650	476	1,075	18,487
LDES (MW)	-	-	-	-	-
Total (MW)	**2,147**	**2,804**	**689**	**2,319**	**28,285**

	Mapped Portfolio		Commercial Queue Interest		
East of Pisgah	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	690	790	-	-	1,007
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	1,810	1,910	62	310	1,418
OOS Wind (MW)	3,268	5,704	-	-	9,728
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-		-	-
Solar (MW)	1,980	2,380	741	3,765	22,360
Li_Battery (MW)	1,240	1,990	3,643	3,729	27,994
LDES (MW)	-	-	-	-	-
Total (MW)	**8,988**	**12,774**	**4,446**	**7,804**	**62,507**

	Mapped Portfolio		Commercial Queue Interest		
SCE Eastern	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	740	740	-	-	871
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	599	599	-	297	998
OOS Wind (MW)	2,000	4,500	-	-	3,000
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	3	8
Solar (MW)	1,300	3,650	100	6,075	23,267
Li_Battery (MW)	695	1,495	1,299	7,111	38,518
LDES (MW)	-	-	500	1,900	1,900
Total (MW)	**5,334**	**10,984**	**1,899**	**15,386**	**68,562**

	Mapped Portfolio		Commercial Queue Interest		
SDG&E	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	50	50	-	-	83
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	2,060	2,860	1	2,117	4,463
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	772	772	498	3,225	11,984
Li_Battery (MW)	390	482	435	4,698	22,686
LDES (MW)	449	499	-	-	-
Total (MW)	**3,721**	**4,613**	**933**	**10,040**	**39,216**

The tables below show the number of substations where commercial non-alignment flags are occurring by CAISO study area for the initial mapping results of the 2039 portfolio. Table 24 shows the results for utility-scale solar and battery storage, Table 25 shows the alignment results for onshore in-CAISO wind and geothermal resources, and Table 26 shows the results distributed solar and biomass. OOS wind, offshore wind, and LDES resources are more limited in geographic scope, mapped to only a few substations, and have only a limit amount of commercial interest info in the queue summaries so are not included in these tables.

Table 24: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the initial 2039 portfolio mapping results of solar and battery storage resources.

Substations with Commercial Develop Interest Criteria Flags										
	Solar					Battery Storage				
2039 Initial Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	0	0	2	1	15	0	0	11	4	21
PG&E Greater Bay	0	0	3	1	10	1	1	13	3	31
PG&E Fresno	1	7	1	0	17	1	2	6	0	26
PG&E Kern	0	1	3	1	8	0	1	3	4	14
SCE Northern Area	1	2	2	1	3	0	1	11	0	7
SCE Metro	0	0	0	0	0	0	3	0	0	21
SCE North of Lugo	0	4	1	0	4	0	3	3	1	7
East of Pisgah	0	1	0	2	9	0	2	3	0	12
SCE Eastern	0	0	4	2	7	0	0	8	0	8
SDG&E	0	0	1	2	3	0	0	7	5	16
Total	2	15	17	10	76	2	13	65	17	163

Table 25: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the initial 2039 portfolio mapping results of onshore "in state" wind and geothermal resources.

Substations with Commercial Develop Interest Criteria Flags										
	Onshore Wind					Geothermal				
2039 Initial Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	2	2	0	0	0	2	1	0	0	0
PG&E Greater Bay	1	0	0	0	1	0	0	0	0	0
PG&E Fresno	0	1	0	0	0	0	0	0	0	0
PG&E Kern	1	0	0	0	0	0	0	0	0	0
SCE Northern Area	3	0	0	0	0	0	0	0	0	0
SCE Metro	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	1	1	0	0	0	0	0	0	0	1
East of Pisgah	2	2	0	0	0	2	1	0	0	0
SCE Eastern	0	2	0	0	1	0	1	0	0	0
SDG&E	0	2	0	0	0	0	1	0	0	0
Total	10	10	0	0	2	4	4	0	0	1

Table 26: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the initial 2039 portfolio mapping results of biomass and distributed solar resources.

Substations with Commercial Develop Interest Criteria Flags										
	Biomass					Distributed Solar				
2039 Initial Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	16	1	0	0	0	0	0	3	0	1
PG&E Greater Bay	7	1	0	0	0	0	0	3	0	6
PG&E Fresno	3	0	1	0	0	0	1	7	0	1
PG&E Kern	2	1	0	0	0	0	0	3	0	1
SCE Northern Area	1	0	0	0	0	0	0	0	0	3
SCE Metro	0	0	0	0	0	0	1	2	0	5
SCE North of Lugo	1	0	0	0	0	0	1	1	0	4
East of Pisgah	0	0	0	0	0	0	0	0	0	0
SCE Eastern	0	0	0	0	0	0	0	1	0	1
SDG&E	0	0	0	0	0	0	0	0	0	0
Total	30	3	1	0	0	0	3	20	0	22

As seen in Table 24, only two substations have mapped solar amounts exceeding total commercial interest and 15 locations where mapped solar is less than higher confidence commercial interest, while 27 substations have more higher confidence solar commercial interest than solar mapped to them and 76 substations with more total commercial interest. Initial battery storage mapping has similar number of substations with mapped solar exceeding total commercial interest and higher confidence amounts, while there are 82 substations with more higher confidence battery interest and 163 with more total commercial interest. These numbers reflect the large amount of commercial interest in the queues for solar and storage.

For solar, two substations, Westley and Santa Clara, there is no solar commercial interest. The 15 substations that have more solar resource mapped in the initial 2039 portfolio than higher confidence commercial interest are Antelope, Borden, Gates 230 kV, Helm, Henrietta, Kramer 230 and 115 kV, Los Banos 230 kV, Panoche, Pisgah, Quinto, Victor, Vista (VEA), Wheeler Ridge, and Whirlwind 230 kV.

For battery storage, two substations with resources mapped in 2039 have no commercial interest: Mariposa and Westley. The 13 substations where more storage is mapped than higher confidence commercial interest are Center, Helm, Hinson, Kramer 115kV, Lathrop, Lighthipe, Metcalf 500 kV, Mustang, Panoche, Pisgah, Santa Clara, Victor, Vista (VEA), and Wheeler Ridge.

In contrast, the initial mapping results for onshore wind and geothermal, as seen in Table 25 have a significantly higher percentage of substations where mapped resources are exceeding total and high confidence commercial interest and very few substations where the amount of commercial interest is larger than resources mapped.

For onshore in-CAISO wind, the ten substations with more mapped resources in 2039 than total commercial interest are Antelope, Coburn, Glenn, Innovation, Lathrop, Pisgah, Table Mountain, Templeton, Whirlwind, and Windhub. The ten substations with more resources mapped than higher confidence commercial interest are Devers, Eagle Rock (PGE), ECO, El Casco, New Sub - Lugo - Pisgah (Proposed), Malin (representing the likely interconnection point for wind at the NVE substations in northeastern California), Mohave, Sloan Canyon, New Sub - Suncrest - Ocotillo (Proposed), Wilson

6.1.E Initial Prior TPP Base Case Criteria Alignment

The methodology guiding principles state that busbar allocations for equivalent TPP cases should be relatively consistent year to year: for example, Base Cases from one year to the next; and Policy-driven Sensitivity Cases exploring the same issue from one year to the next. Where large changes are necessary, the reasons for these should be clear. Staff should consider whether changes are occurring due to exogenous factors (e.g., demand or resource cost shifts) or due to modeling margin of error.

Table 27: Comparison of initial mapping portfolio to the 23-24 TPP base case (adjusted to exclude resources now in baseline) by resource type.

Initial Mapping Compared to Previous Base Case	Total Resources (2034)	Total Resources (2039)	23-24 TPP* (2035)
Geothermal (MW)	1,613.0	1,730.0	1,740.0
Biomass (MW)	171.0	171.0	127.4
OnshoreWind (MW)	8,129.0	10,362.0	2,261.4
OOS Wind (MW)	5,268.4	10,204.1	4,828.0
Offshore Wind (MW)	3,855.0	4,531.0	4,707.0
Solar (MW)	16,398.0	25,181.0	32,930.1
Li_Battery (MW)	16,670.9	21,363.5	19,917.7
LDES (MW)	935.0	935.0	2,000.0
Total (MW)	**53,040**	**74,478**	**68,512**

*Subtracting resources now in updated IRP baseline

Table 27 compares the initial portfolio with the previous 23-24 TPP base case portfolio adjusted for resources now included in the new IRP baseline. As noted in Section 6.1, the new portfolio size and resource composition is different than the previous base case portfolio even after adjusting for the updated baseline. The proposed 24-25 TPP base case 2034 portfolio has roughly 15 GW fewer resources total than the previous 23-24 TPP base case portfolio which modeled 2035. This difference is due to three key factors:

- Different resource mix selected in RESOLVE: Significantly more onshore wind selected in the portfolio, which has higher capacity factor values than solar and thus leads to less nameplate capacity.
- Updated ELCC surfaces: The 2022-2023 IRP Inputs and Assumptions includes new ELCC surfaces which particularly changes the solar-storage curve resulting in less solar and storage needed.
- Updated load projections: the 2022 IEPR load scenario has slightly lower load compared to the 2021 IPER additional transportation electrification (ATE) scenario used for the 23-24 TPP portfolio.

By the 2039 model year, the proposed portfolio is overall larger than the previous portfolio with only solar and LDES resources being significantly less.

Figure 11 and Figure 12 show a summary of the initial mapping for 2034 and 2039 portfolios respectively compared to the 23-24 TPP base case portfolio by CAISO study area. Table 28 shows the same comparison in table form by CAISO study area. Key areas where less resources have been mapped in the 2034 portfolio are SCE Eastern, East of Pisgah, and SCE Northern study areas for solar and battery storage and PG&E North of Greater Bay study area for offshore wind.

Figure 11: Comparison of the initial mapped resource (2034 portfolio) to the 23-24 TPP portfolio by CAISO study area. For each study area the left column represents the resources, by type, mapped to the study area for the initial mapping results and the right columns represents resources mapped to the study area for the 23-24 TPP.

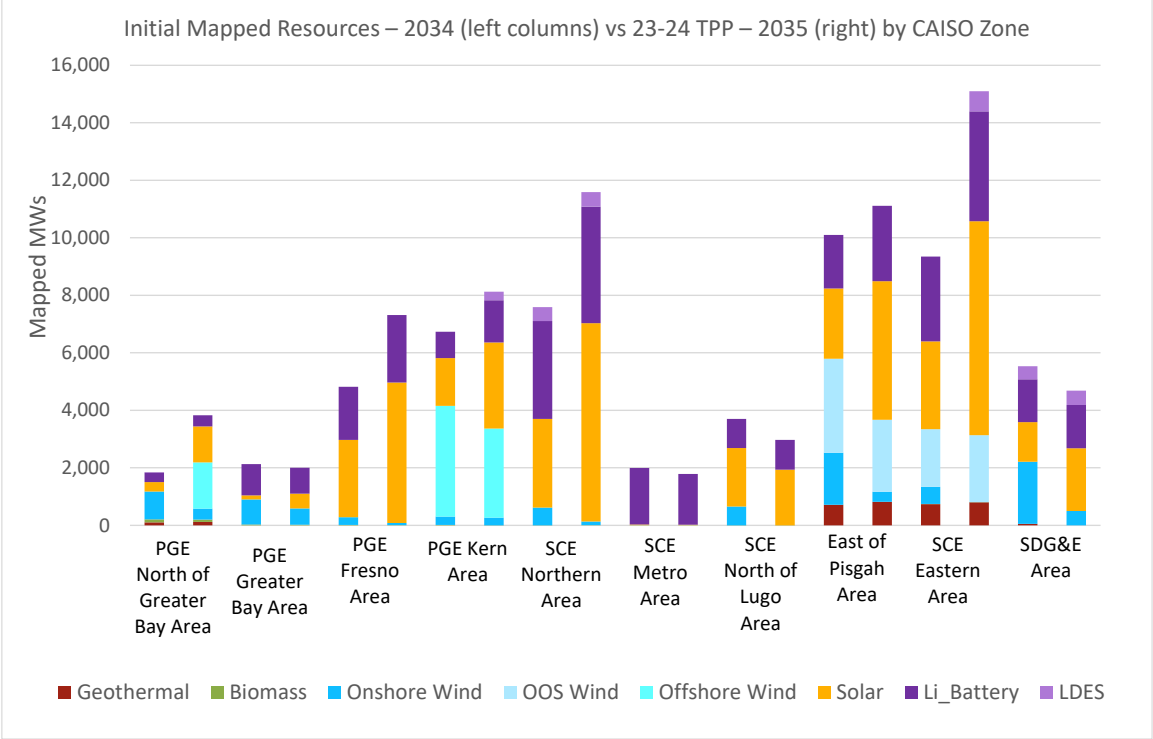


Figure 12: Comparison of the initial mapped resource (2039 portfolio) to the 23-24 TPP portfolio by CAISO study area.

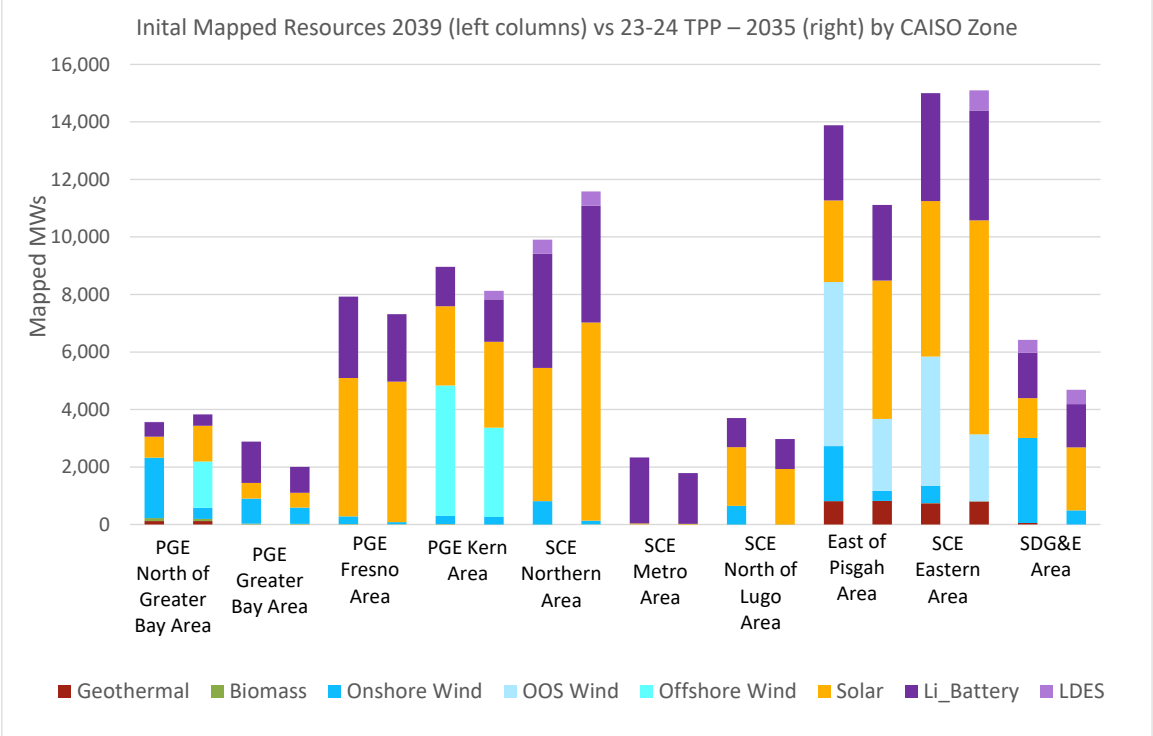


Table 28: Comparison of the initial mapping results (2034 and 2039 portfolios) to the 23-24 TPP portfolio by CAISO study area and resource type.

Initial Mapping Results Compared to 23-24 TPP Base Case by CAISO Study Area									
CAISO Study Area	**Resource Type**	**Total Res (2034)**	**Total Res (2039)**	**23-24 TPP (2035)**	**CAISO Study Area**	**Resource Type**	**Total Res (2034)**	**Total Res (2039)**	**23-24 TPP (2035)**
PG&E North of Greater Bay	Geothermal (MW)	107.0	124.0	118.2	**PG&E Fresno**	Geothermal (MW)	-	-	-
	Biomass (MW)	98.1	98.1	80.0		Biomass (MW)	16.0	16.0	7.6
	OnshoreWind (MW)	971.0	2,104.0	383.5		OnshoreWind (MW)	265.0	265.0	73.6
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	-	-	1,607.0		Offshore Wind (MW)	-	-	-
	Solar (MW)	331.2	731.2	1,249.1		Solar (MW)	2,691.6	4,815.6	4,885.1
	Li_Battery (MW)	331.9	501.9	392.7		Li_Battery (MW)	1,849.2	2,830.3	2,345.3
	LDES (MW)	5.0	5.0	-		LDES (MW)	-	-	-
	Zone Total (MW)	**1,844**	**3,564**	**3,830**		**Zone Total (MW)**	**4,822**	**7,927**	**7,312**
PG&E Greater Bay	Geothermal (MW)	-	-	-	**PG&E Kern**	Geothermal (MW)	-	-	-
	Biomass (MW)	29.2	29.2	22.4		Biomass (MW)	17.0	17.0	2.0
	OnshoreWind (MW)	875.0	875.0	566.8		OnshoreWind (MW)	285.0	285.0	262.6
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	3,855.0	4,531.0	3,100.0
	Solar (MW)	138.3	538.3	511.7		Solar (MW)	1,659.6	2,759.6	2,993.1
	Li_Battery (MW)	1,090.4	1,440.4	905.3		Li_Battery (MW)	918.8	1,368.8	1,467.6
	LDES (MW)	-	-	-		LDES (MW)	-	-	300.0
	Zone Total (MW)	**2,133**	**2,883**	**2,006**		**Zone Total (MW)**	**6,735**	**8,961**	**8,125**
SCE Northern Area	Geothermal (MW)	-	-	-	**East of Pisgah**	Geothermal (MW)	716.0	816.0	816.8
	Biomass (MW)	1.0	1.0	6.4		Biomass (MW)	-	-	-
	OnshoreWind (MW)	614.0	814.0	126.9		OnshoreWind (MW)	1,810.0	1,910.0	353.0
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	3,268.4	5,704.1	2,500.0
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	3,084.0	4,634.0	6,894.2		Solar (MW)	2,440.0	2,840.0	4,818.0
	Li_Battery (MW)	3,409.4	3,973.9	4,057.7		Li_Battery (MW)	1,864.0	2,614.0	2,624.0
	LDES (MW)	481.0	481.0	500.0		LDES (MW)	-	-	-
	Zone Total (MW)	**7,589**	**9,904**	**11,585**		**Zone Total (MW)**	**10,098**	**13,884**	**11,112**
SCE Metro	Geothermal (MW)	-	-	-	**SCE Eastern**	Geothermal (MW)	740.0	740.0	805.0
	Biomass (MW)	5.6	5.6	3.8		Biomass (MW)	2.6	2.6	2.6
	OnshoreWind (MW)	-	-	-		OnshoreWind (MW)	599.0	599.0	-
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	2,000.0	4,500.0	2,328.0
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	27.0	34.0	20.0		Solar (MW)	3,058.5	5,408.5	7,441.3
	Li_Battery (MW)	1,961.5	2,291.5	1,765.3		Li_Battery (MW)	2,950.0	3,750.0	3,820.3
	LDES (MW)	-	-	-		LDES (MW)	-	-	700.0
	Zone Total (MW)	**1,994**	**2,331**	**1,789**		**Zone Total (MW)**	**9,350**	**15,000**	**15,097**
SCE North of Lugo	Geothermal (MW)	-	-	-	**SDG&E**	Geothermal (MW)	50.0	50.0	-
	Biomass (MW)	1.5	1.5	2.7		Biomass (MW)	-	-	-
	OnshoreWind (MW)	650.0	650.0	-		OnshoreWind (MW)	2,060.0	2,860.0	495.0
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	1,585.0	2,037.0	1,930.0		Solar (MW)	1,382.8	1,382.8	2,187.5
	Li_Battery (MW)	806.0	1,011.0	1,036.4		Li_Battery (MW)	1,489.7	1,581.7	1,503.0
	LDES (MW)	-	-	-		LDES (MW)	449.0	449.0	500.0
	Zone Total (MW)	**3,043**	**3,700**	**2,969**		**Zone Total (MW)**	**5,432**	**6,324**	**4,686**

The tables below show the number of substations by CAISO study area and resource type that have fewer resources mapped than in the previous TPP base case for the initial mapping of the 2039 portfolio. Table 29 summarizes the substations with non-alignment flags for the four CAISO study areas in PG&E while Table 30 summarizes for the six CAISO study areas in Southern California.

Table 29: Summary of the number of substations where less resources were mapped and triggered non-alignment flags for consistency with previous base case for the initial mapping results (2039 portfolio) broken down by resource type for the four PG&E study areas.

Initial 2039 Portfolio Mapping – Number of substations by CAISO study area with less resources mapped					
Resource Type	Level of Decrease at Sub	PG&E North of Greater Bay	PG&E Greater Bay	PG&E Fresno	PG&E Kern
Geothermal	Slight*	0	0	0	0
	Significant**	2	0	0	0
Biomass	Slight	1	0	0	0
	Significant	6	3	3	1
Wind, Onshore	Slight	0	0	0	0
	Significant	1	1	0	0
OOS Wind	Slight	0	0	0	0
	Significant	0	0	0	0
Offshore Wind	Slight	0	0	0	0
	Significant	2	0	0	1
Distributed_Solar	Slight	0	0	0	1
	Significant	2	3	2	2
Solar	Slight	1	0	2	1
	Significant	6	0	5	6
Li_Battery	Slight	1	0	0	0
	Significant	2	3	7	9
LDES	Slight	0	0	0	0
	Significant	0	0	0	1

*100 MW or 10% less **500 MW or 33% less

From the tables of non-alignment flags, solar has the largest number of non-alignments, primarily driven by the initial portfolio having nearly 8 GW less solar in 2039 than the previous 23-24 TPP portfolio. Battery storage resource mapping also results in several flags in almost every study area. The battery mapping differences are driven by shifts in battery mapping to better align with the new in-development resources, seeking to better align battery mapping with updated commercial interest, and co-locating with the mapped solar in the new portfolio. Biomass has numerous non-alignment flags in the PG&E study areas as staff sought to better align with updated commercial interest information and with the disadvantaged communities criteria. Additionally, the biomass differences at each substation are relatively small, 1-5 MWs.

For wind, the following buses have mapped resource significantly less than prior portfolio: Delta PP (changed from 80 MW to 0 MW, due to better alignment at other substations for wind in the Altamont area), ECO 115 kV (changed from 135 MW to 60 MW, to better align with updated commercial interest), and Round Mountain (changed from 210 MW to 0 MW, due to a more accurate proposed substation being incorporated into the mapping analysis for this resource).

Table 30: Summary of the number of substations where less resources were mapped and triggered non-alignment flags for consistency with previous base case for the initial mapping results (2039 portfolio) broken down by resource type for the six southern California study areas.

Initial 2039 Portfolio Mapping – Number of substations by CAISO study area with less resources mapped							
Resource Type	Level of Decrease at Sub	SCE Northern Area	SCE Metro	SCE North of Lugo	East of Pisgah	SCE Eastern	SDG&E
Geothermal	Slight*	0	0	0	1	0	0
	Significant**	0	0	0	0	0	0
Biomass	Slight	0	0	0	0	0	0
	Significant	2	1	1	0	0	0
Wind, Onshore	Slight	0	0	0	0	0	0
	Significant	0	0	0	0	0	1
OOS Wind	Slight	0	0	0	0	0	0
	Significant	0	0	0	0	0	0
Offshore Wind	Slight	0	0	0	0	0	0
	Significant	0	0	0	0	0	0
Distributed _Solar	Slight	0	0	0	0	0	0
	Significant	0	1	1	0	0	0
Solar	Slight	3	0	2	0	2	0
	Significant	4	0	1	7	4	2
Li_Battery	Slight	1	2	1	2	0	1
	Significant	0	2	1	2	2	2
LDES	Slight	0	0	0	0	0	0
	Significant	0	0	0	0	1	0

*100 MW or 10% less **500 MW or 33% less

For solar, the following substations have mapped resource significantly less than prior portfolio and are mapped to a substation within a constraint with a previously identified and approved transmission upgrade (level-5 non-alignment): Bellota, Colorado River, Delaney, Desert View, Devers, Gregg, Helm, Henrietta, Kramer, Lathrop, Le Grand, Valley (VEA), Vista (VEA), Westley.

Substations that have mapped solar resource significantly less than prior portfolio not within a constraint previously identified and approved transmission upgrade (level-4 non-alignment): Alpaugh, Antelope, Bellota, Cottonwood, Carpenter Canyon (fka Gamebird), Hassayampa, Imperial Valley, Lamont, Midway, Mohave, Moorpark, Rector, Red Bluff, Rio Bravo, Rio Oso, Solar SS, Springville, Trout Canyon, Vaca Dixon, Woodland.

- Less solar overall in the portfolio reduces the amount of solar that can be mapped.
- Updated commercial interest shows less MWs of interests either from projects withdrawing or better accounting of existing and already in-development projects. This played a key factor in reductions at Red Bluff, Colorado River, Delaney (resources more accurately captured a proposed substation incorporated into the mapping analysis) Moorpark, Kramer, Westley, and Bellota.
- Other criteria alignment such as transmission capability and land-use and environmental

screens demonstrated a need to reduce resources mapped to the substations. This played a key factor in reductions at Rector and Springville (transmission constraints) and Colorado River, Mohave, and Red Bluff (environmental screens criteria)

For battery storage, the following substations have mapped resource significantly less than prior portfolio and mapped to a substation within a constraint with a previously identified and approved transmission upgrade: Delaney Desert View Gregg Helm Henrietta Kramer Martinez Mission Mustang Panoche San Luis Rey Valley (VEA) Westley. These substations have mapped battery resource significantly less than prior portfolio (with no previously identified and approved transmission upgrade): Alamitos, Alpaugh, Curtis, Gates, Humboldt, Lamont, Mesa, Midway, Red Bluff, Rio Bravo, Rio Hondo, Ripon, Sisquoc, Solar SS, Taft, Wheeler Ridge, Woodland. Generally, differences for battery mapping are reflective of the same reasons listed above for solar.

6.2 Post-Ruling Portfolio Modeling and Busbar Mapping Adjustments

Portfolio changes and mapping adjustments include with the Proposed Decision:

In response to stakeholder comments and replies to the January 2024 Proposed Decision, several modeling fixes and resource potential adjustments were made. Staff reran the RESOLVE model with these adjustments to produce an updated base case portfolio for the Proposed Decision, and the resulting portfolio has several changes in resources selected in both the 2034 and 2039 model years, which are discussed further, below. Key adjustments discussed in the Proposed Decision include:

- Staff applied a scalar discount factor across all OOS wind potentials, on top of the applied WECC land-use screens. Table 3 in the Proposed Decision shows the revised potential, with significant resource potential remaining for Idaho, Wyoming, and New Mexico even after the discount.

- Staff extended build limits based on assumed capacity of in-development and potential new transmission lines that could likely be constructed in time to deliver to the CAISO out to 2039 for the various out-of-state resources currently outside of CAISO.

- Staff updated resource potentials in Southern Nevada to exclude potential in the newly created Avi Kwa Ame National Monument. Staff also increased wind potential in Northern California by removing the 30-mile distance from existing CAISO transmission limit for available wind resource potential.

- Post RESOLVE modeling, staff made an additional manual adjustment to resources in the portfolio. In both the 2034 and 2039 model years staff shifted 900 MW of in-state wind to 767 MW of out-of-state wind. The amount is not one-to-one due to differences in resource capacity factors.

For busbar mapping, staff incorporated several changes and fixes to the land-use and environmental impacts criteria data and analysis:

- **Correcting the double counting of recently online resources in land-use and environmental screen analysis**: In application of the land-use and environmental screens for criteria analysis in initial mapping (including analysis in the updated preliminary mapping

dashboard, Appendix C), staff incorporated baseline wind and solar resources online in 2022 or later in the amount of MWs included for criteria calculations. CEC staff noted that their land-use and environmental analysis results captured and excluded existing resources based on satellite imagery as recent as the summer months of 2023. Thus, the land-use criteria alignment results included a double count of many resources, particularly for solar resources interconnecting to Red Bluff, Kramer, Whirlwind, and Colorado River substations. To account for this, staff updated the land-use criteria analysis to only include in-development and baseline resources online after 8/31/2023 reflecting resources not already captured by the CEC's exclusions. These changes generally improved land-use criteria alignment for the above-listed substations. Additionally, the Dashboard for the Proposed Decision Mapping of the 24-25 TPP Base Case (Appendix D) improves communication of these inclusion and exclusion amounts in the land-use analysis tabs.

- **Better identification of likely repowers in commercial interest**: Staff identified several wind projects included in the interconnection queues and commercial interest that are proposed to be repowers of existing projects. Since existing wind turbine locations are also excluded from resource potentials in the land-use and environmental analysis, initial mapping analysis was likely double counting the potential impacts of these resources. In mapping resources aligned with these projects, staff now exclude the MWs amounts from the land-use and environmental analysis. These locations and amounts were also now included in the land-use criteria analysis tabs of the updated dashboard released with the Proposed Decision (Appendix D).

- **Incorporating California onshore wind resource potential using a 20% capacity factor (CF) minimum threshold in addition to the 28% CF threshold analysis:** As noted in the December 8, 2023, busbar mapping webinar, staff observed that the resource potential analysis based on the 28% CF minimum threshold (the analysis incorporated for onshore wind in the initial busbar mapping effort and included in the preliminary mapping dashboard, Appendix C) resulted in little or no base resource potential (potential before the land-use and environmental screens are applied) in areas that had multiple projects in the commercial interest data. Working Group staff recognize the publicly available data utilized to derive the wind resource potential and capacity factors is too coarse to fully capture all locations of potential for onshore wind and may be excluding some developable locations. Working Group staff have incorporated additional analysis for land-use and environmental impacts screens criteria using a lower capacity threshold of 20% to potentially offset this data limitation. Final mapping criteria alignment results in Section 6.3 summarizes the criteria alignment under both the 28% CF datasets and the 20% CF datasets. Working Group staff did not relax the land-use and environmental impacts criteria.

- **Fixes to GIS data analysis used for solar and wind land-use and environmental impact criteria screens:** CEC Working Group staff identified that some locations had incomplete implementation of the various datasets and inclusions/exclusions criteria applied to them. Specifically, some of the wind potential criteria screens did not have existing resource areas excluded from the calculations. Additionally. wind potential in some Bureau of Land Management areas where development is not prohibited by the Desert Renewable Energy Conservation Plan (certain DFA/VPL/GPLs areas) was not included in the base total resource potential for application of the land-use and environmental impact screens. Both issues with the wind resource potential were corrected. Finally, CEC staff updated the

protected areas exclusion layer to allow for gaps to remain between the components of the protected area layer. Previously, the gaps were included as part of the protected area layer, incorrectly adding areas as protected in the Riverside area impacting both solar and wind potentials.

The changes listed above are reflected in the base case mapping results included in the Dashboard for the Proposed Decision Mapping of the 24-25 TPP Base Case (Appendix D) released with the January 2024 Proposed Decision.

Mapping adjustments following proposed decision comments and replies:

After the release of the Proposed Decision, staff made several additional changes which do not significantly affect the mapping results or the transmission implications.

These latest changes include for transmission analysis: Correcting transmission capacity utilization factors for offshore wind as identified by the CAISO in Proposed Decision comments (reducing the HSN utilization to 83% and the SSN to 45%) and removing the Tesla 500 kV bus from two constraints (Windmaster-Delta pumps 230 kV Line and Midway-Q2005 230kV Line constraints) following review from CAISO staff as part of the busbar mapping Working Group. No changes were made to the mapping as a result.

Additionally, the land-use and environmental impact screens were updated to address several staff identified issues after the release of mapping results with the Proposed Decision. First, project exclusions for existing solar and wind resources were not fully included for all land-use and environmental screens; this was corrected. Second, fixes were made to the protected areas exclusion layer which impacts all screens. This layer was updated to capture a missing protected area and removal of areas inadvertently included as part of the protected areas through GIS processing. These land-use screen adjustments resulted in some changes to total acreages available at several substations where resources are mapped. However, those changes are relatively minor, so no mapping adjustments were made as a result. Staff identified that these updated screens caused criteria alignment changes at only a few substations for solar resources:

- The core land-use screen alignment for solar mapped to Imperial valley increased from a level-1 to a level-2.
- The core land-use screen alignment decreased from a level-4 to a level-3 for solar mapped to Red Bluff.
- The parcelization alignment increased from a level-2 to a level-3 for solar at Vaca Dixon.
- Several criteria alignment flags increased for solar mapped to Vincent. The core screen alignment increased from a level-2 to a level-3, parcelization from a level-4 to a level-5, and the three individual ACE screens increased from level-1's to level-2's.

As a result of only minor alignment changes, no mapping adjustments were made.

Staff also corrected an error in the transmission calculator formulas leading to the calculator not including EODS solar in some off-peak constraint utilization calculations. Correcting this led to the identification of additional exceedances in the off-peak capabilities, resulting in some remapping of resources to alleviate the exceedances. Staff remapped generic solar and storage in the Fresno, Kern,

and East of Pisgah areas to alleviate some of the constraint exceedances. Changes impact only a small number of resources (~400 MW of solar, ~100 MW of battery) and only minor changes between study areas. Other exceedances are alleviated by previously identified cost-effective upgrades.

Finally, two mapping adjustments were implemented. First, busbar Working Group staff identified and fixed a mapping mistake that had 50 MW of 4-hr battery storage added to the Metcalf 500 kV substation in only the 2039 portfolio. These resources should be mapped to Metcalf 230 kV in line with commercial interest and interconnection limitations at Metcalf.

The second remapping is based on based on stakeholder reply comments to the January 2024 Proposed Decision. Staff remapped 130 MW of LDES to the Gregg 230 kV substation in both 2034 and 2039 mapping results, reflecting a planned upgrade to increase the capacity of the Helms Pumped Storage plant. Staff remapped 35 MW of LDES (23 MW from the Tehachapi area and 12 from the San Diego area) and converted and remapped 95 MW of 8-hr batteries from several substations (Borden, Helm, Le Grand, and Tranquility) in the same constraints as Gregg 230 kV as the remaining 95 MW of LDES to avoid triggering additional constraint exceedances beyond those identified in the mapping dashboard for the Proposed Decision. Some onshore wind in the same constraints (~50 MW) was remapped as EODS to limit the constraint exceedances as well. Staff also relocated solar from the substations where battery mapping was reduced, as the solar was no longer co-located with storage, and relocated to Carpenter Canyon in the East of Pisgah study area. Staff shifted some storage mapped as stand-alone in East of Pisgah to be co-located with the additional solar. These changes are reflected in the total changes summarized below incorporated since the initial mapping results, and the full remapping adjustments can be viewed in the Final Mapping for the 24-25 TPP Base Case (Appendix E)

Overall changes and mapping adjustments summary:

The overall changes in RESOLVE results of the updated base case portfolio and the adjustments resource mapping for the 2034 and 2039 modeled years are summarized in Table 31 and Table 32 respectively by resource type and RESOLVE resource area. The updated RESOLVE selected resources, the net changes in resources selected, and the final mapping summaries are again compared to the previous 23-24 TPP base case portfolio (model year 2035).

Overall, the updated base case portfolio has 1.7 GW more resources in 2034 and 2.8 GW more in 2039. By 2039, the updated portfolio has 239 MW more geothermal, 5.5 GW more solar, 3.4 GW less in-state onshore wind, 1.1 GW less OOS (specifically Wyoming, Idaho, and New Mexico) wind, and 1.55 GW more battery storage.

Table 31: Summary of the updated base case portfolio (2034 model year) and final mapping results by RESOLVE resource area compared to the previous 23-24 TPP base case.

2034 Updated Base Case Portfolio	RESOLVE Modeled Portfolio		2034 — Mapped Total (In-Dev & Generic)			23-24 TPP (2035) Mapped Total (Subtracting New Baseline)		
RESOLVE Resource Name	Updated Portfolio – 2034 Total (MW)	Difference from Ruling (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	**171**	-	171	-	**171**	127		**127**
Central_Nevada_Geothermal	**40**	-	500	-	**500**	500		**500**
Greater_Imperial_Geothermal	**1,345**	106	950	-	**950**	805		**805**
Inyokern_N_Kramer_Geothermal	**7**	-	-	-	**-**	-		**-**
N_California_Geothermal	**544**	230	144	-	**144**	118		**118**
Northern_Nevada_Geothermal	**-**	-	299	-	**299**	305		**305**
Pacific_Northwest_Geothermal	**33**	20	-	-	**-**	-		**-**
Utah_Geothermal	**-**	-	76	-	**76**	12		**12**
Distributed Solar	**-**	-	260	-	**260**	86		**86**
Arizona_Solar	**2,987**	(256)	610	2,240	**2,850**	1,498	2,947	**4,445**
Greater_Imperial_Solar	**39**	-	200	182	**382**	-	711	**711**
Greater_Kramer_Solar	**1,012**	-	672	910	**1,582**	611	1,317	**1,928**
Greater_LA_Solar	**-**	-	-	-	**-**	125	625	**750**
N_California_Solar	**126**	-	275	420	**695**	679	1,047	**1,726**
Riverside_Solar	**659**	-	700	1,109	**1,809**	1,026	3,448	**4,473**
Southern_NV_Solar	**7,702**	3,036	1,075	1,565	**2,640**	2,032	2,786	**4,818**
Southern_PGAE_Solar	**247**	(1,339)	3,320	2,166	**5,486**	3,093	4,733	**7,826**
Tehachapi_Solar	**6,216**	1,152	1,633	1,653	**3,286**	1,837	4,331	**6,167**
Baja_California_Wind	**1,573**	-	915	185	**1,100**	-	360	**360**
CV_North_Los_Banos_Wind	**241**	209	494	96	**590**	74	-	**74**
Greater_Imperial_Wind	**133**	-	410	54	**464**	135	-	**135**
Greater_Kramer_Wind		-	310	50	**360**	-	-	**-**
Kern_Greater_Carrizo_Wind		-	300	10	**310**	263	-	**263**
Northern_California_Wind	**2,259**	1,410	678	210	**887**	230	109	**339**
Riverside_Palm_Springs_Wind	**-**	-	224	100	**324**	-	-	**-**
Solano_Wind	**375**	-	688	200	**888**	537	75	**612**
Southern_NV_Eldorado_Wind	**711**	(4,300)	620	-	**620**	353	-	**353**
Tehachapi_Wind	**832**	676	564	16	**580**	127	-	**127**
Idaho_Wind	**1,067**	767	1,060	-	**1,060**	1,000	-	**1,000**
New_Mexico_Wind	**2,028**	60	2,131	-	**2,131**	2,328	-	**2,328**
Wyoming_Wind	**3,000**	-	2,905	-	**2,905**	1,500	-	**1,500**
Humboldt_Bay_Offshore_Wind		-	931	-	**931**	1,446	161	**1,607**
Morro_Bay_Offshore_Wind	**3,855**	-	2,924	-	**2,924**	3,100	-	**3,100**
Renewable Resource Total	**37,202**	**1,771**	**26,038**	**11,164**	**37,202**	**23,852**	**22,669**	**46,521**
Arizona_Li_Battery_4hr	**1,059**	86	910	-	**910**	1,554		**1,554**
Arizona_Li_Battery_8hr	**-**	(190)	250	-	**250**			**-**
Greater_Imperial_Li_Battery_4hr	**613**	613	341	-	**341**	332		**332**
Greater_Imperial_Li_Battery_8hr	**6**	6	-	-	**-**			**-**
Greater_Kramer_Li_Battery_4hr	**313**	(132)	716	-	**716**	1,036		**1,036**
Greater_Kramer_Li_Battery_8hr	**100**	(65)	90	-	**90**			**-**
Greater_LA_Li_Battery_4hr	**-**	(3,471)	2,530	-	**2,530**	2,174		**2,174**
Greater_LA_Li_Battery_8hr	**-**	(587)	167	-	**167**			**-**
San_Diego_Li_Battery_4hr	**-**	-	689	-	**689**	709		**709**
San_Diego_Li_Battery_8hr	**-**	-	-	-	**-**			
N_California_Li_Battery_4hr	**2,924**	2,048	1,122	-	**1,122**	1,298		**1,298**
N_California_Li_Battery_8hr	**1,075**	1,075	300	-	**300**			**-**
Riverside_Li_Battery_4hr	**792**	85	2,130	-	**2,130**	2,728		**2,728**
Riverside_Li_Battery_8hr	**-**	-	120	-	**120**			**-**
Southern_NV_Li_Battery_4hr	**2,644**	1,499	1,684	-	**1,684**	2,624		**2,624**
Southern_NV_Li_Battery_8hr	**532**	93	180	-	**180**			**-**
Southern_PGAE_Li_Battery_4hr	**4,186**	(1,451)	2,331	-	**2,331**	3,813		**3,813**
Southern_PGAE_Li_Battery_8hr	**-**	(332)	342	-	**342**			**-**
Tehachapi_Li_Battery_4hr	**2,427**	724	2,505	-	**2,505**	3,526		**3,526**
Tehachapi_Li_Battery_8hr	**-**	-	170	-	**170**			**-**
LI_Battery Total	**16,671**	**(0)**	**16,576**		**16,576**	**19,794**		**19,794**
N_California_Pumped_Storage	**173**	173	-	-	**-**			**-**
Riverside_East_Pumped_Storage	**125**	(173)	-	-	**-**	700		**700**
San_Diego_Pumped_Storage	**-**	-	437	-	**449**	500		**500**
Tehachapi_Pumped_Storage	**178**	-	-	-	**-**			**-**
Southern_PGAE_Pumped_Storage	**-**	-	130		**130**			**-**
Southern_PGAE_Adiabatic_CAES	**-**	-	-	-	**-**	300		**300**
Tehachapi_Adiabatic_CAES	**200**	-	458	-	**481**	500		**500**
Greater_Imperial_Flow_Battery	**50**	21	-	-	**-**			**-**
Greater_LA_Flow_Battery	**50**	-	-	-	**-**			**-**
N_California_Flow_Battery	**50**	(21)	5	-	**5**			**-**
Riverside_Flow_Battery	**108**	108	-	-	**-**			**-**
Southern_PGAE_Flow_Battery	**-**	(108)	-	-	**-**			**-**
Other Storage Total	**935**	**-**	**1,030**		**1,030**	**2,000**		**2,000**
Total Storage+Resources	**54,808**	**1,771**	**43,549**	**11,164**	**54,808**	**45,646**	**22,669**	**68,315**

Table 32: Summary of the updated base case portfolio (2039 model year) and final mapping results by RESOLVE resource area compared to the previous 23-24 TPP base case.

2039 Updated Base Case Portfolio	RESOLVE Modeled Portfolio		2039 — Mapped Total (In-Dev & Generic)			23-24 TPP (2035) Mapped Total (Subtracting New Baseline)		
RESOLVE Resource Name	Updated Portfolio – 2039 Total (MW)	Difference from Ruling (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	**171**	-	171	-	**171**	127		**127**
Central_Nevada_Geothermal	**40**	-	500	-	**500**	500		**500**
Greater_Imperial_Geothermal	**1,345**	**(11)**	950	-	**950**	805		**805**
Inyokern_North_Kramer_Geothermal	**7**	-	-	-	-	-		-
Northern_California_Geothermal	**544**	**230**	144	-	**144**	118		**118**
Northern_Nevada_Geothermal	-	-	299	-	**299**	305		**305**
Pacific_Northwest_Geothermal	**33**	**20**	-	-	-	-		-
Utah_Geothermal	-	-	76	-	**76**	12		**12**
Distributed Solar	-	-	283	-	**283**	86		**86**
Arizona_Solar	**5,870**	**2,627**	1,210	3,065	**4,275**	1,498	2,947	**4,445**
Greater_Imperial_Solar	**39**	-	200	344	**544**	-	711	**711**
Greater_Kramer_Solar	**4,438**	**372**	752	1,258	**2,010**	611	1,317	**1,928**
Greater_LA_Solar	-	-	-	-	-	125	625	**750**
Northern_California_Solar	**126**	-	900	1,330	**2,230**	679	1,047	**1,726**
Riverside_Solar	**818**	**159**	900	2,034	**2,934**	1,026	3,448	**4,473**
Southern_NV_Eldorado_Solar	**7,702**	**3,036**	1,200	2,870	**4,070**	2,032	2,786	**4,818**
Southern_PGAE_Solar	**1,226**	**(361)**	3,931	5,756	**9,686**	3,093	4,733	**7,826**
Tehachapi_Solar	**10,463**	**(333)**	1,634	3,017	**4,651**	1,837	4,331	**6,167**
Baja_California_Wind	**2,473**	-	915	185	**1,100**	-	360	**360**
Central_Valley_North_Los_Banos_Wind	**241**	**209**	494	96	**590**	74	-	**74**
Greater_Imperial_Wind	**133**	-	410	54	**464**	135	-	**135**
Greater_Kramer_Wind		-	310	50	**360**	-	-	-
Kern_Greater_Carrizo_Wind		-	300	10	**310**	263	-	**263**
Northern_California_Wind	**2,259**	**1,410**	1,578	210	**1,787**	230	109	**339**
Riverside_Palm_Springs_Wind		-	224	100	**324**	-	-	-
Solano_Wind	**375**	-	688	200	**888**	537	75	**612**
Southern_NV_Eldorado_Wind	**711**	**(4,300)**	620	-	**620**	353	-	**353**
Tehachapi_Wind	**832**	**(657)**	564	16	**580**	127	-	**127**
Idaho_Wind	**1,067**	**767**	1,060	-	**1,060**	1,000	-	**1,000**
New_Mexico_Wind	**2,028**	**60**	3,536	-	**3,536**	2,328	-	**2,328**
Wyoming_Wind	**6,000**	**(1,936)**	4,500	-	**4,500**	1,500	-	**1,500**
Humboldt_Bay_Offshore_Wind	-	-	1,607	-	**1,607**	1,446	161	**1,607**
Morro_Bay_Offshore_Wind	**4,531**	-	2,924	-	**2,924**	3,100	-	**3,100**
Renewable Resource Total	**53,472**	**1,293**	**32,879**	**20,593**	**53,472**	**23,852**	**22,669**	**46,521**
Arizona_Li_Battery_4hr	**1,059**	**86**	910	-	**910**	1,554		**1,554**
Arizona_Li_Battery_8hr	-	**(190)**	700	-	**700**			-
Greater_Imperial_Li_Battery_4hr	**613**	**613**	341	-	**341**	332		**332**
Greater_Imperial_Li_Battery_8hr	**6**	**6**	63	-	**63**			-
Greater_Kramer_Li_Battery_4hr	**797**	**352**	746	-	**746**	1,036		**1,036**
Greater_Kramer_Li_Battery_8hr	**100**	**(65)**	265	-	**265**			-
Greater_LA_Li_Battery_4hr	-	**(4,020)**	2,580	-	**2,580**	2,174		**2,174**
Greater_LA_Li_Battery_8hr	**4,900**	**4,313**	447	-	**447**			-
San_Diego_Li_Battery_4hr	-	-	689	-	**689**	709		**709**
San_Diego_Li_Battery_8hr	-	-	92	-	**92**			
Northern_California_Li_Battery_4hr	**2,924**	**2,048**	1,172	-	**1,172**	1,298		**1,298**
Northern_California_Li_Battery_8hr	**1,544**	**(1,153)**	1,310	-	**1,310**			-
Riverside_Li_Battery_4hr	**1,019**	**311**	2,130	-	**2,130**	2,728		**2,728**
Riverside_Li_Battery_8hr	-	-	520	-	**520**			-
Southern_NV_Eldorado_Li_Battery_4hr	**2,644**	**1,499**	2,188	-	**2,188**	2,624		**2,624**
Southern_NV_Eldorado_Li_Battery_8hr	**532**	**93**	745	-	**745**			-
Southern_PGAE_Li_Battery_4hr	**4,186**	**(1,651)**	2,446	-	**2,446**	3,813		**3,813**
Southern_PGAE_Li_Battery_8hr	**128**	**(688)**	2,239	-	**2,239**			-
Tehachapi_Li_Battery_4hr	**2,466**	**763**	2,505	-	**2,505**	3,526		**3,526**
Tehachapi_Li_Battery_8hr	-	**(763)**	734	-	**734**			-
LI_Battery Total	**22,917**	**1,553**	**22,822**		**22,822**	**19,794**		**19,794**
Northern_California_Pumped_Storage	**173**	**173**	-	-	-			-
Riverside_East_Pumped_Storage	**125**	**(173)**	-	-	-	700		**700**
San_Diego_Pumped_Storage	-	-	487	-	**487**	500		**500**
Tehachapi_Pumped_Storage	**178**	-	-	-	-			-
Southern_PGAE_Pumped_Storage	-	-	130		**130**			-
Southern_PGAE_Adiabatic_CAES	-	-	-	-	-	300		**300**
Tehachapi_Adiabatic_CAES	**200**	-	481	-	**481**	500		**500**
Greater_Imperial_Flow_Battery	**50**	**21**	-	-	-			-
Greater_LA_Flow_Battery	**50**	-	-	-	-			-
Northern_California_Flow_Battery	**100**	**29**	5	-	**5**			-
Riverside_Flow_Battery	**108**	**108**	-	-	-			-
Southern_PGAE_Flow_Battery		**(158)**	-	-	-			-
Other Storage Total	**985**	-	**1,080**		**1,080**	**2,000**		**2,000**
Storage Total	**23,902**	**1,553**	**23,902**		**23,902**	**21,794**		**21,794**
Total Storage+Resources	**77,374**	**2,846**	**56,685**	**20,593**	**77,279**	**45,646**	**22,669**	**68,315**

6.2.A Net Mapping Adjustments for 2034 Base Case Portfolio

The adjustments to the 2034 mapping results between the initial mapping and final mapping mainly reflect the changes to the modeled portfolio with increases in geothermal and solar resources and decreases in onshore wind in several study areas. The reduction of onshore wind occurred mostly in southern study areas, while additional solar was added to most study areas with the most being added to the Kern and Fresno study areas. Key additional changes include the remapping of offshore wind to the Humboldt area and the switching of 8-hr battery to LDES in the PG&E Fresno area.

The net MW mapping adjustments for the 2034 base case portfolio are summarized by resource type and CAISO in Table 33. Table 34 shows the number of substations by CAISO study area at which resources were added or removed for the 2034 portfolio, and Table 35 shows a narrower focus number of substations where staff remapped 50 MW or more of a single resource, either added or removed. For both Table 34 and Table 35, the top table shows number of substations with mapping increases and the bottom table shows the number with decreases.

Table 33: Summary of the net MW adjustments between initial and final mapping results for the 2034 base case portfolio by CAISO study area and resource type.

2034 Portfolio: Net Change (MW) In Resources Mapped (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	**FCDS**	**FCDS**	**FCDS**	**EODS**	**FCDS**	**FCDS**	**FCDS**	**FCDS**	**EODS**	**FCDS**	**FCDS**	**FCDS**	**Total**
PG&E North of Greater Bay	37	(1)	126	-	-	931	-	170	130	-	50	-	**1,443**
PG&E Greater Bay	-	(5)	(97)	-	-	-	2	-	-	-	(50)	-	**(150)**
PG&E Fresno	-	4	134	91	-	-	32	847	-	-	(95)	130	**1,144**
PG&E Kern	-	1	25	-	-	(931)	-	344	50	-	-	-	**(511)**
SCE Northern Area	-	-	-	(34)	-	-	-	72	135	-	-	(23)	**150**
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	**-**
SCE North of Lugo	-	-	(240)	(50)	-	-	8	-	-	-	-	-	**(282)**
East of Pisgah	159	-	(990)	(200)	696	-	-	-	200	-	-	-	**(135)**
SCE Eastern	50	-	(275)	-	131	-	-	300	100	-	-	-	**306**
SDG&E	110	-	(35)	(461)	-	-	-	200	-	-	-	(12)	**(198)**
All Areas	**356**	**0**	**(1,352)**	**(654)**	**827**	**-**	**42**	**1,933**	**615**	**-**	**(95)**	**95**	**1,768**

Table 34: Summary by CAISO study area of the number of substations with any mapping changes for the 2034 base case portfolio.

2034 Base Case Portfolio Mapping Adjustments

No. of Subs w/ Increase in Res. (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_4hr	Battery_8hr	LDES	All Res
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	2	3	3	2	0	1	0	1	1	0	1	1	15
PG&E Greater Bay	0	0	1	0	0	0	1	0	0	0	0	0	2
PG&E Fresno	0	1	2	3	0	0	6	4	1	0	0	1	18
PG&E Kern	0	1	1	0	0	1	0	4	1	0	0	0	8
SCE Northern Area	0	0	0	0	0	0	0	1	2	0	0	0	3
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	0	0	0	1	0	0	0	0	0	2
East of Pisgah	3	0	0	0	2	0	0	0	1	0	0	0	6
SCE Eastern	1	0	0	0	1	0	0	1	1	0	0	0	4
SDG&E	1	0	1	1	0	0	0	1	0	0	0	0	4
All Areas	7	5	9	6	3	2	8	12	7	0	1	2	62

No. of Subs w/ Decrease in Res. (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_4hr	Battery_8hr	LDES	All Res
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	2	0	1	0	0	0	0	0	0	0	1	4
PG&E Greater Bay	0	2	1	0	0	0	0	0	0	0	1	0	4
PG&E Fresno	0	1	1	0	0	0	0	0	1	0	2	0	5
PG&E Kern	0	0	0	0	0	1	0	0	0	0	0	0	1
SCE Northern Area	0	0	0	1	0	0	0	0	0	0	0	1	2
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	1	0	0	0	0	0	0	0	0	2
East of Pisgah	0	0	4	1	0	0	0	0	0	0	0	0	5
SCE Eastern	0	0	2	0	0	0	0	0	0	0	0	0	2
SDG&E	0	0	2	3	0	0	0	0	0	0	0	1	6
All Areas	0	5	11	7	0	1	0	0	1	0	3	3	31

Table 35: Summary by CAISO study area of the number of substations with mapping changes 50 MW or larger for the 2034 base case portfolio.

2034 Base Case Portfolio Mapping Adjustments

No. of Subs w/ >50 MW Increase (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_4hr	Battery_8hr	LDES	All Res
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	0	1	0	0	1	0	1	1	0	1	0	5
PG&E Greater Bay	0	0	0	0	0	0	0	0	0	0	0	0	0
PG&E Fresno	0	0	2	0	0	0	0	3	0	0	0	1	6
PG&E Kern	0	0	0	0	0	1	0	4	1	0	0	0	6
SCE Northern Area	0	0	0	0	0	0	0	1	1	0	0	0	2
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	0	0	0	0	0	0	0	0	0	0	0
East of Pisgah	3	0	0	0	2	0	0	0	1	0	0	0	6
SCE Eastern	1	0	0	0	1	0	0	1	1	0	0	0	4
SDG&E	1	0	1	0	0	0	0	1	0	0	0	0	3
All Areas	5	0	4	0	3	2	0	11	5	0	1	1	32

No. of Subs w/ >50 MW Decrease (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_4hr	Battery_8hr	LDES	All Res
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	0	0	1	0	0	0	0	0	0	0	0	1
PG&E Greater Bay	0	0	1	0	0	0	0	0	0	0	1	0	2
PG&E Fresno	0	0	0	0	0	0	0	0	0	0	1	0	1
PG&E Kern	0	0	0	0	0	1	0	0	0	0	0	0	1
SCE Northern Area	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	1	0	0	0	0	0	0	0	0	2
East of Pisgah	0	0	4	1	0	0	0	0	0	0	0	0	5
SCE Eastern	0	0	2	0	0	0	0	0	0	0	0	0	2
SDG&E	0	0	2	3	0	0	0	0	0	0	0	0	5
All Areas	0	0	10	6	0	1	0	0	0	0	2	0	19

6.2.B Net Mapping Adjustments for 2039 Base Case Portfolio

The adjustments to the 2039 mapping results between the initial mapping and final mapping also mainly reflect the resources changes to the modeled portfolio. The changes expound on the 2034 adjustments with further increases in solar and decreases in onshore wind in several study areas. The reduction of onshore wind occurred mostly in southern study areas, while additional solar was added to most study areas with the most being added to the Kern and Fresno study areas. The key change in offshore wind is the remapping of 1.6 GW from the Central Coast to the North. For OOS wind, like onshore instate wind, there were significant reductions in the amount of resource included in the portfolio; however, staff made an additional significant adjustment in remapping 1,500 MW of Wyoming Wind to interconnect in Northern California. Key additional changes include the switching of 8-hr battery to LDES in the PG&E Fresno area and minor adjustments to solar and storage reflect mapping changes to improve transmission constraint exceedances.

The net MW mapping adjustments for the 2039 base case portfolio are summarized by resource type and CAISO in Table 36. Table 37 shows the number of substations by CAISO study area at which resources were added or removed for the 2039 portfolio, and Table 38 shows a narrower focus number of substations where staff remapped 50 MW or more of a single resource, either added or removed. For both Table 37 and Table 38, the top table shows number of substations with mapping increases and the bottom table shows the number with decreases.

Table 36: Summary of the net MW adjustments between initial and final mapping results for the 2039 base case portfolio by CAISO study area and resource type.

2039 Portfolio: Net Change (MW) In Resources Mapped(Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	20	(1)	(107)	-	-	1,607	-	225	625	-	280	-	**2,650**
PG&E Greater Bay	-	(5)	(97)	-	1,500	-	2	70	115	-	260	-	**1,845**
PG&E Fresno	-	4	134	91	-	-	32	763	1,046	(54)	495	130	**2,641**
PG&E Kern	-	1	25	-	-	(1,607)	-	174	235	-	45	-	**(1,127)**
SCE Northern Area	-	-	(200)	(34)	-	-	-	(52)	74	(50)	50	(23)	**(235)**
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	**-**
SCE North of Lugo	-	-	(240)	(50)	-	-	-	-	-	-	-	-	**(290)**
East of Pisgah	59	-	(990)	(300)	(1,644)	-	-	75	1,155	104	215	-	**(1,326)**
SCE Eastern	50	-	(275)	-	(964)	-	-	300	125	-	-	-	**(764)**
SDG&E	110	-	(435)	(861)	-	-	-	200	337	-	113	(12)	**(548)**
All Areas	**239**	**0**	**(2,185)**	**(1,154)**	**(1,109)**	**-**	**34**	**1,755**	**3,712**	**-**	**1,458**	**95**	**2,846**

Table 37: Summary by CAISO study area of the number of substations with any mapping changes for the 2039 base case portfolio.

2039 Base Case Portfolio Mapping Adjustments

No. of Subs w/ Increase in Res. (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	1	3	4	2	0	1	0	4	4	0	5	1	25
PG&E Greater Bay	0	0	1	0	1	0	1	1	1	1	3	0	9
PG&E Fresno	0	1	2	3	0	0	6	8	8	1	9	1	39
PG&E Kern	0	1	1	0	0	1	0	3	2	0	2	0	10
SCE Northern Area	0	0	0	0	0	0	0	1	1	0	1	0	3
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	0	0	0	0	0	0	0	0	0	1
East of Pisgah	1	0	0	0	0	0	0	2	5	2	2	0	12
SCE Eastern	1	0	0	0	0	0	0	1	2	0	0	0	4
SDG&E	1	0	1	1	0	0	0	1	2	0	2	0	8
All Areas	4	5	10	6	1	2	7	21	25	4	24	2	111

No. of Subs w/ Decrease in Res. (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	2	2	1	0	0	0	0	0	0	0	1	6
PG&E Greater Bay	0	2	1	0	0	0	0	0	0	1	1	0	5
PG&E Fresno	0	1	1	0	0	0	0	0	1	1	2	0	6
PG&E Kern	0	0	0	0	0	1	0	1	1	0	2	0	5
SCE Northern Area	0	0	1	1	0	0	0	1	1	1	0	1	6
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	1	0	0	0	0	0	0	0	0	2
East of Pisgah	0	0	4	2	2	0	0	0	0	0	0	0	8
SCE Eastern	0	0	2	0	1	0	0	0	0	0	0	0	3
SDG&E	0	0	2	3	0	0	0	0	0	0	0	1	6
All Areas	0	5	14	8	3	1	0	2	3	3	5	3	47

Table 38: Summary by CAISO study area of the number of substations with mapping changes 50 MW or larger for the 2039 base case portfolio.

2039 Base Case Portfolio Mapping Adjustments

No. of Subs w/ >50 MW Increase (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	0	3	0	0	1	0	3	4	0	3	0	14
PG&E Greater Bay	0	0	0	0	1	0	0	1	1	1	3	0	7
PG&E Fresno	0	0	2	0	0	0	0	3	7	0	4	1	17
PG&E Kern	0	0	0	0	0	1	0	3	2	0	1	0	7
SCE Northern Area	0	0	0	0	0	0	0	1	1	0	1	0	3
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	0	0	0	0	0	0	0	0	0	0	0
East of Pisgah	1	0	0	0	0	0	0	1	5	1	1	0	9
SCE Eastern	1	0	0	0	0	0	0	1	1	0	0	0	3
SDG&E	1	0	1	0	0	0	0	1	2	0	2	0	7
All Areas	3	0	6	0	1	2	0	14	23	2	15	1	67

No. of Subs w/ >50 MW Decrease (Final - Initial)	Geothermal	Biomass	Wind	Wind	OOS Wind	Offshore Wind	Distrib. Solar	Solar	Solar	Battery_ 4hr	Battery_ 8hr	LDES	All Res.
CAISO Study Area	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	FCDS	Total
PG&E North of Greater Bay	0	0	2	1	0	0	0	0	0	0	0	0	3
PG&E Greater Bay	0	0	1	0	0	0	0	0	0	1	1	0	3
PG&E Fresno	0	0	0	0	0	0	0	0	1	1	0	0	2
PG&E Kern	0	0	0	0	0	1	0	1	0	0	0	0	2
SCE Northern Area	0	0	1	0	0	0	0	1	1	1	0	0	4
SCE Metro	0	0	0	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	1	1	0	0	0	0	0	0	0	0	2
East of Pisgah	0	0	4	2	2	0	0	0	0	0	0	0	8
SCE Eastern	0	0	2	0	1	0	0	0	0	0	0	0	3
SDG&E	0	0	2	3	0	0	0	0	0	0	0	0	5
All Areas	0	0	13	7	3	1	0	2	2	3	1	0	32

6.2.C Net Mapping Adjustments by CAISO Study Area

This section summarizes the mapping adjustments made by busbar Working Group staff following the initial mapping results broken down by CAISO study area. The mapping adjustments reflect the updated resource portfolio, the mapping analysis changes noted above, stakeholder feedback in comments and replies to the October 2023 Ruling and the January 2024 Proposed Decision, and further Working Group analysis. Full substation level mapping adjustments and complete busbar mapping criteria analysis for both the 2034 and 2039 model years can be found in the Final Mapping Dashboard (Appendix E). The final mapping results and their alignment with the busbar mapping criteria are discussed in Section 6.3.

Northern California – PG&E North of Greater Bay and Greater Bay Study Areas

Table 39 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for the two study areas by resource type and the number of substations with 50 MW or larger mapping adjustments.

Table 39: Post-ruling mapping adjustments for the PG&E North of Greater Bay (Top) and Greater Bay (Bottom) study areas. Tables show net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

PG&E North of Greater Bay: Resources Mapped (Final - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distrib. Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	All Res. Total
2034 Net MW Change	37	(1)	126	-	-	931	-	170	130	-	50	**1,443**
Subs w/ >50 MW Increse	0	0	1	0	0	1	0	1	1	0	1	**5**
Subs w/ >50 MW Decreas	0	0	0	1	0	0	0	0	0	0	0	**1**
2039 Net MW Change	20	(1)	(107)	-	-	1,607	-	225	625	-	280	**2,650**
Subs w/ >50 MW Increse	0	0	3	0	0	1	0	3	4	0	3	**14**
Subs w/ >50 MW Decreas	0	0	2	1	0	0	0	0	0	0	0	**3**

PG&E Greater Bay: Resources Mapped (Final - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distrib. Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	All Res. Total
2034 Net MW Change	-	(5)	(97)	-	-	-	2	-	-	-	(50)	**(150)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	0	0	**0**
Subs w/ >50 MW Decrease	0	0	1	0	0	0	0	0	0	0	1	**2**
2039 Net MW Change	-	(5)	(97)	-	1,500	-	2	70	115	-	260	**1,845**
Subs w/ >50 MW Increse	0	0	0	0	1	0	0	1	1	1	3	**7**
Subs w/ >50 MW Decrease	0	0	1	0	0	0	0	0	0	1	1	**3**

Key mapping adjustments for these two areas are:

- Staff remapped about 1500 MW offshore wind from the central coast to the Humbold area in both 2034 and 2039, while retaining about 3,000 MW at the Central Coast in 2039.
- In the 2039 portfolio, staff remapped 1,500 MW Wyoming wind interconnecting in the East of Pisgah to interconnecting at the Tesla area based on the guidance from the CAISO's 20-year transmission outlook (2021-2022). The shift increases diversity of interconnection locations for the OOS resources and reduces transmission exceedances in the southern study areas.
- North of Greater Bay area had additional geothermal mapped to the Geysers area substations corresponding to updated portfolio including more geothermal resources.

- Staff remapped biomass initially at Wyandotte, Mariposa, and Pease buses to Colgate, Glenn, Honcut, and substations in other study areas to improve compliance with community impacts factors and commercial interest.
- Both areas had small reductions in total onshore wind mapped corresponding to updated portfolio's overall decrease in wind. Wind was remapped between substations in the two study areas to better align with available resource potential (remapped wind from Hilltop to the other two NVE area substations; remapped some wind at Tesla to Round Mountain).
- Both areas had additional solar and co-located storage mapped to substations corresponding to the updated portfolio increases in solar and storage resources. Birds Landing 230 kV, Davis, Rio Oso, Vaca Dixon 230 kV, Delevan, and Weber all had additional solar and storage mapped to them aligning with commercial interest and prior mapping at the buses.
- Stand-alone battery storage was remapped from Metcalf 500 kV to 230 kV as discussed above.
- Stand-alone battery storage was remapped from Mariposa 230 kV (no commercial interest) and additional storage was mapped to Moss Landing 500 kV and Martin 115 kV to also align with commercial interest.

Southern PG&E – PG&E Fresno and Kern Study Areas

Table 40 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for the two study areas by resource type and the number of substations with 50 MW or larger mapping adjustments.

Table 40: Post-ruling mapping adjustments for the PG&E Fresno (Top) and Kern (Bottom) study areas. Tables show net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

PG&E Fresno: Resources Mapped (Final - Initial)	Biomass FCDS	Wind FCDS	Wind EODS	Offshore Wind FCDS	Distrib. Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	4	134	91	-	32	847	-	-	(95)	130	**1,144**
Subs w/ >50 MW Increse	0	2	0	0	0	3	0	0	0	1	**6**
Subs w/ >50 MW Decreas	0	0	0	0	0	0	0	0	1	0	1
2039 Net MW Change	4	134	91	-	32	763	1,046	(54)	495	130	**2,641**
Subs w/ >50 MW Increse	0	2	0	0	0	3	7	0	4	1	**17**
Subs w/ >50 MW Decreas	0	0	0	0	0	0	1	1	0	0	**2**

PG&E Kern: Resources Mapped (Final - Initial)	Biomass FCDS	Wind FCDS	Wind EODS	Offshore Wind FCDS	Distrib. Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	1	25	-	(931)	-	344	50	-	-	-	**(511)**
Subs w/ >50 MW Increse	0	0	0	1	0	4	1	0	0	0	**6**
Subs w/ >50 MW Decreas	0	0	0	1	0	0	0	0	0	0	1
2039 Net MW Change	1	25	-	(1,607)	-	174	235	-	45	-	**(1,127)**
Subs w/ >50 MW Increse	0	0	0	1	0	3	2	0	1	0	**7**
Subs w/ >50 MW Decreas	0	0	0	1	0	1	0	0	0	0	2

Key mapping adjustments for the Fresno and Kern study areas are:

- Staff remapped a portion of the offshore wind at Morro Bay to the Humboldt area (931 MW in 2034 and 1,607 MW in 2039), while retaining about 3,000 MW at the Central Coast in 2039.
- Staff added 130 MW of LDES at Gregg 230 kV bus in line with stakeholder feedback to the January 2024 Proposed Decision and discussed in Section 6.2.
- Staff reduced biomass mapped to Wilson 230 kV and remapped resources, including resources from Northern California to the Exchequer 115 kV (5 MW) and San Luis Obispo 115 kV (1 MW)
- Additional wind was mapped to three substations in the two study areas (150 MW to Gregg, 175 MW to Los Banos 230 kV, 25 MW Templeton) from southern study areas to better align with resource potential and to improve land-use and environmental criteria alignment.
- Both areas had additional solar and co-located storage mapped to substations corresponding to the updated portfolio increases in solar and storage resources with the Fresno study area having a significant number of additional resources. Staff mapped more than 100 MW of additional solar and co-located storage to Arco, Gates 230 kV, Helm 230 kV, Henrietta, Manning 500 kV, Midway, Mustang, Schindler 115 kV, and two proposed substations. Resources were added to these substations to align with commercial interest, land-use, and previous base case criteria.
- Staff remapped solar and storage from the Westley 230 kV substation due to no commercial interest at the substation. Staff also made small reductions in battery storage and remapping of solar a several substations to accommodate LDES at Gregg 230 kV as discussed above.

Greater Tehachapi & LA Metro — SCE Northern and SCE Metro Study Areas

Table 41 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for SCE Northern study area by resource type and the number of substations with 50 MW or larger mapping adjustments. The SCE Metro area had no mapping adjustments after the initial mapping, so no table is shown.

Table 41: Post-ruling mapping adjustments for the SCE Northern study area. The table shows net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

SCE Northern Area: Resources Mapped (Final - Initial)	Wind FCDS	Wind EODS	Solar FCDS	Solar EODS	Battery_ 4hr FCDS	Battery_ 8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	-	(34)	72	135	-	-	(23)	**150**
Subs w/ >50 MW Increse	0	0	1	1	0	0	0	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0
2039 Net MW Change	(200)	(34)	(52)	74	(50)	50	(23)	**(235)**
Subs w/ >50 MW Increse	0	0	1	1	0	1	0	**3**
Subs w/ >50 MW Decrease	1	0	1	1	1	0	0	4

Key mapping adjustments for the SCE Northern area are:

- Staff decreased the amount of wind mapped to Antelope 230 kV in both model years (-34 MW and Whirlwind 230 kV in 2039 (-200 MW) corresponding to the decrease in wind resources included in the updated portfolio.
- Staff remapped the solar and co-located storage at Stanta Clara 230 kV to other locations as the bus has no solar commercial interest.
- Antelope 230 kV, Whirlwind 230 kV, and Windhub 230 kV all had small amounts (< 100 MW) of additional solar mapped to them in the 2034 portfolio results, while Windhub 230 kV had an additional 270 MW of solar and 50 MW of 8-hr storage in the 2039 portfolio remapping corresponding to the general increase in solar and storage in the updated portfolio and significant commercial interest at the bus.

Several substations in the SCE Northern area, beyond of the Tehachapi area, have high alignment for commercial interest, land-use, and environmental impacts criteria; however, Working Group staff did not map additional resources to these buses. Staff sought to limit further increasing the exceedance in the South of Magunden Constraint as discussed in Section 6.1.A.

Greater Kramer – SCE North of Lugo Study Area

Table 42 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for SCE North of Lugo study area by resource type and the number of substations with 50 MW or larger mapping adjustments. The area had only minor post-ruling mapping adjustments corresponding to the reduction in onshore wind in the updated base case portfolio. Staff removed the 300 MW of wind mapped to Pisgah as the substation has no commercial interest and shifted 10 MW to Coolwater 115kV (210 MW total) to align with commercial wind interest there.

Table 42: Post-ruling mapping adjustments for the SCE North of Lugo study area. The table shows net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

SCE North of Lugo: Resources Mapped (Final - Initial)	Wind FCDS	Wind EODS	Solar FCDS	Solar EODS	Battery_ 4hr FCDS	Battery_ 8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	(240)	(50)	-	-	-	-	-	**(282)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	**0**
Subs w/ >50 MW Decrease	1	1	0	0	0	0	0	2
2039 Net MW Change	(240)	(50)	-	-	-	-	-	**(290)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	**0**
Subs w/ >50 MW Decrease	1	1	0	0	0	0	0	2

Southern Nevada – East of Pisgah Study Area

Table 43 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for East of Pisgah study area by resource type and the number of substations with 50 MW or larger mapping adjustments. Mapping adjustments between the initial and final mapping result in the following key shifts:

Table 43: Post-ruling mapping adjustments for the East of Pisgah study area. The table shows net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

East of Pisgah: Resources Mapped (Final - Initial)	Geothermal FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Solar FCDS	Solar EODS	Battery_ 4hr FCDS	Battery_ 8hr FCDS	All Res. Total
2034 Net MW Change	159	(990)	(200)	696	-	200	-	-	**(135)**
Subs w/ >50 MW Increse	3	0	0	2	0	1	0	0	**6**
Subs w/ >50 MW Decrease	0	4	1	0	0	0	0	0	5
2039 Net MW Change	59	(990)	(300)	(1,644)	75	1,155	104	215	**(1,326)**
Subs w/ >50 MW Increse	1	0	0	0	0	5	1	1	**8**
Subs w/ >50 MW Decrease	0	4	2	2	0	0	0	0	8

- Staff made significant reduction in wind mapped to Southern Nevada substations in line with the reduction in onshore wind resources in the area in the update portfolio by removing the 700 MW mapped to Mohave 500 kV and the 200 MW mapped to Innovation and reducing the amounts mapped to Lathrop and Sloan Canyon by 290 MW and 100 MW respectively.
- Staff mapped additional Wyoming Wind and Idaho Wind interconnecting at Harry-Allen-Eldorado interties in the 2034 portfolio corresponding to the increase in OOS wind in the updated base case. Staff decreased the amount of Idaho Wind by 144 MW in 2039 reflecting the general decrease in OOS wind in the updated 2039 portfolio.
- 1,500 MW of Wyoming Wind initially interconnecting at the El Dorado intertie was remapped to interconnect on new transmission into Northern California to reduce

transmission exceedances in the East of Pisgah and SCE Eastern study area and also diversifies the interconnection locations for OOS wind.

- With the increase in the number of geothermal resources in the updated base case portfolio, additional geothermal was mapped to the interties representing Utah, Northern Nevada, and Central Nevada in the 2034 portfolio and to just Northern Nevada in 2039. These out-of-state resources generally align with identified commercial interests.

- Staff mapped additional solar resources to Innovation substation (200 MW) in the 2034 portfolio and to the Trout Canyon (400 MW), Lathrop (Lathrop 350 MW), Innovation (200 MW), Carpentar Canyon (90 MW), and Desert View (190 MW) substations. Mapping adjustments for the 2039 portfolio includes additional battery storage mapped to Valley 138 kV (25 MW 4-hr), Trout Canyon (175 MW 8-hr), Carpenter Canyon (40 MW 8-hr), and Desert View (79 MW 4-hr). These adjustments are inclusive of the adjustment made after the Ruling and between the January 2024 Proposed Decision and final mapping results.

Riverside and Arizona – SCE Eastern Study Area

Table 44 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for SCE Eastern study area by resource type and the number of substations with 50 MW or larger mapping adjustments. The SCE Eastern study area includes some Arizona interconnections – Delaney, Palo Verde, and the proposed Ciel Azul substation. Other Arizona interconnection substations such as Hassayampa, Hoodoo Wash, and North Gila are included in the SDG&E study area.

Table 44: Post-ruling mapping adjustments for the SCE Eastern study area. The table shows net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

SCE Eastern: Resources Mapped (Final - Initial)	Geothermal FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	50	(275)	-	131	300	100	-	-	-	**306**
Subs w/ >50 MW Increse	1	0	0	1	1	1	0	0	0	**4**
Subs w/ >50 MW Decrease	0	2	0	1	0	0	0	0	0	3
2039 Net MW Change	50	(275)	-	(964)	300	125	-	-	-	**(764)**
Subs w/ >50 MW Increse	1	0	0	0	1	1	0	0	0	**3**
Subs w/ >50 MW Decrease	0	2	0	1	0	0	0	0	0	3

Key mapping adjustments for the SCE Eastern study area are:

- Staff added 50 MW of Imperial area geothermal interconnecting at the Mirage-Devers SCE-IID intertie corresponding to the increase of geothermal in the updated portfolio.

- Due to poor land-use and environmental implications alignment for wind mapped to El Casco and Devers substation and the overall reduction of onshore wind resources in the updated portfolio, staff removed 200 MW of wind mapped to El Casco and reduced the amount of wind mapped to Devers 230 kV by 75 MW.

- Corresponding to the small increase in OOS wind in the updated 2034 portfolio and larger decrease in the updated 2039 portfolio, staff increased the amount of New Mexico wind mapped to Palo Verde in 2034 up to 2,131 MW and decreased the amount mapped in 2039 by 964 MW down to 3,535 MW.
- Staff mapped an additional 400 MW of solar to Devers 230 kV in both 2034 and 2039 to align with commercial interest and previous base case consistency criteria.

San Diego, Imperial, and Arizona – San Diego Gas & Electric Study Area

Table 45 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for SDG&E study area by resource type and the number of substations with 50 MW or larger mapping adjustments. The SDG&E study area includes the following Arizona interconnections: Hassayampa, Hoodoo Wash, and North Gila are included in the SDG&E study area. The mapping adjustments resulted in the following changes to the resources mapped in the study area:

- Staff mapped additional Imperial geothermal as interconnecting to the SDGE-IID intertie at Imperial Valley in both 2034 and 2039, corresponding to the increase in geothermal resources of the updated portfolio.
- Baja wind mapped to the ECO 500 kV bus was reduced by 400 MW in the 2034 mapping and 1,200 MW in the 2039 mapping results in an updated total of 500 MW of wind interconnect in both 2034 and 2039. Staff also reduced the amount of Greater Imperial wind interconnecting at a proposed substation on the Suncrest-Ocotillo line by 100 MW resulting in a total of 400 MW being interconnected.
- Staff mapped an additional 200 MW solar in 2034 and 360 MW solar as well as 63 MW of 8-hr battery storage in 2039 to the Imperial Valley 230 kV bus, while for the 2039 mapping results staff increased the amount of solar and storage mapped to Hassayampa by 175 MW and 50 MW for solar and battery storage respectively.

Table 45: Post-ruling mapping adjustments for the SDG&E study area. The table shows net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

SDG&E: Resources Mapped (Final - Initial)	Geothermal FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res. Total
2034 Net MW Change	110	(35)	(461)	-	200	-	-	-	(12)	**(198)**
Subs w/ >50 MW Increse	1	1	0	0	1	0	0	0	0	**3**
Subs w/ >50 MW Decreas	0	2	3	0	0	0	0	0	0	5
2039 Net MW Change	110	(435)	(861)	-	200	337	-	113	(12)	**(548)**
Subs w/ >50 MW Increse	1	1	0	0	1	2	0	2	0	**7**
Subs w/ >50 MW Decreas	0	2	3	0	0	0	0	0	0	5

6.3 Final Mapping Criteria Alignment, Post-Remapping

The final mapping results for the base case portfolio by RESOLVE resource area are shown above in Table 31 for 2034 and Table 32 for 2039. Table 46 below shows the final mapping results summarized by CAISO study area for 2034 and 2039. This section summarizes the criteria alignment of the final mapping results of the base case portfolio with subsections 6.3.A through 6.3.F summarizes the portfolios alignment with each of the busbar mapping criteria categories.

Table 46: Final mapping results of the base case portfolio summarized by CAISO study area and resource type for both 2034 (Top) and 2039 (Bottom) model years.

2034 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	144.0	97.5	1,097	-	931	37	595	382	5	**3,288**
PG&E Greater Bay	-	24.6	778	-	-	40	100	1,040	-	**1,983**
PG&E Fresno	-	20.2	490	-	-	66	3,505	1,754	130	**5,966**
PG&E Kern	-	18.0	310	-	2,924	73	1,981	919	-	**6,224**
SCE Northern	-	1.0	580	-	-	5	3,286	3,409	458	**7,739**
SCE Metro	-	5.6	-	-	-	27	-	1,962	-	**1,994**
SCE North of Lugo	-	1.5	360	-	-	11	1,582	806	-	**2,761**
East of Pisgah	875.0	-	620	3,965	-	-	2,640	1,864	-	**9,964**
SCE Eastern	790.0	2.6	324	2,131	-	-	3,459	2,950	-	**9,656**
SDG&E	160.0	-	1,564	-	-	1	1,582	1,490	437	**5,234**
Total by Res Type:	**1,969.0**	**171.0**	**6,123**	**6,096**	**3,855**	**260**	**18,729**	**16,576**	**1,030**	**54,808**

2039 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	144.0	97.5	1,997	-	1,607	37	1,545	782	5	**6,214**
PG&E Greater Bay	-	24.6	778	1,500	-	40	685	1,700	-	**4,728**
PG&E Fresno	-	20.2	490	-	-	66	6,430	3,276	130	**10,568**
PG&E Kern	-	18.0	310	-	2,924	73	3,096	1,459	-	**7,834**
SCE Northern	-	1.0	580	-	-	5	4,651	3,974	458	**9,669**
SCE Metro	-	5.6	-	-	-	34	-	2,292	-	**2,331**
SCE North of Lugo	-	1.5	360	-	-	27	2,010	1,011	-	**3,410**
East of Pisgah	875.0	-	620	4,060	-	-	4,230	2,884	-	**12,558**
SCE Eastern	790.0	2.6	324	3,536	-	-	5,834	3,750	-	**14,236**
SDG&E	160.0	-	1,564	-	-	1	1,919	1,695	487	**5,826**
Total by Res Type:	**1,969.0**	**171.0**	**7,023**	**9,096**	**4,531**	**283**	**30,399**	**22,822**	**1,080**	**77,374**

6.3.A Final System Level Transmission Criteria Alignment

This section summarizes the final mapping results' utilization of system level transmission and discusses the exceedances in CAISO 2023 White Paper constraints identified through the transmission calculations and their potential upgrade needs. This analysis incorporates the fixes to

the transmission exceedance calculations discussed in Section 6.2, which results in shifts in some exceedances even though no remapping occurred. Full details of the system level transmission criteria alignment and the transmission constraint utilization calculations for the final mapping of the base case portfolio can be found in the Final Base Case Mapping Dashboard (Appendix E).

Table 47 below shows the 2034 portfolio's mapping results transmission constraint exceedance criteria alignment before any potential White Paper upgrades are applied. The table summarizes by resource type whether the resources are mapped to buses that are in transmission constraints with capability exceedances due to the mapped portfolio. Table 48 shows the same analysis for the initial mapping of the 2039 portfolio.

Table 47: Final mapping (2034 Portfolio) alignment with transmission constraint exceedance criteria summarized by resource type before any upgrades.

2034 Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedancess	Actual Constraint Exceedances
Geothermal (MW)	-	790	1,147
Biomass (MW)	41	-	129
OnshoreWind (MW)	2,345	-	3,779
OOS Wind (MW)	-	-	6,096
Offshore Wind (MW)	2,924	-	931
Solar (MW)	11,624	116	7,126
Li_Battery (MW)	8,012	700	7,809
LDES (MW)	458	-	572
Total by Status (MW)	**25,402**	**1,606**	**27,589**

Table 48: Final mapping (2039 Portfolio) alignment with transmission constraint exceedance criteria summarized by resource type before any upgrades.

2039 Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	-	790	1,147
Biomass (MW)	30	-	140
OnshoreWind (MW)	2,345	-	4,679
OOS Wind (MW)	-	-	9,096
Offshore Wind (MW)	2,924	-	1,607
Solar (MW)	17,670	1,013	11,876
Li_Battery (MW)	8,951	1,309	12,506
LDES (MW)	458	-	622
Total by Status (MW)	**32,378**	**3,112**	**41,673**

Remapping increased the number of constraint exceedances in both 2034 and 2039 modeling years. The final mapping of the base case portfolio results in 19 exceedances (on-peak, off-peak, or both)

in actual constraints and one exceedance in a default constraint for the 2034 model year, per Working Group staff calculations, and 23 actual and seven default exceedances in the 2039 model year. Table 49 shows the number of constraint exceedances by CAISO study area and whether the constraints exceeded are actual values or default values per the information provided in the CAISO 2023 White Paper. A calculated exceedance does not determine if the identified upgrade in the CAISO White Paper will necessarily occur; calculated exceedances only highlight locations of potential need for transmission upgrades within the CAISO system due to the mapped resources. Only full TPP analysis can assess what upgrades may be needed if at all.

Table 49: Number of transmission constraint exceedances by CAISO study for the final mapping results (2034 and 2039 portfolios).

Final Mapping Tx Constraint Exceedances	2034		2039	
	Actual	Default	Actual	Default
PG&E North of Greater Bay	3	0	5	0
PG&E Greater Bay	3	0	3	0
PG&E Fresno	5	0	6	1
PG&E Kern	2	0	2	0
SCE Northern Area	1	0	1	0
SCE Metro	0	0	0	0
SCE North of Lugo	0	0	0	0
East of Pisgah	1	0	1	1
SCE Eastern	0	1	1	2
SDG&E	4	0	4	3
Total	**19**	**1**	**23**	**7**

The table also does not reflect additional transmission upgrade needs beyond the current CAISO transmission system including upgrades or new transmission for out-of-CAISO resources to reach the CAISO system or new transmission likely needed to interconnect resources in new areas of California such as offshore wind. The final mapped resources' alignment with the transmission criteria and additional analysis of the calculated constraint exceedance are discussed further by CAISO study area below.

Northern California – PG&E North of Greater Bay and PG&E Greater Bay Study Areas

Most resources mapped to these two study areas in both the 2034 and 2039 model years are behind exceeded constraints, as seen in Table 50. In total, the remapping efforts resulted in six 2023 White Paper constraint exceedances between the two study areas in 2034, an increase of one from initial mapping results, and eight in 2039, an increase of three. For the final 2034 mapped portfolio, the North of Greater Bay and Greater Bay study areas have three constraint exceedances apiece, and in 2039 the North of Greater Bay sees two additional exceedances.

Table 50: Summary of mapped resources alignment with available transmission criteria in the PG&E Greater Bay and North of Greater Bay study areas.

PG&E Greater Bay and North of Greater Bay Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	112	112
Biomass (MW)	22	11	-	-	100	111
OnshoreWind (MW)	842	842	-	-	1,034	1,934
OOS Wind (MW)	-	-	-	-	-	1,500
Offshore Wind (MW)	-	-	-	-	931	1,607
Solar (MW)	449	1,459	-	297	322	551
Li_Battery (MW)	512	512	-	-	855	1,915
LDES (MW)	-	-	-	-	5	5
Total by Status (MW)	**1,825**	**2,823**	**-**	**297**	**3,359**	**7,735**

For the North of Greater Bay study area, both the Vaca Dixon-Tesla 500 kV Line and the Carberry-Round Mountain 230kV Line constraints have on-peak exceedances in the 2034 model year of similar magnitudes as was calculated in the initial results in Section 6.1.A. The third exceedance, in 2034, occurs in the Rocklin-Pleasant Grove 115kV Line constraint, which has a 2023 White Paper upgrade that provides at least 700 MW of additional capacity and costs an estimated $125 million. While small, approximately only 25 MW in 2034, the exceedance increases to 170 MW in 2039 with additional resources. With that level of exceedance, the upgrade is likely necessary and an effective solution to the exceedance.

As noted in Section 6.1.A, the 2034 exceedance level (~840 MW) in the Vaca Dixon-Tesla 500 kV Line constraint may require an upgrade; however, the identified 2023 White Paper upgrade is not a cost-effective upgrade solution for the amount mapped in 2034. With the significant number of additional resources mapped to the constraint in the 2039 model year, which increase the exceedance to ~2,350 MW, the large upgrade is an effective solution. If an upgrade is necessary, CAISO staff may want to consider less costly alternatives or identify a transmission solution that would also enable interconnection of the offshore wind remapped to the Humboldt area.

The final 2039 mapping resulted in two addition North of Greater Bay area exceedances: a 67 MW exceedance in the on-peak Woodland- Davis 115kV Line constraint, which also has a small exceedance in its default off-peak capability, and a 545 MW on-peak exceedance in the Bellota-Weber 230kV Line constraint. The two constraints have identified 2023 White Paper upgrades costing an estimated $9 million and $400 million respectively and are effective solutions for the resources mapped.

For the Greater Bay study area, the three constraints exceeded are the same as for the initial mapping results: the Windmaster-Delta pumps 230 kV Line, the Morganhill-Metcalf 115kV Line, and the Birds Landing-Contra Costa 230kV Line constraints. The remapping results in similar exceedance levels in 2034, which as discussed in Section 6.1.A are unlikely to require transmission upgrades but full TPP analysis is necessary to confirm. For the final 2039 mapping results, there is again an increase in the Birds Landing-Contra Costa 230kV Line constraint exceedance. The increase exceedance could require the identified 2023 White Paper upgrade costing an estimated $700 million to alleviate, which would be an effective solution in lieu of remapping the resources to other buses.

Beyond the 2023 White Paper constraints, the Humboldt offshore wind mapped to a proposed new 500 kV Humboldt substation would require a major new transmission upgrade in both the 2034 and 2039 portfolio. In the 2021-22 TPP offshore wind sensitivity, the CAISO identified three potential transmission solutions. The CAISO is again studying potential solutions for the Humboldt offshore wind included in the ongoing 2023-24 TPP base case portfolio. Although the $2.3 billion AC overlaid transmission line to Fern Road option is used as the upgrade option in the RESOLVE model and in busbar mapping analysis, it was selected as a placeholder upgrade and not intended to indicate a CPUC preferred upgrade option. CPUC staff note that the overland option to Fern Road has the potential to utilize any upgrade that is likely needed for the Vaca-Dixon-Tesla 500 kV line constraint noted above. The co-optimizing of upgrades could remove the need for a separate new transmission line in the Sacramento Valley, costing an estimated $1.1 billion, as identified in the 2021-22 TPP sensitivity study.

For the final 2039 portfolio, the North of Greater Bay study area includes 900 MWs of wind mapped to three substations in northeastern California outside of the existing CAISO balancing area and modeled as interconnecting along the Malin-Round Mountain system. As noted in Section 6.1.A, these resources would either need long gen-ties (>50 miles) to interconnect to the current CAISO system or to major new transmission line to connect the CAISO system to the NVE system in Northern California, which CPUC staff estimate could cost more than a billion dollars.

Finally, staff also remapped 1,500 MW of Wyoming wind as interconnecting at the Tesla 500 kV substation. Working Group staff aligned this mapping with a potential transmission solution identified in the CAISO's 20-year Transmission Outlook (2021-2022) with an estimate cost of $2.5 billion. This mapping reflects a diversification of the intertie points for OOS wind given the large amount of OOS wind in the portfolio mapped to CAISO intertie points in Southern California (over 7.5 GW interconnecting in the East of Pisgah and SCE Eastern study areas). CPUC staff note that this mapping merely reflects the high-level solution identified in the 20-year outlook and is not a mandate to assume this specific intertie.

Southern PG&E — PG&E Fresno and PG&E Kern Study Areas

Most resources mapped to the Fresno and Kern study areas in both the 2034 and 2039 model years are behind exceeded constraints, as shown in Table 51. Morro Bay offshore wind is the significant resource mapped to substations without any CAISO 2023 White Paper transmission constraint exceedances. In both the 2034 and 2039 model years, 2.9 GW of offshore wind mapped to the Morro Bay wind area is modeled as interconnecting to the existing Diablo Canyon 500 kV substation, with none being mapped to the proposed new Morro Bay 500 kV substations.

Table 51: Summary of mapped resources alignment with available transmission criteria in the PG&E Fresno and Kern study areas.

PG&E Fresno and Kern Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	-	-
Biomass (MW)	11	11	-	-	27	27
OnshoreWind (MW)	-	-	-	-	800	800
OOS Wind (MW)	-	-	-	-	-	-
Offshore Wind (MW)	2,924	2,924	-	-	-	-
Solar (MW)	676	820	6	6	4,820	8,716
Li_Battery (MW)	481	642	-	40	2,192	4,053
LDES (MW)	-	-	-	-	130	130
Total by Status (MW)	**4,092**	**4,397**	**6**	**46**	**7,969**	**13,726**

Remapping results have increased the number of exceedances in the Fresno study area from two to five in the 2034 model year and from five to seven in 2039. In the Kern study area, the updated mapping results in the same two exceedances area in 2034 and 2039 as discussed in Section 6.1.A.

The two Kern study area constraints: Oceano-Calendar 115kV Line and the Midway-Q2005 230kV Line constraints have on-peak and off-peak exceedances in 2034 and 2039. The initial mapping results did not capture the off-peak exceedances due to a dashboard calculation error. The exceedance magnitude in the Oceano-Calendar 115kV Line is comparable to the initial mapping results in both 2034 and 2039, while the exceedance in the Midway-Q2005 230kV Line constraint is larger than in the initial 2039 mapping, increasing to over 3,500 MW in 2039. The two constraints have significant off-peak exceedances by 2039 as well. For the 2034 mapping results, the exceedance in the Oceano-Calendar 115kV Line constraint may not trigger an upgrade. CPUC staff note the 23-24 TPP base case had a comparable exceedance and preliminary results presented in the CAISO's 23-24 TPP November 2023 Stakeholder Call indicate that an upgrade may not be necessary. However, given the number of resources mapped and significantly larger exceedances in 2039, both the Oceano-Calendar 115kV Line constraint and Midway-Q2005 230kV Line constraint 2023 White Paper upgrades will likely be triggered and are effective solutions to the exceedances.

The remapping for the 2034 model year results in three on-peak exceedances of actual constraints and two off-peak exceedances of actual constraints in the Fresno study area. In addition to the Chowchilla-Le grand 115kV Line and Schindler 115/70kV TB #1 constraints that were also exceeded in initial mapping, the third on-peak exceedance occurred in Gates 500/230kV TB #12 constraint, which has a 2023 White Paper upgrade costing $35 million and increasing the capacity by over 14,000 MW. The exceedances in Chowchilla-Le grand 115kV Line and Schindler 115/70kV TB #1 are 320 MW and 300 MW respectively. These exceedances are comparable to the initial mapping exceedances and, as discussed in Section 6.1.A, have a low likelihood of triggering the identified White Paper upgrades (an estimated $370 million upgrade providing over 3 GW of additional capacity for the Schindler 115/70kV TB #1 constraint and an estimated $550 million upgrade providing around 1.2 GW of additional capability for the Chowchilla-Le grand 115kV Line constraint). Similarly, the exceedance in the Gates 500/230 kV TB #12 constraint is small, only ~160 MW. Though the need for all three upgrades is likely low for the 2034 mapping results, all three exceedances increase significantly in the 2039 portfolio making all three upgrades effective

solutions if needed in 2034 as well.

The two 2034 Fresno area off-peak exceedances occur in the Moss Landing-Las Aguilas 230 kV Line (~590 MW) and the Panoche-Mendota 115 kV Line (~50 MW) constraints. Both these exceedances are less than calculated for the 23-24 TPP base case and the identified 2023 White Paper upgrades — an estimated $40 million upgrade providing 1,760 MW of off-peak capacity for the Moss Landing-Las Aguilas 230 kV Line and an estimated $370 million upgrade for Panoche-Mendota 115 kV Line, which is the same upgrade identified for the Schindler 115/70kV TB #1 constraint — may not be triggered in 2034. Both exceedances increase in the 2039 mapping results and would be cost effective upgrades particularly if the Panoche-Mendota 115 kV Line upgrade is needed for the on-peak exceedance in the Schindler 115/70kV TB #1 constraint.

Updated mapping results for 2039 in the Fresno area increases the exceedances in all five constraints identified for the 2034 mapping results and causes two additional on-peak exceedances in actual constraints. The Gates 500/230kV TB #11 constraint has an 1,860 MW exceedance which can be alleviated by the identified White paper upgrade that is the same upgrade as for the Gates 500/230kV TB #12 constraint, which in 2039 has a similar 1,880 MW exceedance. The second additional exceedance in the 2039 model year occurs in the Tranquility-Helm 230kV Line. The ~440 MW could be alleviated by the 2023 White Paper upgrade which costs an estimated $1.5 billion and increases capacity by more than 2,200 MW. Generally, given the significant number of resources mapped to the study area causing all six exceedances and the amounts of resources mapped to the area in the recent 2022-2023 CAISO 20-year transmission outlook, all the potential 2023 White Paper upgrades would be effective solutions.

The remapping further increases the on-peak default limit exceedance in the Moss Landing-Las Aguilas 230 kV Line constraint, which as discussed in Section 6.1.A has no identified upgrade and full TPP analysis is needed to determine if any upgrade would be need. Updated results also create an additional default limit exceedance for the off-peak capacity of the previously approved upgrade for the Los Banos 500/230 kV Bank constraint. The 177 MW exceedance is likely accommodated by the already approved upgrade, but full TPP analysis is necessary to confirm.

Greater Tehachapi & LA Metro — SCE Northern and SCE Metro Study Areas

As seen in Table 52, most resources in these two areas are mapped to substations with no constraint exceedances. In the remapping results, the only exceedance in the SCE Northern study area is again in the on-peak South of Magunden constraint in both 2034 and 2039 of ~600 MW. No exceedances were calculated for the SCE metro area study area. The final remapped portfolio has the same considerations of potential upgrades for the South of Magunden constraint and likelihood of triggering an upgrade as discussed in Section 6.1.A. If the mapping were to require either upgrade, CPUC staff view either upgrade as not effective for the resources alone and remapping of the generic resources would be a more effective alternative. However, CPUC staff noted Working Group feedback in Section 6.1.A that the identified upgrades have the potential to improve Path 26 congestion and provide benefits to other constraints. Those benefits are not fully known until the mapping results are studied in the TPP.

Table 52: Summary of mapped resources alignment with available transmission criteria in the SCE Northern and Metro study areas.

SCE Northern and Metro Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	-	-
Biomass (MW)	6	6	-	-	1	1
OnshoreWind (MW)	580	580	-	-	-	-
OOS Wind (MW)	-	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	-
Solar (MW)	3,110	4,482	-	-	208	208
Li_Battery (MW)	4,221	5,116	-	-	1,150	1,150
LDES (MW)	458	458	-	-	-	-
Total by Status (MW)	8,375	10,642	-	-	1,359	1,359

Greater Kramer — SCE North of Lugo Study Area

Table 53: Summary of mapped resources alignment with available transmission criteria in the SCE North of Lugo study area.

SCE North of Lugo Study Area	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	-	-
Biomass (MW)	2	2	-	-	-	-
OnshoreWind (MW)	360	360	-	-	-	-
OOS Wind (MW)	-	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	-
Solar (MW)	1,593	2,037	-	-	-	-
Li_Battery (MW)	806	1,011	-	-	-	-
LDES (MW)	-	-	-	-	-	-
Total by Status (MW)	2,761	3,410	-	-	-	-

As with the initial mapping, there are no calculated transmission exceedances in updated 2034 or 2039 mapping results (see Table 53). The 22-23 TPP authorized three upgrades in the North of Lugo study area and these upgrades can support the number of resources mapped to the area. Staff did not map significant amounts of resources to substations north of Kramer as the Control-Inyokern constraint is near its capability limit.

Southern Nevada & El Dorado — East of Pisgah Study Area

Remapping results in similar transmission exceedances in the East of Pisgah study area as observed in the initial mapping: one exceedance in 2034 and two exceedances in 2039. Table 54 shows that all the resources aside from energy only solar, which requires only off-peak deliverability, are behind the exceeded Lugo - Victorville Area constraint. The Lugo - Victorville Area constraint exceedance in

2034 increases slightly to 1,700 MW but decreases significantly to 4,100 MW in 2039. The significant changes in 2039 are primarily driven by decrease in out-of-state wind in the portfolio and the remapping of 1,500 MW of Wyoming wind to a new Northern California interconnection point discussed above in the Northern California areas discussion. As discussed in the initial transmission criteria alignment Section 6.1.A, the 2034 exceedance may not result in triggering the identified White Paper transmission upgrade based on a similar exceedance seen in the 23-24 TPP; however, the larger exceedance in the 2039 portfolio indicates that the upgrade is likely necessary.

Table 54: Summary of mapped resources alignment with available transmission criteria in the East of Pisgah study area.

East of Pisgah Study Area	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	875	875
Biomass (MW)	-	-	-	-	-	-
OnshoreWind (MW)	-	-	-	-	620	620
OOS Wind (MW)	-	-	-	-	3,965	4,060
Offshore Wind (MW)	-	-	-	-	-	-
Solar (MW)	1,565	3,030	-	-	1,075	1,200
Li_Battery (MW)	-	-	-	-	1,864	2,884
LDES (MW)	-	-	-	-	-	-
Total by Status (MW)	**1,565**	**3,030**	**-**	**-**	**8,399**	**9,639**

The on-peak default exceedance in the GLW 230kV Area Constraint increases to 570 MW with the remapping. This constraint has a default capacity value as it incorporates the estimate capacity increase of the approved 22-23 TPP upgrades. It is not known if additional upgrades will be required or if the already approved upgrade can accommodate the resources creating the exceedance. CPUC staff note the number of resources mapped within the constraint is comparable to the 22-23 TPP sensitivity portfolio and likely will not require further transmission upgrades but cannot be guaranteed without a full TPP analysis.

The updated mapping maintains 500 MW of Central Nevada geothermal interconnecting to the expanded Beatty substation. Though interconnecting directly with the CAISO system this configuration would likely still require long gen-ties (>50 miles) to interconnect the known geothermal areas in Central/Southern Nevada

The Working Group maintained the same CAISO intertie points for Idaho and Wyoming Wind as noted in Section 6.1.A, though staff did remap 1,500 MW of Wyoming wind away from the Harry Allen/Eldorado interties to a new Northern California interconnection point. Northern Nevada resources are still mapped as interconnecting into the CAISO at Eldorado – Harry Allen 500 kV tie-in points, while Utah geothermal remain modeled as interconnecting at the Eldorado 230 kV tie-in points. The busbar mapping Working Group assumes the Northern Nevada geothermal is likely to utilize either the NVE grid to reach the interties or capacity through the SWIP-North transmission line. The Utah geothermal mapping location identifies the likely location of Maximum Import Capability (MIC) expansion if such resources cannot utilize existing MIC capacities at the CAISO scheduling points around the Intermountain Power Plant (IPP) interties. Working Group staff note

that those IPP intertie points cannot readily be expanded so an alternative path to wheel to the Harry Allen/Eldorado interties is likely needed.

Riverside & Arizona — SCE Eastern Study Area

Table 55: Summary of mapped resources alignment with available transmission criteria in the SCE Eastern study area.

SCE Eastern Study Area	No Constraint		Default Constraint		Actual Constraint	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	790	790	-	-
Biomass (MW)	3	3	-	-	-	-
OnshoreWind (MW)	324	324	-	-	-	-
OOS Wind (MW)	-	-	-	-	2,131	3,536
Offshore Wind (MW)	-	-	-	-	-	-
Solar (MW)	3,349	4,624	110	710	-	500
Li_Battery (MW)	1,875	1,671	700	1,100	375	979
LDES (MW)	-	-	-	-	-	-
Total by Status (MW)	**5,551**	**6,622**	**1,600**	**2,600**	**2,506**	**5,015**

Remapping has resulted in a shift in the constraint exceedance in the SCE Eastern Study Area. The 2034 mapping still results in one exceedance in the default on-peak limit for the Devers-Red Bluff constraint. As seen in Table 55, the Imperial geothermal, significant amounts of storage, and OOS wind are behind this default exceedance. The New Mexico Wind is flagged as behind a constraint with an actual on-peak limit because those resources area also behind Lugo - Victorville Area constraint discussed above. In 2034 the exceedance in the Devers-Red Bluff constraint has increased to over 2,100 MW. As discussed in Section 6.1.A, this constraint limit incorporates the estimated capacity from a 22-23 TPP approved upgrade so staff do not know if the exceedances will trigger additional upgrades without performing the TPP analysis. The resource amounts mapped and the magnitude of the exceedance are comparable to the amounts for the constraint in the 23-24 TPP base case. Preliminary results for the 23-24 TPP indicate that an upgrade is not likely needed. In the 2039 portfolio, the exceedance increases to nearly 5,000 MW. As discussed in Section 6.1.A, CAISO staff feedback noted that an exceedance of this magnitude will likely require an additional upgrade.

Remapping in the 2039 portfolio, mostly the reduction of wind in Southern Nevada and the shifting of 1,500 MW of Wyoming wind to a new Northern California, eliminate the initial mapping's exceedance in the Serrano-Alberhill-Valley Constraint and significantly reduces the exceedance, down to only ~830 MW, in the Colorado River-Red Bluff constraint's default capability limit. This small exceedance in the default limit is likely to not require an additional upgrade as CAISO staff feedback noted the previously approved upgrade is likely able to accommodate smaller exceedances, though full TPP analysis is necessary to confirm. The 2039 updated mapping still results in a calculated exceedance in the on-peak Colorado River 500/230 kV Constraint by 220 MW, which would likely require the identified $67 million dollar CAISO's 2023 White Paper upgrade.

As previously discussed in Section 6.1.A, the Imperial geothermal resources interconnecting to the CAISO at the Mirage-Dever intertie would likely require transmission upgrades in the IID system.

Remapping decreased the amount the New Mexico wind mapped to the study area as interconnecting to the Palo Verde CAISO boundary intertie point (2,130 MW in 2034 and 3,500 MW in 2039). As discussed in the initial mapping results, Working Group staff assumed most of the wind will utilize the in development SunZia line per CAISO's 20-year transmission outlook (2021-2022) with a portion of the 2039 mapped amount requiring additional new transmission to reach Palo Verde.

San Diego & Greater Imperial — SDG&E Study Area

Table 56: Summary of mapped resources alignment with available transmission criteria in the SDG&E study area.

SDG&E Study Area	No Constraint		Default Constraint		Actual Constraint	
Transmission Criteria Alignment	2034	2039	2034	2039	2034	2039
Geothermal (MW)	-	-	-	-	160	160
Biomass (MW)	-	-	-	-	-	-
OnshoreWind (MW)	239	239	-	-	1,325	1,325
OOS Wind (MW)	-	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	-
Solar (MW)	882	1,219	-	-	701	701
Li_Battery (MW)	169	-	-	169	1,321	1,526
LDES (MW)	-	-	-	-	437	487
Total by Status (MW)	**1,290**	**1,458**	**-**	**169**	**3,944**	**4,199**

Updated busbar mapping in the SDG&E area results in four on-peak exceedances in 2034 portfolio and seven in the 2039 portfolio with the exceedance slightly increasing in magnitude as additional resources were mapped to the study area. These exceedances impact most resources mapped to the study area as seen in Table 56. The study area also includes 160 MW of geothermal mapped to IID and interconnecting to the CAISO at the Imperial Valley intertie.

The four constraints exceeded by the 2034 mapping are the on-peak actual constraints: Chicarita 138 kV, Silvergate - Bay Blvd 230 kV, Silvergate-Old Town 230 kV, and Talega 230 kV constraints identified in the initial mapping results. These exceedances have increased with the addition of more resources and now range between 300-600 MW in 2034 and 350-700 MW in the 2039 portfolio. The 2023 White Paper upgrades are likely needed as busbar Working Group feedback noted that even small exceedances in these constraints will likely trigger upgrades. The 2034 mapping also results in a small 11 MW exceedance in the default on-peak limit of the Encina - San Luis Rey 230 kV constraint, which has estimated capacity from a 22-23 TPP approved transmission upgraded included. Feedback from CAISO staff note that the already approved upgrade likely can accommodate the small exceedance and an additional upgrade is not necessary, though full TPP analysis is necessary to confirm.

The updated 2039 mapping results in same exceedances as in the initial mapping, with the three additional exceedances, compared with 2034, of default on-peak capability limits for the Internal San Diego Area, Encina - San Luis Rey 230 kV, and San Luis Rey-San Onofre 230 kV Line constraints. These three small default exceedances all are less than 300 MW, and all have previously approved 22-

23 TPP transmission upgrades. These small exceedances are not likely to trigger additional upgrades but cannot be guaranteed without a full TPP analysis.

6.3.B Final Substation Interconnection Viability Criteria Alignment

As noted above in Section 5, the busbar mapping Working Group only implemented some portions of the criteria analysis due to timing and staffing constraints. The analysis focused on approximate distances to interconnection based on land-use and environmental impact criteria analysis radii. Staff also incorporated the lists of substations with fault duty limitations and space limitation as identified in the PG&E Transmission Interconnection Handbook. For these substations, staff sought to not map resources amounts greater than what has already been studied in the CAISO and PG&E existing interconnection queues.

The final mapping criteria alignment for solar, in-state and in-CAISO wind, and in-state and in-CAISO geothermal resources for the distance from interconnection analysis is shown in the tables below. Table 57, Table 58, and Table 59 summarize the criteria alignment by RESOLVE resource area for the generic solar, wind, and geothermal resources mapped in the 2039 model year, respectively. The MW number of generic resources mapped in each region is shown by likely maximum distance from substation based on the land-use and environmental criteria analysis radii and by criteria alignment flag, which reflects that larger amounts of resources can economically be sited further from the substation.

Table 57: Final mapping results alignment with the distance to interconnection criteria for the generic solar in the 2039 portfolio. Table summarizes by RESOLVE resource area the likely maximum distance from transmission and the criteria alignment flag.

Interconnection Distance Criteria	Maximum Distance from Substation				Criteria Alignment Flag			
Solar Generic MWs Mapped (2039)	**5 mi**	**10 mi**	**15 mi**	**20 mi**	**1**	**2**	**3**	**4**
Northern California	215	1,645	230	-	1,115	745	230	-
Southern PG&E	1,097	5,239	1,147	-	5,089	2,047	347	-
Greater Tehachapi	205	1,828	1,587	-	1,683	1,937	-	-
Greater Kramer	515	21	663	279	515	21	663	279
Riverside	-	400	700	425	400	700	-	425
Arizona	400	3,025	-	-	3,425	-	-	-
Southern Nevada	1,060	2,710	-	-	3,230	540	-	-
Greater Imperial	-	434	-	-	-	434	-	-
Total Generic	**3,492**	**15,302**	**4,327**	**704**	**15,457**	**6,424**	**1,240**	**704**

As seen in Table 57, over 80% of the generic solar is mapped is mapped to substations where the resource potential likely to be utilized is within 10 miles of the interconnection point. Only solar mapped to two substations, Kramer in the Greater Kramer region and Red Bluff in the Riverside region, may require siting locations up to 20 miles from the substation. These resources received a -level-4 alignment flag as the amounts mapped to each bus are less than 400 MW. In the Greater Kramer region, the Pisgah and Coolwater substations have less than 400 MW of solar mapped to each, resulting in a level-3 alignment flag for the up to 15-mile radii needed. Similarly, solar mapped

to the Cortina substation in Northern CA and the Midway 115 kV bus in Southern PG&E have level-3 flags for the up to 15-mile radii. Several other buses with up to 15-mile distance receive level-2 alignment flags as more than 400 MW are mapped to those buses.

For onshore wind, the final mapping resulted in only two alignment flags higher than level-2 as seen in Table 58. The 200 MW of wind mapped to the Wilson substation in the Southern PG&E region likely requires wind areas up to 30 miles from the substation, but given the amount mapped results in a level-3 alignment flag. The 150 MW of wind mapped to a proposed new substation on the Lugo-Pisgah line, also receives a level-3 alignment flag for it's up to 20-mile maximum distance since the amount mapped is less than 200 MW. The 900 MW of wind mapped to three substations in northeastern California can likely be sited within 20 miles of those substations resulting in a level-2 flag since more than 200 MW is mapped to each substation; however, their distance from the existing CAISO system is significantly more as noted in Section 6.3.A and either require much longer gen-ties to reach the CAISO system or new transmission to interconnect the area to the CAISO. The analysis was not performed for out-of-state, out-of-CAISO resources including Wyoming, Idaho, and New Mexico wind.

Table 58: Final mapping results alignment with the distance to interconnection criteria for the generic onshore instate wind in the 2039 portfolio. Table summarizes by RESOLVE resource area the likely maximum distance from transmission and the criteria alignment flag.

Interconnection Distance Criteria	Maximum Distance from Substation				Criteria Alignment Flag			
In-State Wind Generic MWs Mapped (2039)	10 mi	15 mi	20 mi	30 mi	1	2	3	4
Northern California	438	1,437	900	-	438	2,337	-	-
Southern PG&E	-	600	-	200	-	600	200	-
Greater Tehachapi	456	124	-	-	456	124	-	-
Greater Kramer	-	210	150	-	-	210	150	-
Riverside	-	-	324	-	-	324	-	-
Southern Nevada	310	-	310	-	310	310	-	-
Greater Imperial	-	64	400	-	-	1,564	-	-
Total Generic	**1,204**	**2,435**	**2,084**	**200**	**1,204**	**5,469**	**350**	**-**

Table 59 shows distance analysis for in-state or in-CAISO geothermal. Out-of-state and out-of-CAISO Northern Nevada and Utah geothermal is not included. The geothermal mapped to the Geysers area in Northern California and the Salton Sea area in Imperial have level-1 or -2 alignment flags. The 500 MW of Central Nevada geothermal mapped as interconnecting to the Beatty substation in the Southern Nevada region has a level-4 flag as the distance from the known potential geothermal fields in Central Nevada are greater than 50 miles from the Beatty intertie.

Table 59: Final mapping results alignment with the distance to interconnection criteria for the generic in-state or in-CAISO geothermal in the 2039 portfolio. Table summarizes by RESOLVE resource area the likely maximum distance from transmission and the criteria alignment flag.

Interconnection Distance Criteria	Maximum Distance from Substation				Criteria Alignment Flag			
Geothermal Generic MWs Mapped (2039)	10 mi	15 mi	20 mi	>30 mi	1	2	3	4
Northern California	-	112	-	-	-	112	-	-
Southern Nevada	-	-	-	500	-	-	-	500
Greater Imperial	950	-	-	-	950	-	-	-
Total Generic	**950**	**112**	**-**	**500**	**950**	**112**	**-**	**500**

6.3.C Final Land-use Feasibility and Environmental Implications Criteria Alignment

The final mapping results have significant reductions in level-4 and -5 environmental flags for most areas. These changes are mostly driven by updates to the land-use and environmental mapping analysis and fixes to the datasets themselves discussed in Section 6.2.

Utility-Scale Solar

The general alignment with the land-use and environmental impacts criteria for the final solar mapping results 2039 portfolio is summarized in Table 60. The table summarizes by RESOLVE resource area the MW of solar mapped and their highest non-alignment flag for the various criteria. The first set of columns shows the amount of solar in each region and the amount of MWs at each level of alignment for the Core Land-use screen criteria, which uses either the CEC's Core Land-use Screen for instate resources and the WECC Data Layer for out-of-state solar resources. The second set of columns represents the same breakdown for the highest alignment flag amongst the environmental (conservation and biological) impacts criteria. Table 61 summarizes the net change in the criteria alignment. The reductions in leve-4 non-alignment in the Greater Kramer region and the level-5 non-alignment in the Riverside region are due to the fixes to the land-use and environmental screens rather than remapping of resources. Additionally, the updated 2039 portfolio has over 5,000 MW more solar than mapped in the initial results and staff mostly mapped these resources to locations with level-1 or -2 alignment, which is reflected in the increases in those columns.

Overall, as seen in Table 60, only two regions Northern California and Greater Kramer have solar with a level-4 alignment for the Core land-use screen criteria. The 400 MW of solar mapped to the Tesla 500 kV bus has the level-4 alignment flag in the Northern California area. In Greater Kramer, 33 MW of solar are mapped to the Kramer 115 kV bus resulting in a level-4 alignment, due to the small amount of lower implication land available near the substation. While the solar mapped to the Kramer 230 kV bus can be economically sited further from the substation in areas with more low implication land, the 33 MW will likely need to be located close to the substation. While there is significantly more lower implication land around Kramer than likely needed for 33 MW, the higher flag indicates the higher risk for impacts, particularly if any resources interconnecting to the 230 kV bus are also sited closer to the substation. The solar resources with level-3 alignment flags for the core land-use screen are mapped to El Dorado 230 kV, Gates 230 kV, Red Bluff 230 kV and 500 kV, and Vincent 230 kV. The area around El Dorado has limited land available for solar resources

resulted in the higher flag, while the remaining substation have over 1,000 MW mapped which utilizes over 50% of the lower implication area. The level-3 alignment environmental criteria flags for solar mapped to some substations in Northern California and SPG&E regions are driven by those substations having a large percentage of the area around the substation with high values for ACE Connectivity or ACE Irreplaceability; however, the amount of land likely needed to accommodate the mapped solar is still less than the amount of lower implications resource potential available.

Table 60: Summary of final solar mapping results alignment with the Core land-use screen and the environmental impacts criteria for the 2039 portfolio. Criteria alignment is summarized by category and RESOLVE resource area.

Final 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Environmental Criteria Alignment - Highest Flag			
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	1,830	-	400	-	1,463	767	-	-
Southern PG&E	8,141	1,545	-	-	8,871	815	-	-
Greater Tehachapi	3,584	1,067	-	-	4,651	-	-	-
Greater Kramer	1,977	-	33	-	1,977	33	-	-
Riverside	1,795	1,139	-	-	2,934	-	-	-
Arizona	4,275	-	-	-	N/A	N/A	N/A	N/A
Southern Nevada	3,770	300	-	-	N/A	N/A	N/A	N/A
Greater Imperial	544	-	-	-	544	-	-	-
Total:	**25,916**	**4,051**	**433**	**-**	**20,440**	**1,615**	**-**	**-**

Table 61: Net change in criteria compliance for key land-use implications and environmental impacts criteria between the initial and final mapping for the 2039 portfolio by RESOLVE resource area.

Change in Alignment Final - Initial	Core Land-use Screen Criteria Alignment				Environmental Criteria Alignment - Highest Flag			
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	1,265	(230)	-	-	1,035	(0)	-	-
Southern PG&E	3,097	(920)	-	-	2,136	41	-	-
Greater Tehachapi	770	(748)	-	-	1,837	(1,815)	-	-
Greater Kramer	961	(350)	(611)	-	961	(961)	-	-
Riverside	1,795	(257)	-	(1,114)	1,539	(1,114)	-	-
Arizona	175	-	-	-	N/A	N/A	N/A	N/A
Southern Nevada	1,230	-	-	-	N/A	N/A	N/A	N/A
Greater Imperial	362	-	-	-	362	-	-	-
Total:	**9,655**	**(2,505)**	**(611)**	**(1,114)**	**7,870**	**(3,849)**	**-**	**-**

Table 62 shows the final solar mapping results for the 2039 portfolio alignment with the other four land-use feasibility criteria: Parcelization, Fire threat, Cropland Index, and overdrafted groundwater basin.

Table 62: Summary of final solar mapping results alignment with the four other land-use implications and feasibility criteria. Criteria alignment is summarized by category and RESOLVE resource area.

Final 2039 Portfolio Mapping	Parcelization Criteria Alignment - Highest Flag				Fire Threat Criteria Alignment - Highest Flag			
Solar	1 or 2	3	4	5	1 or 2	3	4	5
Northern California	2,045	185	-	-	2,118	112	-	-
Southern PG&E	8,524	1,162	-	-	9,686	-	-	-
Greater Tehachapi	-	255	775	3,621	3,117	-	-	1,534
Greater Kramer	280	383	611	736	2,010	-	-	-
Riverside	2,534	-	-	400	2,934	-	-	-
Arizona	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Southern Nevada	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	182	362	-	-	362	182	-	-
Total:	**13,564**	**2,347**	**1,386**	**4,757**	**20,227**	**294**	**-**	**1,534**

Final 2039 Portfolio Mapping	Cropland Index Criteria Alignment - Highest Flag				Overdrafted Groundwater Basin	
Solar	1 or 2	3	4	5	In	Out
Northern California	1,735	495	-	-	185	2,045
Southern PG&E	8,029	1,657	-	-	8,946	740
Greater Tehachapi	4,651	-	-	-	255	4,396
Greater Kramer	2,010	-	-	-	-	2,010
Riverside	2,934	-	-	-	-	2,934
Arizona	N/A	N/A	N/A	N/A	N/A	N/A
Southern Nevada	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	544	-	-	-	-	544
Total:	**19,902**	**2,152**	**-**	**-**	**9,386**	**12,668**

Three regions have solar mapped to substations with high non-alignment flags for parcelization. The Riverside region has 400 MW mapped to the Dever substation with a level-5 alignment flag. In the Greater Tehachapi region, solar mapped to the Antelope, Vincent, and Windhub substations have level-5 flags and to the Whirlwind substation has a level-4 flag. In the Greater Kramer area, Calcite, Kramer, Roadway, and Victor substations all have level-4 or -5 flags. In both regions as discussed in Section 6.1.B, recent large-scale development of solar provides evidence that high-parcelization may not be a large barrier to development. The Antelope and Vincent substations also have level-5 alignment for fire threat reflecting these substations proximity to high fire-risk mountainous areas in southern California. While the likely areas of development are not within these areas directly, the resource's proximity and the substation's proximity are reflected in these criteria flags.

Onshore Wind

In addition to the remapping adjustments, three changes discussed in Section 6.2 significantly impacted the final mapping alignment for the wind resources with the land-use and environmental impacts criteria: 1) the fixes to the land-use and environmental datasets and analysis, 2) the reduction of onshore wind selected in the updated portfolio, and 3) the inclusion of analysis using the 20% CF threshold base layer. Table 63 summarizes the final mapping results for onshore in-CAISO wind and its alignment with the land-use and environmental criteria using the updated 20% CF threshold resource potential base layer. It also shows the change in compliance of mapped resources between

the initial results and these final mapping results. Table 64 shows the same summary for analysis with the updated datasets still using the 28% CF threshold base layer. This analysis only includes in-state wind and wind mapped to the CAISO system in southern Nevada. OOS wind on new transmission and wind mapped to Baja California, MX, is excluded due to lack of available data.

Table 63: (Top) Summary of onshore in-CAISO wind mapping results alignment with the land-use implications and environmental impacts criteria for the final 2039 portfolio using the updated 20% CF resource potential base layer. (Bottom) Change in criteria-alignment between the final mapping analysis and the initial results.

Onshore wind – land-use and environmental screens applied to a 20% capicty factor (CF) base potential layer

Final 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Onshore Wind	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	1,247	710	818	-	1,634	-	-	1,141	1,616	1,028	-	131
Southern PG&E	590	-	210	-	700	-	100	-	450	350	-	-
Greater Tehachapi	580	-	-	-	424	-	-	156	580	-	-	-
Greater Kramer	360	-	-	-	360	-	-	-	360	-	-	-
Riverside	-	324	-	-	-	-	-	324	324	-	-	-
Southern Nevada	620	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	64	-	400	-	-	-	-	464	464	-	-	-
Total:	**3,461**	**1,034**	**1,428**	**-**	**3,118**	**-**	**100**	**2,085**	**3,794**	**1,378**	**-**	**131**

Onshore wind – land-use and environmental screens applied to a 20% capicty factor (CF) base potential layer

Change in Alignment Final - Initial	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Onshore Wind	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	814	710	(727)	(901)	96	-	-	(200)	413	658	(200)	(975)
Southern PG&E	290	-	210	(350)	125	-	100	(75)	150	350	(75)	(275)
Greater Tehachapi	266	(500)	-	-	300	(500)	-	(34)	(234)	-	-	-
Greater Kramer	160	(300)	-	(150)	(290)	-	-	-	(140)	(150)	-	-
Riverside	-	324	-	(499)	-	-	-	(175)	324	-	(200)	(399)
Southern Nevada	(880)	(410)	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	4	-	400	(500)	-	(60)	-	(36)	404	(500)	-	-
Total:	**654**	**(176)**	**(117)**	**(2,400)**	**231**	**(560)**	**100**	**(520)**	**917**	**358**	**(475)**	**(1,649)**

As seen in Table 63, wind mapped to several stations in Northern California (Tesla, Birds Landing, and Eagle Rock), on substation in Southern PG&E (Caliente) and one substation in Greater Imperial (proposed sub on the Suncrest-Ocotillo line) have level-4 nonalignment flags for the CEC Core land-use screen indicated the amount of wind mapped could utilize all of the lower implication resource potential and may impact some of the higher implication land. With the higher CF threshold (Table 64), the reduced available wind potential results in additional substations having a level-4 or -5 non-alignment flag: Round Mountain and a proposed new substation on the Pit 1-Cottonwood line in Northern California, Los Banos and Templeton in Southern PG&E, and Devers in Riverside.

Table 64: (Top) Summary of onshore in-CAISO wind mapping results alignment with the land-use implications and environmental impacts criteria for the final 2039 portfolio using the updated 28% CF resource potential base layer. (Bottom) Change in criteria-alignment between the final mapping analysis and the initial results.

Onshore wind – land-use and environmental screens applied to a 28% capicty factor (CF) base potential layer

Final 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Onshore Wind	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	634	613	920	608	1,434	-	-	1,341	1,253	914	-	608
Southern PG&E	350	-	140	310	700	-	-	100	350	-	240	210
Greater Tehachapi	580	-	-	-	424	-	-	156	580	-	-	-
Greater Kramer	210	150	-	-	360	-	-	-	360	-	-	-
Riverside	-	-	324	-	-	-	324	-	-	324	-	-
Southern Nevada	620	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	64	-	400	-	-	-	-	464	64	400	-	-
Total:	**2,458**	**763**	**1,784**	**918**	**2,918**	**-**	**324**	**2,061**	**2,607**	**1,638**	**240**	**818**

Onshore wind – land-use and environmental screens applied to a 28% capicty factor (CF) base potential layer

Change in Alignment Final - Initial	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Onshore Wind	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
Northern California	201	613	(625)	(293)	(104)	-	-	0	50	544	(200)	(498)
Southern PG&E	50	-	140	(40)	125	-	-	25	50	-	165	(65)
Greater Tehachapi	266	(500)	-	-	300	(500)	-	(34)	(234)	-	-	-
Greater Kramer	10	(150)	-	(150)	(290)	-	-	-	(140)	(150)	-	-
Riverside	-	-	324	(499)	-	-	324	(499)	-	324	(200)	(399)
Southern Nevada	(880)	(410)	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater Imperial	4	-	400	(500)	-	(60)	-	(36)	4	(100)	-	-
Total:	**(349)**	**(447)**	**239**	**(1,482)**	**31**	**(560)**	**324**	**(544)**	**(270)**	**618**	**(235)**	**(962)**

Over 40% of the wind mapped to Northern California has a level-5 non-alignment flag for fire threat (Eagle Rock, Round Mountain, a proposed new substation on the Pit 1-Cottonwood line, and the two substations in eastern Lassen County). The other mapping locations for wind with level-5 alignment are ECO and the new Suncrest-Ocotillo line substation in Greater Imperial, Devers in Riverside, and Antelope in Greater Tehachapi. In both CF threshold analyses, most of the mapped wind has good alignment with the environmental impact criteria. Under the expanded 20% CF resource baseline analysis only the wind mapped to the Eagle Rock substation in Northern California has a high nonalignment flag. The flag is due to a combination of the ACE Connectivity, Biodiversity, and Irreplaceability factors. Using the 28% CF base layer, several substations (Caliente, Los Banos, and Templeton in SPG&E and Tesla in Northern California) have high environmental non-alignments because these substations have very little resource potential available under the 28% CF threshold.

Geothermal

Table 65 depicts a summary of the updated 2039 portfolio's mapped geothermal resources alignment with the land-use implications and environmental impacts criteria. Again, the analysis is for geothermal resources mapped to known geothermal areas in California only. For the geothermal mapping, the only level-5 flags are for the 144 MW of resources mapped to the Geysers area for the fire threat criteria.

Table 65: Summary of final in-state geothermal mapping results alignment with the land-use implications and environmental impacts criteria for the 2039 portfolio. Criteria alignment summarized by category and RESOLVE resource area.

Final 2039 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Environmental Criteria Alignment - Highest Flag			
Geothermal	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
Gesyers	144	-	-	-	-	-	-	144	-	144	-	-
Salton Sea	850	-	-	-	850	-	-	-	850	-	-	-
East Brawley	100	-	-	-	100	-	-	-	100	-	-	-
Total (MW):	1,094	-	-	-	950	-	-	144	950	144	-	-

6.3.D Final Community and Societal Environmental Impacts Criteria Alignment

The final alignment of mapped resources in the updated portfolio with the community and societal environmental impacts criteria is shown for both the 2034 and 2039 model years in Table 66 and Table 67. In the 2034 mapping, approximately 45% of generation MWs and 65% of storage MWs are mapped in or within 5 miles of a disadvantaged community. In the 2039 mapping, those percentages increase to 50% and 75% respectively. In both model years, 45% of mapped generation and 50% of mapped storage is in an Inflation Reduction Act Energy Community area, while the final mapping result in 55% of generation and 71% of storage being located in an air quality non-attainment area.

Table 67 shows the change between the initial and final mapping for the 2039 portfolio in the amount of generation and storage aligning with the criteria. Corresponding to the increase in battery storage in the updated portfolio, battery storage amounts aligned within all four criteria increased overall. In total, the updated portfolio includes roughly 1,500 MW more battery storage than the initial portfolio and in total the amount of storage mapped near disadvantaged communities increased by comparable amount. Similarly, remapping the updated portfolio resulted in significant increases in the amount of generation mapped to locations in air quality non-attainment areas and near disadvantaged communities. Generation amounts near former and existing fossil fuel plants and in IRA energy communities were reduced in the Fresno and SDG&E studies due to the relocation of offshore wind from Morro Bay to Humboldt and the reduction of onshore wind mapped to substations in the SDG&E study area.

Table 66: Summary of final mapping results (2034 portfolio) alignment with the community environmental impacts criteria. Table summarizes the mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area.

Final 2034 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Near Existing Gas plant (<1 mile)		In IRA Energy Community		In or near (<5 mi) DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	471	181	745	170	222	38	546	77
PG&E Greater Bay	829	776	215	561	810	176	714	426
PG&E Fresno	3,906	1,697	2,197	1,377	-	32	7,790	3,362
PG&E Kern	2,156	834	3,048	-	5,187	824	3,695	1,577
SCE Northern Area	3,871	3,797	2,379	1,067	3,869	3,642	2,227	1,445
SCE Metro	33	1,962	31	1,485	33	1,382	34	2,830
SCE North of Lugo	1,803	806	562	110	1,179	496	1,008	330
East of Pisgah	-	-	700	500	3,150	1,385	-	200
SCE Eastern	3,797	1,305	724	990	1,503	850	5	1,335
SDG&E	1,706	1,217	1,346	217	-	250	720	467
Total	**18,571**	**12,575**	**11,947**	**6,477**	**15,952**	**9,076**	**16,739**	**12,049**

Table 67: Summary of final mapping results (2039 portfolio) alignment with the community environmental impacts criteria. Table summarizes the mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area.

Final 2039 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Thermal Plant (<1 mile)		In IRA Energy Community		In or near (<5 mi) DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	1,221	456	1,335	435	877	273	926	197
PG&E Greater Bay	2,914	886	215	1,111	2,895	236	2,984	1,046
PG&E Fresno	6,241	2,739	3,467	2,049	-	32	12,461	5,446
PG&E Kern	3,271	1,329	3,148	38	6,302	1,319	5,285	2,382
SCE Northern Area	5,236	4,362	3,091	1,422	5,234	4,207	2,727	1,695
SCE Metro	40	2,292	31	1,615	40	1,712	48	3,440
SCE North of Lugo	2,247	1,011	693	170	1,492	641	1,699	620
East of Pisgah	190	79	700	500	4,580	2,104	-	200
SCE Eastern	5,352	1,405	724	990	2,603	1,150	5	1,335
SDG&E	1,868	1,422	1,346	309	-	250	1,044	593
Total	**28,579**	**15,980**	**14,750**	**8,639**	**24,022**	**11,924**	**27,179**	**16,954**

Table 68: Change in mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area between the initial and final mapping results for the 2039 portflio.

2039 Portfolio Mapping Difference: Final – Initial	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Thermal Plant (<1 mile)		In IRA Energy Community		In or near (<5 mi) DAC	
MWs Difference	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	743	275	492	145	654	235	366	120
PG&E Greater Bay	1,585	10	(3)	150	1,590	60	1,767	220
PG&E Fresno	1,815	496	417	142	-	-	3,630	992
PG&E Kern	409	45	(1,582)	(12)	(1,172)	45	728	45
SCE Northern Area	(212)	(23)	238	50	(212)	(23)	22	-
SCE Metro	-	-	-	-	-	-	-	-
SCE North of Lugo	(290)	-	10	-	(290)	-	(590)	-
East of Pisgah	190	79	(700)	-	40	319	-	-
SCE Eastern	(789)	-	325	-	-	-	(200)	-
SDG&E	(724)	51	(1,196)	-	-	-	944	126
Total	**2,727**	**933**	**(1,998)**	**475**	**610**	**636**	**6,667**	**1,503**

The analysis for the updated biomass mapping is shown in Table 69. Overall staff remapped roughly half of the generic biomass resources initially mapped to substations in or near disadvantaged communities to alternative substations.

Table 69: Mapping of biomass resources' alignment with proximity to disadvantaged communities and change between initial and final mapping results.

Biomass/gas in 2034 & 2039 Final Portfolio	>5 mi from DAC	<5 miles from DAC	in DAC
In-Development (MW)	6.0	10.6	5.6
Generic (MW)	135.5	6.3	7.0
Total (MW)	**141.5**	**16.9**	**12.6**
Change from Initial	12.2	(7.7)	(4.6)

6.3.E Final Commercial Development Interest Criteria Alignment

Table 70 and Table 71 summarize the final mapping results for both model years compared to identified commercial development interest by CAISO study area. Table 70 shows the mapped generic resources in the four PG&E study areas compared to the amount of commercial interest by confidence category. Table 71 shows the same comparison for the six study areas in the southern part of CAISO.

Table 70: Comparison of final mapping results (2034 and 2039 model years) to identified commercial interest by CAISO study area and resource type for the PG&E study areas.

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E North of Greater Bay	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**	**PG&E Greater Bay**	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	112	112	-	-	32	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	92	92	-	12	22	Biomass (MW)	20	20	-	-	-
OnshoreWind (MW)	1,097	1,997	201	416	1,667	OnshoreWind (MW)	778	778	208	787	1,187
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	1,500	-	-	-
Offshore Wind (MW)	931	1,607	-	162	2,462	Offshore Wind (MW)	-	-	-	-	3,825
Distrib. Solar (MW)	24	24	-	29	30	Distrib. Solar (MW)	26	26		27	55
Solar (MW)	555	1,505	105	1,076	7,028	Solar (MW)	-	585	-	453	2,705
Li_Battery (MW)	288	888	308	1,938	17,551	Li_Battery (MW)	870	1,530	1,903	3,245	21,656
LDES (MW)	5	5	-	-	567	LDES (MW)	-	-	-	-	-
Total (MW)	**3,104**	**6,230**	**613**	**3,633**	**29,359**	**Total (MW)**	**1,694**	**4,439**	**2,111**	**4,512**	**29,428**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E Fresno	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**	**PG&E Kern**	**Generic (2034)**	**Generic (2039)**	**TPD**	**High Confi-dence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	17	17	-	5	10	Biomass (MW)	18	18	-	5	17
OnshoreWind (MW)	490	490	60	64	264	OnshoreWind (MW)	310	310	-	210	210
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	2,924	2,924	1,000	1,029	11,491
Distrib. Solar (MW)	40	40	-	42	49	Distrib. Solar (MW)	41	40	-	45	53
Solar (MW)	1,933	5,019	451	1,995	32,403	Solar (MW)	1,509	2,624	206	2,351	7,399
Li_Battery (MW)	300	1,817	1,556	1,976	44,661	Li_Battery (MW)	732	1,227	1,286	2,681	13,228
LDES (MW)	130	130	-	-	114	LDES (MW)	-	-	465	500	500
Total (MW)	**2,911**	**7,513**	**2,068**	**4,082**	**77,501**	**Total (MW)**	**5,534**	**7,143**	**2,957**	**6,821**	**32,898**

Table 71: Comparison of final mapping results (2034 and 2039 model years) to identified commercial interest by CAISO study area and resource type for the CAISO southern area study areas.

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
SCE Northern Area	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest	SCE Metro	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest
Geothermal (MW)	-	-	-	-	-	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	1	1	-	-	-	Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	580	580	100	124	229	OnshoreWind (MW)	-	-	-	-	-
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	2,300	Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	9	Distrib. Solar (MW)	-	7	-	4	17
Solar (MW)	2,255	3,620	1,191	3,418	8,327	Solar (MW)	-	-	-	-	-
Li_Battery (MW)	1,170	1,734	3,799	5,248	26,376	Li_Battery (MW)	1,067	1,397	1,000	1,080	24,327
LDES (MW)	258	258	300	300	800	LDES (MW)	-	-	-	-	-
Total (MW)	**4,264**	**6,193**	**5,390**	**9,090**	**38,041**	**Total (MW)**	**1,067**	**1,404**	**1,000**	**1,084**	**24,344**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
SCE North of Lugo	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest	East of Pisgah	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest
Geothermal (MW)	-	-	-	-	5	Geothermal (MW)	849	849	-	-	1,007
Biomass (MW)	2	2	-	-	-	Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	360	360	-	212	462	OnshoreWind (MW)	620	620	62	310	1,418
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	3,965	4,060	-	-	9,728
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	8	24	-	13	44	Distrib. Solar (MW)	-	-		-	-
Solar (MW)	1,050	1,478	213	1,019	9,287	Solar (MW)	2,180	3,770	741	3,765	22,360
Li_Battery (MW)	445	650	476	1,075	18,487	Li_Battery (MW)	1,240	2,259	3,643	3,729	27,994
LDES (MW)	-	-	-	-	-	LDES (MW)	-	-	-	-	-
Total (MW)	**1,865**	**2,514**	**689**	**2,319**	**28,285**	**Total (MW)**	**8,854**	**11,558**	**4,446**	**7,804**	**62,507**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
SCE Eastern	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest	SDG&E	Generic (2034)	Generic (2039)	TPD	High Confi-dence	All Queue Interest
Geothermal (MW)	790	790	-	-	871	Geothermal (MW)	160	160	-	-	83
Biomass (MW)	-	-	-	-	-	Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	324	324	-	297	998	OnshoreWind (MW)	1,564	1,564	1	2,117	4,463
OOS Wind (MW)	2,131	3,536	-	-	3,000	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	3	8	Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	1,700	4,075	100	6,075	23,267	Solar (MW)	972	1,309	498	3,225	11,984
Li_Battery (MW)	695	1,495	1,299	7,111	38,518	Li_Battery (MW)	390	595	435	4,698	22,686
LDES (MW)	-	-	500	1,900	1,900	LDES (MW)	437	487	-	-	-
Total (MW)	**5,640**	**10,220**	**1,899**	**15,386**	**68,562**	**Total (MW)**	**3,523**	**4,115**	**933**	**10,040**	**39,216**

Generally, the mapping adjustments made for the updated portfolio improved alignment with commercial interest. As seen in Table 72, staff reduced the number of substations where the mapped amount exceed total commercial interest, the number of substations with more commercial interest with TPD or an executed interconnection agreement than amount mapped, and the number of substations with more overall commercial interest that amount mapped. These improvements were primarily driven by the increase of solar and storage in the updated portfolio, which enabled staff to map those additional resources to substations with identify solar and storage commercial interest. In contrast, the reduction of onshore wind in the portfolio resulted in three more substations substation with more commercial wind interest than mapped.

Table 72: Change in number of substations with non-alignment flags between initial and final mapping by resource type.

2039 Final - Initial Difference Change in number of Flags	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
Geothermal	0	0	0	0	0
Biomass	-1	0	0	0	0
Onshore Wind	1	-4	1	0	2
Distributed Solar	0	0	-6	0	1
Solar	-2	14	-11	0	-9
Battery Storage	-2	9	-11	0	-4
Total	**-4**	**19**	**-27**	**0**	**-10**

Table 73, Table 74, and Table 75 summarize the remaining substations with non-alignment flags following the remapping adjustments. The tables show both the number of substations where the amount mapped exceeds the various categories of commercials and the number of substations where the commercial interest exceeds the amount mapped. Table 73 has the analysis for the final utility-scale solar and battery storage; Table 74 has it for onshore, in-CAISO wind and geothermal; and Table 75 has it for biomass and community-scale distributed solar.

Biomass and geothermal mapping results have a significant number of flags for mapped amounts exceeding the total commercial interest. Staff mapped biomass to many substations with no commercial interest. The key driver behind these flags is that there are very few biomass and geothermal projects in the interconnection queues. The updating biomass mapping analysis results in one substation (Borden 230 kV) that has more commercial interest than mapped. Staff limited mapping to align with this biomass interest because the substation is in a disadvantaged community.

For solar and battery storage, remapping eliminated locations where the resources mapped exceeded the total amount of commercial interest a seen in Table 73. Even though the updated portfolio includes more of both resources in 2039, 16 substations still had more higher-confidence commercial interest than mapped for solar and 71 substations for battery storage. For battery storage, a key factor driving the number of flags for more commercial interest is that there are more than 6,000 MW of higher-confidence battery storage than the amount of battery storage included in the 2039 portfolio. Furthermore, while a substation may have higher-confidence commercial interest, it may also have poor alignment with the other mapping criteria. Additionally, in locations where the storage commercial interest was co-located with solar interest, the Working Group factored in the solar mapping alignment as well. The Mohave substation, for example, has a large amount of high confidence storage with TPD co-located with solar. The recent creation of the Avi Kwa Ame National Monument significantly reduced the available solar resource potential around Mohave substation, so staff have mapped less resources overall to the substation.

Table 73: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2039 portfolio mapping results of solar and battery storage resources.

Substations with Commercial Develop Interest Criteria Flags										
	Solar					Battery Storage				
2039 Final Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	0	2	0	0	14	0	2	8	5	19
PG&E Greater Bay	0	1	0	4	9	0	2	10	2	32
PG&E Fresno	0	12	0	0	12	0	6	4	0	24
PG&E Kern	0	2	1	0	9	0	2	3	4	13
SCE Northern Area	0	3	0	2	3	0	0	11	0	8
SCE Metro	0	0	0	0	0	0	3	0	0	21
SCE North of Lugo	0	4	1	0	4	0	3	3	1	7
East of Pisgah	0	5	0	1	6	0	4	3	0	10
SCE Eastern	0	0	4	1	7	0	0	7	0	9
SDG&E	0	0	0	2	3	0	0	5	5	16
Total	0	29	6	10	67	0	22	54	17	159

Table 74: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2039 portfolio mapping results of onshore wind and geothermal resources.

Substations with Commercial Develop Interest Criteria Flags										
	Onshore Wind					Geothermal				
2039 Final Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	4	3	0	0	0	2	1	0	0	0
PG&E Greater Bay	1	0	1	0	1	0	0	0	0	0
PG&E Fresno	2	1	0	0	0	0	0	0	0	0
PG&E Kern	1	0	0	0	0	0	0	0	0	0
SCE Northern Area	3	0	0	0	0	0	0	0	0	0
SCE Metro	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	0	1	0	0	0	0	0	0	0	1
East of Pisgah	0	1	0	0	1	1	2	0	0	0
SCE Eastern	0	0	0	0	2	0	1	0	0	0
SDG&E	0	0	0	0	0	1	0	0	0	0
Total	11	6	1	0	4	4	4	0	0	1

Table 75: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2039 portfolio mapping results of biomass and distributed solar resources.

Substations with Commercial Develop Interest Criteria Flags										
	Biomass					Distributed Solar				
2039 Final Mapping Results Number of Substations by Area	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)	Exceeds Total CI (Flag: 4- or 5-)	Exceeds Higher Confidence CI (Flag: 3-)	More Executed IA or TPD CI (3+ or 4+)	More higher confidence CI (2+)	More total CI (1+)
PG&E North of Greater Bay	15	1	0	0	0	0	0	3	0	1
PG&E Greater Bay	7	0	0	0	0	0	0	2	0	7
PG&E Fresno	3	1	1	0	0	0	1	2	0	1
PG&E Kern	2	1	0	0	0	0	0	3	0	1
SCE Northern Area	1	0	0	0	0	0	0	0	0	3
SCE Metro	0	0	0	0	0	0	1	2	0	5
SCE North of Lugo	1	0	0	0	0	0	1	1	0	4
East of Pisgah	0	0	0	0	0	0	0	0	0	0
SCE Eastern	0	0	0	0	0	0	0	1	0	1
SDG&E	0	0	0	0	0	0	0	0	0	0
Total	29	3	1	0	0	0	3	14	0	23

For solar, on the other hand, the amount mapped is greater than the amount of higher-confidence commercial interest. The alignment flags for these 16 subs are driven by the mapping alignment with the other criteria mostly either land-use criteria or transmission capacity availability. Additional solar was not mapped to Colorado River, Midway, Mohave, Red Bluff, and Taft to avoid increasing land-use or environmental criteria non-alignment, while additional solar was not mapped to Vestal, Inyokern, or Pastoria to limit additional transmission exceedances. Finally, a few substations including Hoodoo Wash and Cielo Azul already have over 1,000 MW mapped to each of them, and staff sought to increase location diversity and limit potential interconnection complexity at these substations.

For the updated 2039 portfolio results, onshore wind is mapped 11 substations where the amount mapped exceeds total commercial interest include several substations with no commercial interest. Compared to solar and storage there is significantly less wind in the identified queues. The remapping results in one (Tesla 500 kV) substation with a non-alignment flag for more higher-confidence wind commercial interest than mapped and four substations with higher total commercial interest than mapped. Additional wind was not mapped to Tesla due to limited resource potential and high environmental impact implications as noted in Section 6.3.C. The four substations with the 1+ flags for wind, Devers 500 kV, El Casco, Metcalf, and Mohave all have identified commercial interest from the Cluster 15 application list and generally higher potential environmental impacts.

6.3.F Final Prior TPP Base Case Criteria Alignment

The final mapping results for both 2034 and 2039 are compared to the previous 23-24 TPP base case portfolio summarized by resource type in Table 76 . The 23-24 TPP portfolio resource amounts have again been updated removing resources in the updated IRP baseline. With the changes incorporated in the update portfolio, solar resources in the portfolio have increased though the total solar amounts are still less than the amount mapped in the 23-24 TPP. Thus, several substations still have significant non-alignment flags for mapped solar amounts.

Table 76: Comparison of initial mapping portfolio to the 23-24 TPP base case (adjusted to exclude resources now in baseline) by resource type.

Final Mapping Compared to Previous Base Case	Total Resources (2034)	Total Resources (2039)	23-24 TPP* (2035)
Geothermal (MW)	1,969.0	1,969.0	1,740.0
Biomass (MW)	171.0	171.0	127.4
OnshoreWind (MW)	6,123.0	7,023.4	2,261.4
OOS Wind (MW)	6,095.6	9,095.6	4,828.0
Offshore Wind (MW)	3,855.0	4,531.0	4,707.0
Solar (MW)	18,988.5	30,682.0	32,930.1
Li_Battery (MW)	16,575.9	22,821.5	19,917.7
LDES (MW)	1,030.0	1,080.0	2,000.0
Total (MW)	**54,808**	**77,374**	**68,512**

*Subtracting resources now in updated IRP baseline

Figure 13 and Figure 14 compare the final mapping results for 2034 and 2039 model years respectively to the 23-24 TPP base case portfolio, summarizing the number of resources mapped to each CAISO study area. With the mapping adjustments noted in Section 6.2.C, only two areas (SCE Northern and SCE Eastern) shown in Figure 13 have significantly fewer resources. Those differences are driven by less solar and storage mapped to both areas as the 2034 portfolio still has significantly less solar than the previous 23-24 TPP base case. By 2039, the final mapping results all areas have more, or a similar number of total resources mapped as seen in Figure 14. The SCE Northern area still has fewer overall resources compared to the 23-24 TPP base case mapping results, with less solar mapped to the area. The SCE Eastern area also still has less solar mapped, but it has been offset by an increase in mapped OOS wind interconnecting to the area. In contrast, the PG&E Fresno study area has more solar and storage mapped to it than the 23-24 TPP did. The increase in solar and storage resources in the area is driven by the better alignment for land-use screens and higher confidence commercial interest for substations in the area compared to the SCE Northern and Eastern areas. Additionally in both SCE Northern and Eastern areas, the updated commercial interest analysis showed generally less higher confidence commercial interest as staff more accurately reflected already online and in-development resources to limit double counting. Table 77 shows the comparison between the final mapping results and 23-24 TPP base case by CAISO study area in table form.

Figure 13: Comparison of the final 2034 mapped portfolio to the 23-24 TPP portfolio by CAISO study area. For each study area the left column represents the resources, by type, mapped to the study area for the initial mapping results and the right columns.

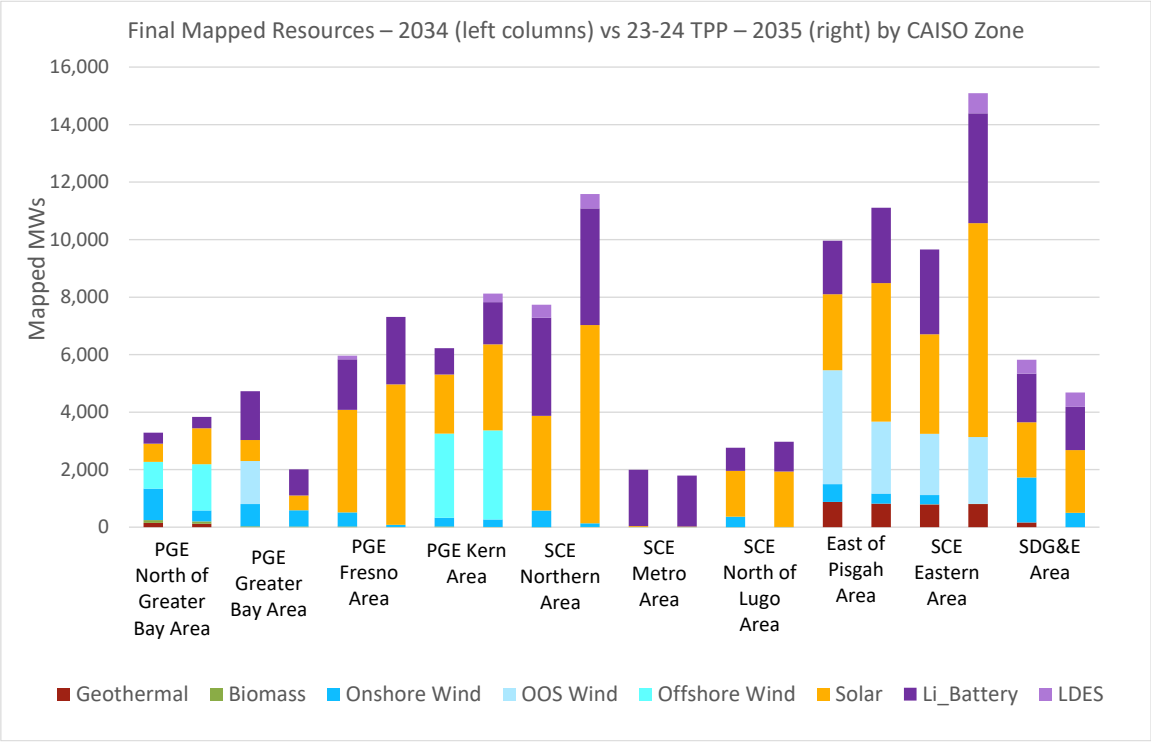


Figure 14: Comparison of the final 2039 mapped resource to the 23-24 TPP portfolio by CAISO study area.

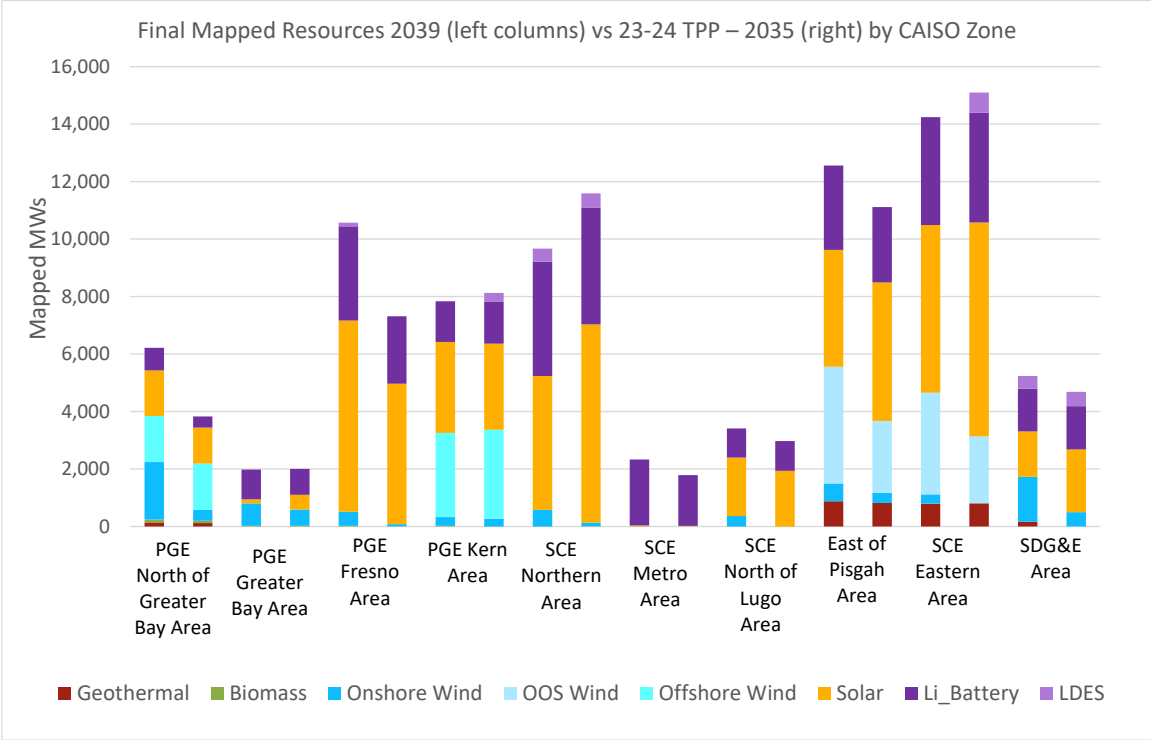


Table 77: Comparison of final mapping results for the 2034 and 2039 model years to the 23-24 TPP portfolio by CAISO study area and resource type.

Final Mapping Results Compared to 23-24 TPP Base Case by CAISO Study Area									
CAISO Study Area	**Resource Type**	**Total Res (2034)**	**Total Res (2039)**	**23-24 TPP (2035)**	**CAISO Study Area**	**Resource Type**	**Total Res (2034)**	**Total Res (2039)**	**23-24 TPP (2035)**
PG&E North of Greater Bay	Geothermal (MW)	144.0	144.0	118.2	**PG&E Fresno**	Geothermal (MW)	-	-	-
	Biomass (MW)	97.5	97.5	80.0		Biomass (MW)	20.2	20.2	7.6
	OnshoreWind (MW)	1,097.0	1,997.4	383.5		OnshoreWind (MW)	490.0	490.0	73.6
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	931.0	1,607.0	1,607.0		Offshore Wind (MW)	-	-	-
	Solar (MW)	631.2	1,581.2	1,249.1		Solar (MW)	3,571.1	6,656.3	4,885.1
	Li_Battery (MW)	381.9	781.9	392.7		Li_Battery (MW)	1,754.2	3,271.2	2,345.3
	LDES (MW)	5.0	5.0	-		LDES (MW)	130.0	130.0	-
	Zone Total (MW)	**3,288**	**6,214**	**3,830**		**Zone Total (MW)**	**5,966**	**10,568**	**7,312**
PG&E Greater Bay	Geothermal (MW)	-	-	-	**PG&E Kern**	Geothermal (MW)	-	-	-
	Biomass (MW)	24.6	24.6	22.4		Biomass (MW)	18.0	18.0	2.0
	OnshoreWind (MW)	778.0	778.0	566.8		OnshoreWind (MW)	310.0	310.0	262.6
	OOS Wind (MW)	-	1,500.0	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	2,924.0	2,924.0	3,100.0
	Solar (MW)	140.3	725.3	511.7		Solar (MW)	2,053.6	3,168.6	2,993.1
	Li_Battery (MW)	1,040.4	1,700.4	905.3		Li_Battery (MW)	918.8	1,413.8	1,467.6
	LDES (MW)	-	-	-		LDES (MW)	-	-	300.0
	Zone Total (MW)	**1,983**	**4,728**	**2,006**		**Zone Total (MW)**	**6,224**	**7,834**	**8,125**
SCE Northern Area	Geothermal (MW)	-	-	-	**East of Pisgah**	Geothermal (MW)	875.0	875.0	816.8
	Biomass (MW)	1.0	1.0	6.4		Biomass (MW)	-	-	-
	OnshoreWind (MW)	580.0	580.0	126.9		OnshoreWind (MW)	620.0	620.0	353.0
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	3,964.8	4,060.0	2,500.0
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	3,291.0	4,656.3	6,894.2		Solar (MW)	2,640.0	4,070.0	4,818.0
	Li_Battery (MW)	3,409.4	3,973.9	4,057.7		Li_Battery (MW)	1,864.0	2,933.1	2,624.0
	LDES (MW)	458.0	458.0	500.0		LDES (MW)	-	-	-
	Zone Total (MW)	**7,739**	**9,669**	**11,585**		**Zone Total (MW)**	**9,964**	**12,558**	**11,112**
SCE Metro	Geothermal (MW)	-	-	-	**SCE Eastern**	Geothermal (MW)	790.0	790.0	805.0
	Biomass (MW)	5.6	5.6	3.8		Biomass (MW)	2.6	2.6	2.6
	OnshoreWind (MW)	-	-	-		OnshoreWind (MW)	324.0	324.0	-
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	2,130.8	3,535.6	2,328.0
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	27.0	34.0	20.0		Solar (MW)	3,458.5	5,833.5	7,441.3
	Li_Battery (MW)	1,961.5	2,291.5	1,765.3		Li_Battery (MW)	2,950.0	3,750.0	3,820.3
	LDES (MW)	-	-	-		LDES (MW)	-	-	700.0
	Zone Total (MW)	**1,994**	**2,331**	**1,789**		**Zone Total (MW)**	**9,656**	**14,236**	**15,097**
SCE North of Lugo	Geothermal (MW)	-	-	-	**SDG&E**	Geothermal (MW)	160.0	160.0	-
	Biomass (MW)	1.5	1.5	2.7		Biomass (MW)	-	-	-
	OnshoreWind (MW)	360.0	360.0	-		OnshoreWind (MW)	1,564.0	1,564.0	495.0
	OOS Wind (MW)	-	-	-		OOS Wind (MW)	-	-	-
	Offshore Wind (MW)	-	-	-		Offshore Wind (MW)	-	-	-
	Solar (MW)	1,593.0	2,037.0	1,930.0		Solar (MW)	1,582.8	1,919.8	2,187.5
	Li_Battery (MW)	806.0	1,011.0	1,036.4		Li_Battery (MW)	1,489.7	1,694.7	1,503.0
	LDES (MW)	-	-	-		LDES (MW)	437.0	487.0	500.0
	Zone Total (MW)	**2,761**	**3,410**	**2,969**		**Zone Total (MW)**	**5,234**	**5,826**	**4,686**

Table 78: Number of substations in each CAISO study area with non-alignment flags for the consistency with previous base case criteria for the final mapping results (2039 model year) broken down by resource type.

Final 2039 Portfolio Mapping – Number of substations by CAISO study area with less resources mapped											
Resource Type	Level of Decrease at Sub	PG&E North of Greater Bay	PG&E Greater Bay	PG&E Fresno	PG&E Kern	SCE Northern Area	SCE Metro	SCE North of Lugo	East of Pisgah	SCE Eastern	SDG&E
Geothermal	Slight*	1	0	0	0	0	0	0	0	0	0
	Significant**	1	0	0	0	0	0	0	0	0	0
Biomass	Slight	1	0	0	0	0	0	0	0	0	0
	Significant	8	3	3	1	2	1	1	0	0	0
Wind, Onshore	Slight	0	1	0	0	0	0	0	0	0	0
	Significant	1	1	0	0	0	0	0	1	0	1
OOS Wind	Slight	0	0	0	0	0	0	0	0	0	0
	Significant	0	0	0	0	0	0	0	0	0	0
Offshore Wind	Slight	0	0	0	1	0	0	0	0	0	0
	Significant	1	0	0	0	0	0	0	0	0	0
Distributed_ Solar	Slight	0	0	0	1	0	0	0	0	0	0
	Significant	2	3	2	2	0	0	1	0	0	0
Solar	Slight	0	0	3	1	2	0	2	1	2	1
	Significant	5	0	4	5	5	0	1	5	3	1
Li_Battery	Slight	1	0	1	0	1	2	1	2	0	1
	Significant	2	3	5	9	0	2	1	1	2	2
LDES	Slight	0	0	0	0	0	0	0	0	0	0
	Significant	0	0	0	1	0	0	0	0	1	0

*100 MW or 10% less (level-3 alignment)

**500 MW or 33% less (level-4 or -5 alignment)

Table 78 shows the number of substations by CAISO study area and resource type that have non-alignment flags for having fewer resources mapped than in the previous TPP base case for the final mapping results of the 2039 model year. Overall solar and battery storage mapping results in the most non-alignment flags. Biomass again has numerous non-alignment flags in the PG&E study areas due to the percentage change factors as the biomass differences are relatively small 1-5 MWs.

The change in number of substations with non-alignment flags between the initial and these final mappings results is summarized by resource type in Table 79. The increase in solar, battery storage, and geothermal resources due to the portfolio modeling updates resulted in better alignment with the previous base case for those resources, while the decrease in wind resources in the portfolio did results in a few more non-alignment flags for wind resources. Biomass non-alignment increased as staff sought to relocate resources to locations not in disadvantaged communities.

Table 79: Net change by resource type in number of substations with a non-alignment flag between the initial and final mapping results for the 2039 portfolio.

Change in substations with alingment flags between Initial and Final Mapping (2039 Portfolio)		
Resource Type	Level of Decrease at Sub	Total Number of Flags
Geothermal	Slight*	0
	Significant**	-1
Biomass	Slight	0
	Significant	2
Wind, Onshore	Slight	1
	Significant	1
OOS Wind	Slight	0
	Significant	0
Offshore Wind	Slight	1
	Significant	-2
Distributed_Solar	Slight	0
	Significant	-1
Solar	Slight	1
	Significant	-5
Li_Battery	Slight	1
	Significant	-3
LDES	Slight	0
	Significant	0

*100 MW or 10% less
**500 MW or 33% less

The key non-alignments flags remaining with the final mapping results are summarized by resource type:

Geothermal: The two substations with less geothermal resources are Fulton and Geyser 12 in the North of Greater Bay study area. While the Geysers area has a comparable amount of geothermal as the 23-24 TPP base case, staff mapped the resource to different substations in the area to better align with the likely interconnection points and development interest.

Biomass: Over 20 substations have less biomass than in the previous TPP. As noted above these are flagged as significant due to the previous amounts of 1-4 MW no longer being mapped. Biomass resources have been shifted generally from the previous TPP base case mapping locations to better align with commercial interest and the environmental community impacts criteria, which was not previously implemented for biomass in the 23-24 TPP mapping.

Onshore, in-state wind: Final mapping resulted in five substations with non-alignment flags. Two of the Northen California flags, Delta PP 230 kV and Round Mountain 230 kV, reflect resources being mapped to nearby substations, which were added to the analysis this cycle, to better reflect commercial interest locations. The level-3 flag, slight reduction at the Tesla 500 kV bus, reflects reduction due to land-use and environmental impact non-alignment flags with limited available resource potential around the substation with lower environmental impacts. Staff mapped less wind to the ECO 138 kV bus compared to the 23-24 TPP portfolio and no resources to the Innovation 230 kV substation compared. The mapping two these to substations better reflects the commercial interest with both study areas SDG&E and East of Pisgah having more wind overall than in 23-24 TPP albeit at nearby substations.

Offshore Wind: The one significant non-alignment flag corresponds to staff not mapping any energy only offshore wind to the Humboldt 115 kV substation in this final mapping. All the Humboldt offshore wind is mapped as fully deliverability to a proposed 500 kV substation.

Distributed Solar: Over 10 substations have less distributed solar than in the previous TPP portfolio. Like biomass mapping, these amounts are small amounts no longer being mapped to certain substations, with shifts generally driven by lack of commercial interest as previously mapped to substations.

Utility-Scale Solar and Battery Storage: 12 substations had a level-3 alignment flag for less solar, and 25 had level-4 or -5 flags for significantly less solar. Of those staff did not map any solar to 15. These generally corresponded to two factors: 1) no higher confidence commercial interest or very little commercial interest. 2) Transmission exceedance factors.

LDES: The two non-alignment flags at Morro Bay 230 kV and Red Bluff 500 kV substations, which have no LDES in the final mapping results. The main driver for these reductions is the portfolio has less LDES resources than included in the previous 23-24 TPP portfolio.

7. Results

Sections 7.1-7.6 summarize the final mapping results by CAISO study area for the base case portfolio following the adjustments and busbar mapping analysis outlined previously. The summaries include the resources mapped in both 2034 and 2039 and key transmission implications of the mapping. Table 80 shows the total mapped resources by CAISO study area for the 2034 portfolio and Table 81 shows the results for the 2039 portfolio. Results are shown by CAISO study area for easier comparison and integration with the CAISO's TPP and other transmission analysis and interconnection processes. The Final Mapping Dashboard (Appendix E) contains the full details of the mapping results and the busbar mapping criteria analysis, including mapping summaries by RESOLVE resource area.

Table 80: Final mapping results of the base case portfolio (2034 model year) summarized by CAISO study area and resource type.

2034 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	144.0	97.5	1,097	-	931	37	595	382	5	**3,288**
PG&E Greater Bay	-	24.6	778	-	-	40	100	1,040	-	**1,983**
PG&E Fresno	-	20.2	490	-	-	66	3,505	1,754	130	**5,966**
PG&E Kern	-	18.0	310	-	2,924	73	1,981	919	-	**6,224**
SCE Northern	-	1.0	580	-	-	5	3,286	3,409	458	**7,739**
SCE Metro	-	5.6	-	-	-	27	-	1,962	-	**1,994**
SCE North of Lugo	-	1.5	360	-	-	11	1,582	806	-	**2,761**
East of Pisgah	875.0	-	620	3,965	-	-	2,640	1,864	-	**9,964**
SCE Eastern	790.0	2.6	324	2,131	-	-	3,459	2,950	-	**9,656**
SDG&E	160.0	-	1,564	-	-	1	1,582	1,490	437	**5,234**
Total by Res Type:	**1,969.0**	**171.0**	**6,123**	**6,096**	**3,855**	**260**	**18,729**	**16,576**	**1,030**	**54,808**

Table 81: Final mapping results of the base case portfolio (2039 model year) summarized by CAISO study area and resource type.

2039 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	144.0	97.5	1,997	-	1,607	37	1,545	782	5	**6,214**
PG&E Greater Bay	-	24.6	778	1,500	-	40	685	1,700	-	**4,728**
PG&E Fresno	-	20.2	490	-	-	66	6,430	3,276	130	**10,568**
PG&E Kern	-	18.0	310	-	2,924	73	3,096	1,459	-	**7,834**
SCE Northern	-	1.0	580	-	-	5	4,651	3,974	458	**9,669**
SCE Metro	-	5.6	-	-	-	34	-	2,292	-	**2,331**
SCE North of Lugo	-	1.5	360	-	-	27	2,010	1,011	-	**3,410**
East of Pisgah	875.0	-	620	4,060	-	-	4,230	2,884	-	**12,558**
SCE Eastern	790.0	2.6	324	3,536	-	-	5,834	3,750	-	**14,236**
SDG&E	160.0	-	1,564	-	-	1	1,919	1,695	487	**5,826**
Total by Res Type:	**1,969.0**	**171.0**	**7,023**	**9,096**	**4,531**	**283**	**30,399**	**22,822**	**1,080**	**77,374**

Finally, Section 7.7 discusses the mapping of the high gas retirement sensitivity portfolio, particularly information on the gas capacity selected to be modeled as not retained. The full mapping results of the high gas retirement sensitivity portfolio are in Appendix J.

7.1 Northern California: PG&E Greater Bay and PG&E North of Greater Bay Study Areas

Mapped Resources Summary

Table 82 and Table 83 summarize the resources mapped to the PG&E North of Greater Bay and Greater Bay study areas, respectively. The tables summarize the identified in-development resources and mapped generic resources for the 2034 and 2039 portfolios by resource type and modeled deliverability status. In addition to resources mapped to substation in Northern California and the Bay area, the mapped resources in these two areas include Humboldt offshore wind in both 2034 and 2039, Wyoming Wind interconnecting to the Tesla area in 2039, and onshore wind mapped in 2039 to the Nevada Energy (NVE) balancing area of northeastern California, which would require new transmission to interconnect to the CAISO system.

Table 82: Final mapping results (2034 & 2039) for the PG&E North of Greater Bay study area by resource type.

PG&E North of Greater Bay	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	32	-	112	-	**144**	112	-	**144**
Biomass	6	-	92	-	**97**	92	-	**97**
OnshoreWind	-	-	778	320	**1,097**	1,678	320	**1,997**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	931	-	**931**	1,607	-	**1,607**
Distributed Solar	13	-	24	-	**37**	24	-	**37**
Solar	-	40	275	280	**595**	430	1,075	**1,545**
Li_Battery_4hr	93	-	200	-	**293**	200	-	**293**
Li_Battery_8hr	-	-	88	-	**88**	488	-	**488**
LDES	-	-	5	-	**5**	5	-	**5**
Total by Status	**144**	**40**	**2,504**	**600**	**3,288**	**4,635**	**1,395**	**6,214**

Transmission Implications

Table 84 and Table 85 highlight the CAISO's 2023 White Paper transmission constraints with exceedances for the mapped 2034 portfolio (Table 84) and 2039 portfolio (Table 85) in the PG&E Greater Bay and North of Greater Bay study areas based on the busbar mapping transmission calculations. The tables show the resources mapped within each constraint, the calculated exceedance level, the identified 2023 White Paper upgrade, the calculated exceedance of the previous 23-24 TPP base case mapping, and CPUC staff estimated likelihood of the upgrade being triggered. Since the 23-244 TPP analysis is ongoing at the time of this busbar mapping, any upgrades that may be approved through the 23-24 TPP and their impacts are not captured in this analysis.

Table 83: Final mapping results (2034 & 2039) for the PG&E Greater Bay study area by resource type.

PG&E Greater Bay	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	5	-	20	-	**25**	20	-	**25**
OnshoreWind	-	-	688	90	**778**	688	90	**778**
OOS Wind	-	-	-	-	**-**	1,500	-	**1,500**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	14	-	26	-	**40**	26	-	**40**
Solar	-	100	-	-	**100**	470	115	**685**
Li_Battery_4hr	170	-	658	-	**829**	708	-	**879**
Li_Battery_8hr	-	-	212	-	**212**	822	-	**822**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**190**	**100**	**1,604**	**90**	**1,983**	**4,234**	**205**	**4,728**

In the 2034 portfolio, resource mapping results in six transmission constraint exceedances as seen in Table 84. The three in the PG&E Greater Bay study area are unlikely to be triggered as noted in Section 6.3.A, though full TPP analysis is needed to confirm. The three exceedances in the North of Greater Bay study area are likely to trigger between one and three upgrades with a combined estimated 2023 White Paper Costs ranging from $180 - $3,157 million. The major component of those potential upgrades is the White Paper upgrade for the Vaca-Dixon-Tesla 500 kV line constraint (~8.6 GW capacity increase and $2,852 million estimated cost). CPUC staff view it as not a cost-effective upgrade solution for the only the number of resources mapped in 2034; however, the significant increase of resources mapped to this constraint in 2039 as seen in Table 85 makes this upgrade more cost-effective. If an upgrade is found necessary in the CAISO's TPP, CPUC staff encourage the CAISO to consider less costly alternatives (e.g., the 21-22 TPP white paper identified a new Fern Road to Tesla line as costing ~$1.1 billion) or upgrades that can also be utilized by the offshore wind mapped to the Humboldt wind area.

In the 2039 portfolio, resource mapping results in eight constraint exceedances, three in the Greater Bay study area and five in the North of Greater Bay study area, as seen in Table 85. The three in the Greater Bay study area are the same as in 2034, though additional mapped resources have increased the exceedance in Contra Costa 230 kV constraint, which potentially could trigger the identified 2023 White Paper upgrade with an estimated $700 million cost. The five exceedances in the North of Greater Bay study area are all likely to trigger the identified 2023 White Paper upgrades: the four smaller upgrades, which have a combined estimated cost of $714 million, and the Vaca-Dixon-Tesla 500 kV line constraint upgrade. Busbar mapping Working Group staff view these upgrades as effective solutions to the exceedances created by the mapped resources.

Beyond the 2023 White Paper constraints and identified upgrades, the Humboldt offshore wind mapped to a proposed new 500 kV Humboldt substation would require a major new transmission upgrade in both the 2034 and 2039 portfolio. In the 2021-22 TPP offshore wind sensitivity, the CAISO identified three potential transmission solutions and is again studying potential solutions for the Humboldt offshore wind included in the 2023-24 TPP base case portfolio. Although the $2.3 billion AC overlaid transmission line to Fern Road option is used as the upgrade option in the

RESOLVE model and in busbar mapping analysis, it was selected as a placeholder upgrade and not intended to indicate a CPUC preferred upgrade option. CPUC staff note that the overland option to Fern Road has the potential to utilize the upgrade that would be needed for the Vaca-Dixon-Tesla 500 kV line constraint exceedance noted above. The co-optimizing of upgrades could remove the need for a separate new transmission line in the Sacramento Valley, costing an estimated $1.1 billion, as identified in the 2021-22 TPP sensitivity study.

The 2039 portfolio includes 900 MWs of wind mapped to Northeastern California outside of existing CAISO territory aligning with substation in the NVE balancing area and modeled in busbar mapping as interconnecting along the Malin-Round Mountain area. These wind resources will either need long (50+ miles) gen-ties to interconnect to the existing CAISO system or, more effectively, a new transmission line to the area or interconnecting to the NVE system in the area. The new transmission line would be a major transmission project, with potential costs of over a billion dollars, per CPUC staff high-level estimates. Such a line could have the added benefits of strengthening the CAISO's interconnection to the NVE energy grid and serving as another point of import for Northern Nevada area resources including geothermal.

In the 2039 portfolio, staff also mapped 1,500 MW of Wyoming wind as interconnecting at Tesla 500 kV substation. Working Group staff aligned this mapping with a potential transmission solution in the CAISO's 20-year Transmission Outlook (2021-2022), which identified this high-level solution with an estimate cost of $2.5 billion. This mapping reflects a diversification of the intertie points for OOS wind given the large amount of OOS wind in the portfolio mapped to CAISO intertie points in Southern California (over 7.5 GW interconnecting in the East of Pisgah and SCE Eastern study areas). A new northern Californian injection location could also help alleviate the need for additional in-CAISO upgrades in that area. CPUC staff note that this solution is not a mandate to assume this specific intertie if alternative, more effective solutions are available, such as any being identified in the new 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. It should be noted that while project-specific transmission costs for the TransWest Express line have been included in the characterization for the Wyoming wind resource in the RESOLVE model, specific cost assumptions for delivery at Tesla have not been characterized.

These northeastern California and Wyoming wind resource mapping are only in the 2039 portfolio and have not previously been studied in either the CAISO's TPP or interconnection studies. CPUC staff note that any upgrades identified as needed exclusively due to these resources will have a high degree of uncertainty and warrant further study. In total for the 2034 portfolio, mapped resources in the Greater Bay and North of Greater Bay study areas could need transmission upgrades costing between $2.5 – 5 billion based on CPUC staff analysis and including transmission necessary to interconnect Humboldt offshore wind. For the 2039 portfolio, potential transmission solutions needed could cost between $6.5 – 10 billion including transmission necessary to interconnect Humboldt offshore wind and the mapped out-of-CAISO resources.

Table 84: Summary of CAISO 2023 White Paper constraint exceedances in the PG&E North of Greater Bay and Greater Bay study areas caused by the final mapping results for the 2034 base case portfolio.

Base Case (2034) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
PG&E North of Greater Bay	Vaca Dixon-Tesla 500kV Line	1,044	934	319	468	181	**(837)**	8,645	$ 2,852	**(456)**	**Larger**	Medium
	Carberry-Round Mt. 230kV Line	14	200	-	-	-	**(119)**	26	$ 180	**(35)**	**Similar**	High
	Rocklin-Pleaseant grove 115kV line	92	61	8	50	22	**(27)**	707	$ 125	**(20)**	**Similar**	Medium
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	710	256	54	231	85	**(133)**	6,034	$ 417	**(364)**	**Smaller**	Low
	Morganhill-Metcalf 115kV Line	314	-	-	354	2	**(299)**	712	$ 380	**(185)**	**Similar**	Low
	Birds Landing-Contra Costa 230kV Line	836	437	288	336	126	**(326)**	1,766	$ 700	**None**	**Larger**	Low

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

Table 85: Summary of CAISO 2023 White Paper constraint exceedances in the PG&E North of Greater Bay and Greater Bay study areas caused by the final mapping results for the 2039 base case portfolio.

Base Case (2039) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
PG&E North of Greater Bay	Vaca Dixon-Tesla 500kV Line	1,044	1,834	474	1,368	181	**(2,351)**	8,645	$ 2,852	**(456)**	**Larger**	High
	Woodland- Davis 115kV Line	76	-	77	135	-	**(67)**	109	$ 9	**None**	**Larger**	High
	Carberry-Round Mt. 230kV Line	14	200	-	-	-	**(119)**	26	$ 180	**(35)**	**Larger**	High
	Rocklin-Pleaseant grove 115kV line	92	61	83	185	22	**(170)**	707	$ 125	**(20)**	**Larger**	High
	Bellota-Weber 230kV Line	2,382	386	928	1,919	56	**(545)**	460	$ 400	**None**	**Larger**	High
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	710	256	104	371	85	**(278)**	6,034	$ 417	**(364)**	**Similar**	Low
	Morganhill-Metcalf 115kV Line	314	-	-	404	2	**(349)**	712	$ 380	**(185)**	**Larger**	Low
	Birds Landing-Contra Costa 230kV Line	836	437	368	596	126	**(599)**	1,766	$ 700	**None**	**Larger**	Medium

Base Case (2039) Off-peak Tx Constraint Exceedances		White Paper Off-Peak Capability (MW)	Total Resources Mapped (In-Dev & Generic)				Calculated Off-peak Exceedance **	White Paper Off-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous Off-peak Exceedance	24-25 TPP Exceedance is	
PG&E N. of Greater Bay	Woodland- Davis 115kV Line	76	-	374	135	-	**(43)**	None, default limit	$ -	**None**	**Larger**	High for on-peak exceedance

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

7.2 Southern PG&E: PG&E Fresno and Kern Study Areas

Mapped Resources Summary

Table 86 and Table 87 summarize the resources mapped to the PG&E Fresno and Kern study areas. The tables summarize the identified in-development resources and mapped generic resources for the 2034 and 2039 portfolios by resource type and modeled deliverability status. These two study areas encompass resources mapped to substations in the San Joaquin Valley and the Central Coast including Morro Bay offshore wind resources.

Table 86: Final mapping results (2034 & 2039) for the PG&E Fresno study area by resource type.

PG&E Fresno	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	3	-	17	-	**20**	17	-	**20**
OnshoreWind	-	-	394	96	**490**	394	96	**490**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	26	-	40	-	**66**	40	-	**66**
Solar	1,388	184	1,248	685	**3,505**	1,634	3,225	**6,430**
Li_Battery_4hr	1,455	-	100	-	**1,554**	215	-	**1,669**
Li_Battery_8hr	-	-	200	-	**200**	1,607	-	**1,607**
LDES	-	-	130	-	**130**	130	-	**130**
Total by Status	**2,872**	**184**	**2,129**	**781**	**5,966**	**4,036**	**3,321**	**10,412**

Table 87: Final mapping results (2034 & 2039) for the PG&E Kern study area by resource type

PG&E Kern	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	-	-	18	-	**18**	18	-	**18**
OnshoreWind	-	-	300	10	**310**	300	10	**310**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	2,924	-	**2,924**	2,924	-	**2,924**
Distributed Solar	32	-	41	-	**73**	41	-	**73**
Solar	240	232	440	1,069	**1,981**	796	1,829	**3,096**
Li_Battery_4hr	186	-	590	-	**777**	590	-	**777**
Li_Battery_8hr	-	-	142	-	**142**	682	-	**682**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**458**	**232**	**4,455**	**1,079**	**6,224**	**5,351**	**1,839**	**7,879**

Transmission Implications

Table 88 and Table 89 highlight the CAISO's 2023 White Paper transmission constraints with exceedances for the mapped 2034 (Table 88) and 2039 portfolios (Table 89) in the PG&E Fresno and Kern study areas based on the busbar mapping transmission calculations. Each table is split into the identified on-peak exceedances and the off-peak exceedances in the areas. The tables show the resources mapped within each constraint, the calculated exceedance level, the identified 2023 White Paper upgrade, the calculated exceedance of the previous 23-24 TPP base case mapping, and CPUC staff estimated likelihood of the upgrade being triggered. Since the 23-24 TPP analysis is ongoing at the time of this busbar mapping, any upgrades that may be approved through the 23-24 TPP and their impacts are not captured in this analysis.

In the 2034 portfolio, resource mapping results in five on-peak exceedances and one off-peak exceedance in constraints with actual limits and two additional default constraint exceedances. As seen in Table 88, two of the actual exceeded constraints are in the Kern study area and four are in the Fresno area. The two exceeded constraints in the Kern study area are in the Oceano-Calendar 115kV Line constraint and the Midway-Q2005 230kV Line constraint, which both can be alleviated by 2023 White Paper upgrades costing an estimated $1,008 million and $940 million respectively. Staff noted in Section 6.3.A that similar amounts of mapped resources and comparable exceedances are observed in both the 22-23 TPP sensitivity portfolio and the 23-24 TPP base case and do not appear to trigger upgrades in currently available analysis for both of those portfolios. However, both identified upgrades would be effective solutions to alleviate the exceedances particularly given the increase in exceedances seen in the mapped 2039 portfolio (Table 89). Of the three on-peak constraints exceeded in the Fresno study area in the 2034 mapping, two are not likely to be triggering per CAISO staff feedback in the busbar mapping group as noted in Section 6.3.A; however, the upgrades are all potentially effective solutions given the exceedances increase significantly in the 2039 mapped portfolio. The one actual off-peak constraint exceedance in the Frenso area for the 2034 portfolio is alleviated by the identified upgrade which costs an estimated $40 million and would be an effective solution.

In the 2039 portfolio, mapping resulted in the same two exceedances as seen in 2034 for the Kern study area. As shown in Table 89, both exceedances are larger than in previous portfolios and likely to trigger upgrades, which CPUC staff view as effective solutions. The Fresno area has five on-peak exceedances in actual constraint and one on-peak exceedances in the default capability of the Moss Landing-Las Aguilas 230 kV Line constraint. The default on-peak constraint does not have an identified 2023 White Paper upgrade and may or may not require a transmission upgrade. A single upgrade, costing an estimated $35 million, increases the capability of two of the exceedance constraints (Gates 500/30 kV TB #12 and TB #11 constraints), which are the two most likely to require upgrades. The other three constraints have 2023 White Paper upgrades costing an estimated $370 million (for the Schindler 115/70kV TB #1 constraint), $550 million (for the Chowchilla-Le grand 115kV Line constraint), and $1,500 million (for the Tranquility-Helm 230 kV Line constraint). As noted in Section 6.3.A, all three constraints have larger exceedances than was calculated for the 23-24 TPP, and potentially could trigger the upgrades. All three upgrades are effective solutions given the number of resources mapped in 2039 and the number of additional resources in these areas in both 20-year Transmission Outlook portfolios. Nevertheless, CPUC staff encourage the CAISO to consider smaller, less costly upgrade alternatives particular for the exceedance in the Tranquility-Helm 230 kV Line constraint.

Table 88: Summary of CAISO 2023 White Paper constraint exceedances in the PG&E Kern and Fresno study areas caused by the final mapping results for the 2034 base case portfolio.

Base Case (2034) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
PG&E Kern	Oceano-Calendar 115kV Line	937	300	1,363	874	2	**(375)**	1,418	$ 1,008	**(478)**	**Similar**	Medium
	Midway-Q2005 230kV Line	1,396	574	2,737	2,151	31	**(1,260)**	16,891	$ 940	**(2,368)**	**Smaller**	High
PG&E Fresno	Gates 500/230kV TB #12	3,213	794	2,540	2,135	34	**(157)**	14,825	$ 35	**(988)**	**Smaller**	Medium
	Chowchilla-Le grand 115kV Line	699	274	402	714	21	**(320)**	1,211	$ 550	**(316)**	**Similar**	Low
	Schindler 115/70kV TB #1	399	274	382	682	11	**(304)**	3,160	$ 370	**(309)**	**Similar**	Low
	Moss Landing-Las Aguillas 230 kV Line Off-Peak	2,276	325	1,764	1,697	21	**(59)**	None, default limit	$ -	**(59)**	**Similar**	High for off-peak exceedance

Base Case (2034) Off-peak Tx Constraint Exceedances		White Paper Off-Peak Capability (MW)	Total Resources Mapped (In-Dev & Generic)				Calculated Off-peak Exceedance **	White Paper Off-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous Off-peak Exceedance	24-25 TPP Exceedance is	
PG&E Kern	Oceano-Calendar 115kV Line	174	310	1,654	874	2	**(296)**	230	$ 1,008	**(740)**	**Smaller**	Medium for on-peak
	Midway-Q2005 230kV Line	278	650	4,100	2,151	31	**(927)**	968	$ 940	**(1,763)**	**Smaller**	High for on-peak
PG&E Fresno	Panoche-Mendota 115 kV Line	7	440	683	682	22	**(53)**	302	$ 370	**(189)**	**Similar**	Low
	Moss Landing-Las Aguillas 230 kV Line Off-Peak	-	390	2,632	1,697	21	**(593)**	1,760	$ 40	**(1,905)**	**Smaller**	Medium

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

Table 89: Summary of CAISO 2023 White Paper constraint exceedances in the PG&E Kern and Fresno study areas caused by the final mapping results for the 2039 base case portfolio.

Base Case (2039) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
PG&E Kern	Oceano-Calendar 115kV Line	937	300	1,598	1,606	2	**(1,130)**	1,418	$ 1,008	**(478)**	**Larger**	High
	Midway-Q2005 230kV Line	1,396	574	3,483	4,412	31	**(3,596)**	16,891	$ 940	**(2,368)**	**Larger**	High
PG&E Fresno	Gates 500/230kV TB #12	3,213	794	3,285	3,786	34	**(1,882)**	14,825	$ 35	**(988)**	**Larger**	High
	Gates 500/230kV TB #11	3,684	794	3,831	4,183	34	**(1,863)**	10,038	Same as TB #12	**(423)**	**Larger**	High
	Tranquility-Helm 230kV Line	2,229	274	1,772	2,223	22	**(438)**	2,274	$ 1,500	**None**	**Larger**	Medium
	Chowchilla-Le grand 115kV Line	699	274	527	988	21	**(607)**	1,211	$ 550	**(316)**	**Larger**	Medium
	Schindler 115/70kV TB #1	399	274	402	896	11	**(521)**	3,160	$ 370	**(309)**	**Larger**	Medium
	Moss Landing-Las Aguillas 230 kV Line Off-Peak	2,276	325	2,104	2,534	21	**(919)**	None, default limit	$ -	**(59)**	**Larger**	High for off-peak exceedance

Base Case (2039) Off-peak Tx Constraint Exceedances		White Paper Off-Peak Capability (MW)	Total Resources Mapped (In-Dev & Generic)				Calculated Off-peak Exceedance **	White Paper Off-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous Off-peak Exceedance	24-25 TPP Exceedance is	
PG&E Kern	Oceano-Calendar 115kV Line	174	310	3,064	1,606	2	**(677)**	230	$ 1,008	**(740)**	**Similar**	High for on-peak
	Midway-Q2005 230kV Line	278	650	7,637	4,412	31	**(1,460)**	968	$ 940	**(1,763)**	**Similar**	High for on-peak
PG&E Fresno	Los Banos 500/230 kV Bank	608*	690	6,263	3,876	28	**(177)**	None, default	$ -	**(630)**	**Smaller**	Low
	Panoche-Mendota 115 kV Line	7	340	1,343	1,046	11	**(210)**	302	$ 370	**(189)**	**Similar**	Medium for on-peak
	Moss Landing-Las Aguillas 230 kV Line Off-Peak	-	325	4,327	2,534	21	**(1,096)**	1,760	$ 40	**(1,905)**	**Smaller**	High

*Includes capability increase from TPP approved upgrade

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

In the off-peak analysis for 2039, two additional constraints are exceeded in the Fresno area. One is a default constraint limit from a previously approved upgrade for the Los Banos 500/230 kV Bank constraint and the previously approved upgrade will likely accommodate the exceedance. The other, the Panoche-Mendota 115 kV line constraint, is an actual off-peak limit and has the same upgrade as identified as potentially needed for the Schindler 115/70kV TB #1 constraint on-peak exceedance. The exceedance amount is comparable to the 23-24 TPP mapping results.

In both the 2034 and 2039 portfolios, 2.9 GW of offshore wind mapped to the Morro Bay wind area is modeled as interconnecting to the existing Diablo Canyon 500 kV substation. The 21-22 TPP offshore wind sensitivity identified the potential need for a new Morro Bay 500 kV substations, with an estimated cost of $110 million; however, more recent TPP studies and CAISO staff feedback to the busbar mapping working indicate that the existing Diablo Canyon 500 kV substation is likely able to accommodate the amount of offshore resources included in the portfolio at Morro Bay.

In total for the 2034 portfolio, mapped resources in the PG&E Fresno and Kern study areas could need transmission upgrades costing between $940 million – $2.2 billion based on CPUC staff analysis, with the upper range including the potential loop-in substation for the Morro Bay offshore wind. For the 2039 mapped portfolio, potential transmission solutions needed could cost between $2.2 – 4.6 billion, again per CPUC staff analysis.

7.3 Greater Tehachapi and LA Metro: SCE Northern and Metro Study Areas

Mapped Resources Summary

Table 90 and Table 91 summarize the resources mapped to the SCE Northern and Metro Study Areas, resepectively. The tables summarize the identified in-development resources and mapped generic resources for the 2034 and 2039 portfolios by resource type and modeled deliverability status. In addition to the Tehachapi region, the SCE Northern area includes portions of the Central Valley interconnecting to the SCE system which extends up to the Big Creek hydroelectric facilities.

Table 90: Final mapping results (2034 & 2039) for the SCE Northern study area by resource type

SCE Northern Area	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	-	-	1	-	**1**	1	-	**1**
OnshoreWind	-	-	564	16	**580**	564	16	**580**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	5	-	-	-	**5**	-	-	**5**
Solar	230	801	1,403	852	**3,286**	1,404	2,216	**4,651**
Li_Battery_4hr	2,240	-	1,000	-	**3,240**	1,000	-	**3,240**
Li_Battery_8hr	-	-	170	-	**170**	734	-	**734**
LDES	200	-	258	-	**458**	258	-	**458**
Total by Status	**2,675**	**801**	**3,396**	**868**	**7,739**	**3,961**	**2,232**	**9,669**

Table 91: Final mapping results (2034 & 2039) for the SCE Metro study area by resource type.

SCE Metro	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	-	-	-	-
Biomass	6	-	-	-	6	-	-	6
OnshoreWind	-	-	-	-	-	-	-	-
OOS Wind	-	-	-	-	-	-	-	-
Offshore Wind	-	-	-	-	-	-	-	-
Distributed Solar	27	-	-	-	27	7	-	34
Solar	-	-	-	-	-	-	-	-
Li_Battery_4hr	895	-	900	-	1,795	950	-	1,845
Li_Battery_8hr	-	-	167	-	167	447	-	447
LDES	-	-	-	-	-	-	-	-
Total by Status	928	-	1,067	-	1,994	1,404	-	2,331

Transmission Implications

Between the two study areas, mapping in both the 2034 and 2039 model years results in just one constraint exceedance based on the busbar mapping transmission calculations as shown in Table 92. The exceedance occurs South of Magunden on-peak constraint, with 2034 and 2039 mapping results having the same level of exceedance. CPUC staff view the identified 2023 White Paper upgrade, which costs an estimated $4,358 million for approximately 2,000 MW of additional capacity, as not a cost-effective solution. CAISO staff noted the 2021 White Paper identified an alternative solution, an estimate $1,500 million upgrade providing ~840 MW of additional capability; but for the number of resources mapped, CPUC staff would likely view this as also not cost-effective.

Table 92: Summary of CAISO 2023 White Paper constraint exceedances in the SCE Northern study area caused by the final mapping results for the 2034 (Top) and 2039 (Bottom) base case portfolios.

Base Case (2034) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
SCE Northern	South of Magunden	740	-	208	1,150	1	(596)	2,000	$ 4,358	(336)	Larger	Low

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

Base Case (2039) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
SCE Northern	South of Magunden	740	-	208	1,150	1	(596)	2,000	$ 4,358	(336)	Larger	Low

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

As discussed in Sections 6.1.A and 6.3.A, CPUC staff view that the mapped resources are unlikely to trigger the identified upgrades based on the location of the mapped resources and general alignment

to existing TPD allocations. CAISO staff feedback to the busbar mapping Working Group also noted potential benefits of either potential upgrade to reducing Path 26 congestion. CPUC staff ask the CAISO to consider other potentially less costly upgrades. and if CAISO's TPP analysis does show that either upgrade is likely needed and alternative benefits do not warrant the costs, CPUC staff request that the CAISO consult with CPUC staff about the potential of remapping generic resources as an alternative to triggering the upgrade.

7.4 Greater Kramer: SCE North of Lugo Study Area

Mapped Resources Summary

Table 93 summarizes the resources mapped to the SCE North of Lugo Study Area. The table summarizes the identified in-development resources and mapped generic resources for the mapped 2034 and 2039 portfolios by resource type and modeled deliverability status.

Table 93: Final mapping results (2034 & 2039) for the SCE North of Lugo study area by resource type.

SCE North of Lugo	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	-	-	2	-	**2**	2	-	**2**
OnshoreWind	-	-	310	50	**360**	310	50	**360**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	3	-	8	-	**11**	24	-	**27**
Solar	282	250	390	660	**1,582**	470	1,008	**2,010**
Li_Battery_4hr	361	-	355	-	**716**	385	-	**746**
Li_Battery_8hr	-	-	90	-	**90**	265	-	**265**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**646**	**250**	**1,155**	**710**	**2,761**	**1,456**	**1,058**	**3,410**

Transmission Implications

Busbar mapping for both the 2034 and 2039 portfolio results in no calculated transmission exceedances for the SCE North of Lugo study area. The 22-23 TPP resulted in the approval of three transmission upgrades in the North of Lugo area and these upgrades provide sufficient capacity for the mapped resources.

7.5 Southern Nevada and El Dorado: East of Pisgah Study Area

Mapped Resources Summary

Table 94 summarizes the resources mapped to the East of Pisgah Study Area. The table summarizes the identified in-development resources and mapped generic resources for the 2034 and 2039 portfolios by resource type and modeled deliverability status. This study area summary contains the resources mapped to in-CAISO areas of Southern Nevada (resources mapped to substations in the

GLW, VEA, and SCE systems in the area) and out-of-CAISO resources mapped as interconnecting to intertie points within the study area. These OOS out-of-CAISO resources include Wyoming and Idaho Wind as well as Northern Nevada and Utah geothermal all modeled as interconnecting with the existing CAISO system's Harry Allen and Eldorado interties.

Table 94: Final mapping results (2034 & 2039) for the East of Pisgah study area by resource type.

East of Pisgah	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	26	-	849	-	**875**	849	-	**875**
Biomass	-	-	-	-	**-**	-	-	**-**
OnshoreWind	-	-	620	-	**620**	620	-	**620**
OOS Wind	-	-	3,965	-	**3,965**	4,060	-	**4,060**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	-	-	-	**-**	-	-	**-**
Solar	125	335	950	1,230	**2,640**	1,075	2,695	**4,230**
Li_Battery_4hr	624	-	1,060	-	**1,684**	1,564	-	**2,188**
Li_Battery_8hr	-	-	180	-	**180**	696	-	**696**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**775**	**335**	**7,624**	**1,230**	**9,964**	**8,864**	**2,695**	**12,669**

Transmission Implications

Busbar mapping results in one transmission constraint exceedance in the 2034 portfolio and two in the 2039 portfolio based on the transmission calculations as seen in Table 95. The table shows the resources mapped within each constraint the calculated exceedance level, the identified 2023 White Paper upgrade, the calculated exceedance of the previous 23-24 TPP base case mapping, and CPUC staff estimated likelihood of the upgrade being triggered. Since the 23-244 TPP analysis is ongoing at the time of this busbar mapping, any upgrades that may be approved through the 23-24 TPP and their impacts are not captured in this analysis.

The 2034 portfolio exceedance in the Lugo-Victorville area constraint has an identified 2023 White Paper upgrade that provides approximately 6,800 MW of additional constraint capacity and costs an estimated $2.165 billion. The identified upgrade is potentially triggered by the mapping results as the 2034 model year's exceedance is slightly larger than the calculated exceedance for the 23-24 TPP base case. The upgrade is likely triggered by the 2039 portfolio and would be a cost-effective solution as significant increases in OOS wind are mapped as interconnecting within the constraint, which greatly increases the exceedance. The other constraint exceeded in the 2039 portfolio mapping is the GLW 230 kV constraint; however, this is a default constraint with an estimated capacity value based on an approved 22-23 TPP upgrade. As discussed in Section 6.3.A, CPUC staff note the magnitude of exceedance can likely be accommodated by the already approved upgrade and will likely not require additional upgrades.

In both 2034 and 2039, the portfolio includes 500 MW of Central Nevada geothermal mapped as in-CAISO resources and interconnecting to the Beatty substation within the GLW-VEA system. These resources will likely require a long gen-tie (50+ miles) from potential geothermal areas in Central Nevada to the Beatty interconnection point with potential costs of $200-700 million dollars, per CPUC staff high-level estimates.

Table 95: Summary of CAISO 2023 White Paper constraint exceedances in the East of Pisgah study area caused by the final mapping results for the 2034 (Top) and 2039 (Bottom) base case portfolios.

Base Case (2034) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
East of Pisgah	**Lugo-Victorville Area**	10,100	8,041	1,983	4,190	1,036	**(1,716)**	6,800	$ 2,165	**(1,144)**	**Larger**	Medium

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

Base Case (2039) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
East of Pisgah	**GLW 230kV Area**	2,185*	620	1,200	1,654	500	**(520)**	None, default	$ -	**(173)**	**Larger**	Low
	Lugo-Victorville Area	10,100	9,541	2,108	5,552	1,036	**(4,066)**	6,800	$ 2,165	**(1,144)**	**Larger**	High

*Includes capability increase from TPP approved upgrade ^ CAISO staff identified additional upgrade from previous 2021 White Paper

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

The busbar mapping Working Group modeled the out-of-CAISO resources as Maximum Import Capability (MIC) expanding or utilizing in-development CAISO transmission. The portfolio's 1,060 MW Idaho wind is mapped to the Harry Allen intertie and modeled as using the conditionally approved SWIP-North transmission line, which has an updated CAISO cost of ~$850 million. The busbar mapping Working Group modeled the portfolios' 299 MW of Northern Nevada geothermal as interconnecting to the existing CAISO system at the Harry Allen/Eldorado interties and likely to utilize either the NVE grid to reach the interties or capacity through the SWIP-North transmission line. The 76 MW of Utah geothermal is presumed to use existing transmission to reach the same interties, while 3,000 MW of Wyoming wind is modeled as utilizing the in-development subscriber model TransWest line, which also interconnects to the Harry Allen/Eldorado interties and has an estimated cost per the 2021-2022 TPP report of $2.7 billion. As a subscriber model, the transmission costs of TransWest would not be included in the transmission access charge (TAC) but incorporated through any power purchase agreements for wind resources; however, the costs still impact ratepayers and thus are included in the portfolio modeling and busbar mapping analysis.

7.6 Riverside, Arizona, San Diego, and Imperial: SCE Eastern and San Diego Gas & Electric Study Areas

Mapped Resources Summary

Table 96 and Table 97 summarize the resources mapped to the SCE Eastern and SDG&E Study Areas. The tables summarize the identified in-development resources and mapped generic resources for the 2034 and 2039 portfolios by resource type and modeled deliverability status. The SCE Eastern study area includes out-of-CAISO resources with OOS New Mexico wind modeled as interconnecting to the Palo Verde intertie and resources (geothermal and some in-development solar and storage) in the Imperial Irrigation District (IID) modeled as interconnecting to the Mirage-Devers intertie. The SDG&E area also includes IID geothermal resources interconnecting to the CAISO through the Imperial Valley intertie. Finally, the SDG&E area includes onshore wind mapped to Baja California, Mexico, but interconnecting directly to the CAISO at the East County buses.

Table 96: Final mapping results (2034 & 2039) for the SCE Eastern study area by resource type.

SCE Eastern	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	790	-	**790**	790	-	**790**
Biomass	3	-	-	-	**3**	-	-	**3**
OnshoreWind	-	-	224	100	**324**	224	100	**324**
OOS Wind	-	-	2,131	-	**2,131**	3,536	-	**3,536**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	-	-	-	**-**	-	-	**-**
Solar	410	1,349	400	1,300	**3,459**	1,200	2,875	**5,834**
Li_Battery_4hr	2,180	-	500	-	**2,680**	500	-	**2,680**
Li_Battery_8hr	75	-	195	-	**270**	995	-	**1,070**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**2,668**	**1,349**	**4,240**	**1,400**	**9,656**	**7,245**	**2,975**	**14,236**

Table 97: Final mapping results (2034 & 2039) for the SDG&E study area by resource type.

SDG&E	In-Development		Mapped Generic (2034)		Total (2034)	Mapped Generic (2039)		Total (2039)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	160	-	**160**	160	-	**160**
Biomass	-	-	-	-	**-**	-	-	**-**
OnshoreWind	-	-	1,325	239	**1,564**	1,325	239	**1,564**
OOS Wind	-	-	-	-	**-**	-	-	-
Offshore Wind	-	-	-	-	**-**	-	-	-
Distributed Solar	1	-	-	-	**1**	-	-	1
Solar	-	610	700	272	**1,582**	700	609	**1,919**
Li_Battery_4hr	1,100	-	290	-	**1,390**	290	-	**1,390**
Li_Battery_8hr	-	-	100	-	**100**	305	-	**305**
LDES	-	-	437	-	**437**	487	-	**487**
Total by Status	**1,101**	**610**	**3,012**	**511**	**5,234**	**3,267**	**848**	**5,826**

Transmission Implications

Table 98 highlights the CAISO's 2023 White Paper transmission constraints with exceedances for the 2034 portfolio (Top table) and 2039 portfolio (Bottom table) in the SCE Eastern and SDG&E study areas based on the busbar mapping transmission calculations. The tables show the resources mapped within each constraint the calculated exceedance level, the identified 2023 White Paper upgrade, the calculated exceedance of the previous 23-24 TPP base case mapping, and CPUC staff estimated likelihood of the upgrade being triggered. Since the 23-244 TPP analysis is ongoing at the time of this busbar mapping, any upgrades that may be approved through the 23-24 TPP and their impacts are not captured in this analysis.

In the 2034 portfolio, resource mapping results in five transmission constraint exceedances as seen in Table 98. The only exceedance in the SCE Eastern study area occurs in the Devers-Red Bluff constraint. The constraint includes capacity from an approved 22-23 TPP upgrade making the constraint capability limit a default amount so the exceedance may not trigger an additional transmission upgrade. As noted in Section 6.3.A, the previously identified 2021 White Paper upgrade, providing an estimated 3,000 MW of additional capacity and costing an estimated $1.02 billion, would be a potential solution to any exceedance. CPUC staff note that the exceedance is comparable to the amount seen for the 23-24 TPP base case for which the preliminary results indicated a transmission upgrade is not likely needed for the 2034 portfolio. The exceedance increases significantly in 2039 and would likely require an additional transmission upgrade. The four exceedances in the SDG&E study for the 2034 portfolio, as noted in Section 6.3.A, are likely to trigger the 2023 White Paper upgrades. The four 2023 White Paper upgrades have a total combined estimated cost of $623 million.

In the 2039 portfolio, the SDG&E study area has the same four actual exceedances plus three default exceedances of constraints with previously approved 22-23 TPP upgrades. These small exceedances are not likely to trigger additional upgrades but cannot be guaranteed without a full TPP analysis. In the SCE Eastern area, 2039 mapping results cause an additional calculated exceedance in the on-peak Colorado River 500/230 kV Constraint, which would likely require the identified $67 million dollar CAISO's 2023 White Paper upgrade. The exceedance in the default capability limit for the Colorado River-Red Bluff constraint's is small relative to the size of the

previously approved upgrade's estimated capability and will likely not require an additional upgrade, though full TPP analysis is necessary to confirm.

The Imperial geothermal resources interconnecting to the CAISO at the Mirage-Dever intertie in the SCE Easter study area would likely require transmission upgrades in the IID system. The New Mexico wind is mapped to as interconnecting to the Palo Verde CAISO boundary intertie point (2,130 MW in 2034 and 3,500 MW in 2039). As discussed in the initial mapping results, Working Group staff assumed most of the wind will utilize the in development SunZia line per CAISO's 20-year Transmission Outlook (2021-2022) with a portion of the 2039 mapped amount requiring additional new transmission to reach Palo Verde. While not a CAISO upgrade, the SunZia project has an estimated cost of $2.6 billion per CAISO's 20-year Transmission Outlook. The Working Group assumed these out-of-CAISO resources are MIC expanding.

In total, the 2034 mapped portfolio could require in-CAISO upgrades $620 – $1,620 million plus additional transmission costs to bring out-of-CAISO resource in Imperial and New Mexico to the CAISO border. For the 2039 portfolio, the increased likelihood of needing an upgrade for the Devers-Red Bluff constraint and the Colorado River 500/230 kV Constraint increases the potential costs of in-CAISO upgrades to $1,620 – $1,650 million.

Table 98: Summary of CAISO 2023 White Paper constraint exceedances in the SCE Eastern and SDG&E study areas caused by the final mapping results for the 2034 (Top) and 2039 (Bottom) base case portfolios.

Base Case (2034) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
SCE Eastern	Devers-Red Bluff	9,050*	8,041	1,885	3,040	1,825	**(2,124)**	3,000^	$ 1,022^	**(2,260)**	**Similar**	Medium
SDG&E	Chicarita 138 kV	301	-	1	447	-	**(437)**	700	$ 100	**(600)**	**Smaller**	High
	Silvergate - Bay Blvd 230 kV	796	1,325	200	301	160	**(627)**	4,754	$ 30	**(51)**	**Larger**	High
	Silvergate-Old Town 230 kV	1,221	975	200	401	160	**(284)**	2,522	$ 283	**None**	**Larger**	High
	Talega 230 kV	1,205	-	-	856	-	**(291)**	2,201	$ 211	**(480)**	**Smaller**	High

Base Case (2039) Tx Constraint On-Peak Exceedances		White Paper On-Peak Capability (MW)	FCDS Resources Mapped (In-Dev & Generic)				Calculated Largest On-peak Exceedance **	White Paper On-Peak Upgrade Info		23-24 TPP Base Case Exceedance w/ New 2023 White Paper		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name		Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)		Capability Increase (MW)	Estimated Cost (millions)	Previous On-peak Exceedance	24-25 TPP Exceedance is	
SCE Eastern	Colorado River 500/230 kV	1,035	-	500	404	-	**(221)**	1,370	$ 67	**(52)**	**Larger**	Medium
	Colorado River-Red Bluff	11,521*	9,541	2,610	4,148	1,035	**(832)**	1,170	$ 357	**None**	**Larger**	Low
	Devers-Red Bluff	9,050*	9,541	2,610	4,773	1,825	**(4,988)**	3,000^	$ 1,022^	**(2,260)**	**Larger**	High
SDG&E	Chicarita 138 kV	301	-	1	497	-	**(487)**	700	$ 100	**(600)**	**Similar**	High
	Internal San Diego Area	1937*	975	200	1,263	160	**(116)**	None,	$ -	**None**	**Larger**	Low
	Encina - San Luis Rey 230 kV	2,688*	1,325	450	1,634	160	**(254)**	None,	$ -	**None**	**Larger**	Low
	San Luis Rey-San Onofre 230 kV Line	2,837*	1,325	450	1,622	160	**(85)**	None, default	$ -	**None**	**Larger**	Low
	Silvergate - Bay Blvd 230 kV	796	1,325	200	364	160	**(690)**	4,754	$ 30	**(51)**	**Larger**	High
	Silvergate-Old Town 230 kV	1,221	975	200	464	160	**(347)**	2,522	$ 283	**None**	**Larger**	High
	Talega 230 kV	1,205	-	-	998	-	**(433)**	2,201	$ 211	**(480)**	**Similar**	High

*Includes capability increase from TPP approved upgrade ^ CAISO staff identified additional upgrade from previous 2021 White Paper

** Includes calculations from IRP baseline resources not in mapped portfolio numbers

7.7 High Gas Retirement Sensitivity Portfolio

Table 99 shows the mapped generation and storage resources for the high gas retirement sensitivity portfolio's 2034 model year summarized by CAISO study area and resource type. Table 100 displays the same summary for the 2039 model year. Figure 15 depicts a map of the 2039 mapping results by approximate interconnection location. Full mapping details at the substation level and the criteria alignment analysis for the sensitivity portfolio are in Appendix J.

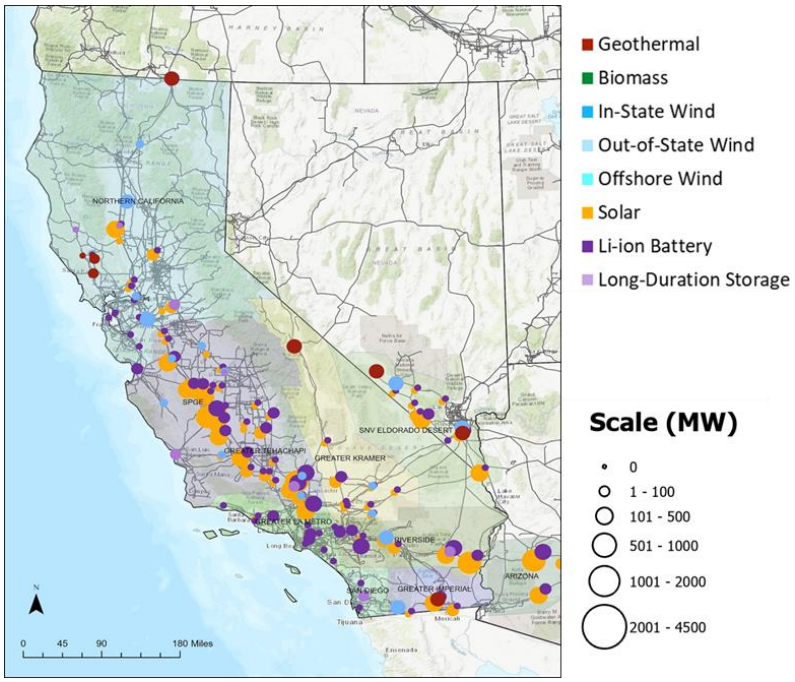
Table 99: Summary of mapping results of the high gas retirement sensitivity portfolio (2034 model year) by CAISO study area and resource type.

2034 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	246	6	933	-	-	37	595	227	959	**3,002**
PG&E Greater Bay	-	5	788	-	-	64	100	529	-	**1,487**
PG&E Fresno	-	3	400	-	-	68	3,871	1,748	131	**6,221**
PG&E Kern	-	-	200	-	-	78	2,311	456	-	**3,045**
SCE Northern	-	-	530	-	-	8	3,286	2,579	500	**6,903**
SCE Metro	-	6	-	-	-	40	-	1,302	-	**1,347**
SCE North of Lugo	454	-	360	-	-	34	1,597	526	-	**2,971**
East of Pisgah	1,215	-	620	3,945	-	-	3,030	1,019	-	**9,829**
SCE Eastern	1,280	3	324	2,121	-	-	3,859	2,525	1,190	**11,301**
SDG&E	766	-	1,584	-	-	1	1,582	1,260	500	**5,693**
Total by Res Type:	**3,961**	**22**	**5,739**	**6,066**	**-**	**329**	**20,230**	**12,171**	**3,280**	**51,799**

Table 100: Summary of mapping results of the high gas retirement sensitivity portfolio (2039 model year) by CAISO study area and resource type.

2039 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Summary by Area
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	FCDS (MW)	Total (MW)	Total (MW)	FCDS (MW)	Total (MW)
PG&E North of Greater Bay	1,074	6	933	-	-	37	3,732	1,167	959	**7,907**
PG&E Greater Bay	-	5	788	-	-	69	1,340	1,815	-	**4,018**
PG&E Fresno	-	3	400	-	-	68	11,160	4,235	131	**15,997**
PG&E Kern	-	-	200	-	-	79	4,791	1,404	400	**6,873**
SCE Northern	-	-	530	-	-	8	8,306	4,534	500	**13,878**
SCE Metro	-	6	-	-	-	40	-	2,187	-	**2,232**
SCE North of Lugo	454	-	360	-	-	34	2,964	1,044	-	**4,856**
East of Pisgah	1,315	-	620	4,060	-	-	6,280	2,393	-	**14,668**
SCE Eastern	1,380	3	324	3,006	-	-	8,784	4,055	1,190	**18,741**
SDG&E	866	-	1,584	-	-	1	4,494	2,085	500	**9,530**
Total by Res Type:	**5,089**	**22**	**5,739**	**7,066**	**-**	**335**	**51,851**	**24,917**	**3,680**	**98,699**

Figure 15: Map of the final busbar mapping results for the 24-25 TPP high gas retirement sensitivity (2039) shown by mapped interconnection location and amount mapped by resource type.



The mapping of the gas capacity not retained is discussed in Section 8.1 and summarized in Appendix H, with the full results included in Appendix G. Table 101 summarizes by CAISO study area the units selected in the 2039 model year, excluding the OTC plants, and compares the amounts to those studied in the previous CAISO 20-year Transmission Outlook (2021-2022).

Table 101: Summary of units selected to modeled as not retained for the high gas retirement sensitivity portfolio (2039 model year) by local area and compared to the 20-year transmission outlook amounts.

	High Gas Retirement Sensitivity – 2039			
Local Area	**Selected CCGT & Peakers (MWs)**	**Selected CHPs (MWs)**	**Sensitivity Total (MWs)**	**20-year Tx Outlook – 2040 (MWs)**
Bay Area	1,819	273	2,092	4,427
BC/Ventura	1,153	413	1,567	695
Fresno	526	25	551	669
Humboldt	-	-	-	-
Kern	304	103	407	407
LA Basin	2,361	430	2,791	3,632
SD-IV	-	-	-	131
Sierra	146	8	153	153
Stockton	25	-	25	361
Not_in_LCR	4,205	483	4,688	3,933
Total:	**10,539**	**1,735**	**12,273**	**14,408**

8. Other Assumptions for TPP

Guidance previously provided to CAISO as part of the annual CPUC portfolio transmittal was included in a document called the "Unified Inputs & Assumptions". CPUC and CAISO staff agree that any necessary content be included in this Report. This section describes the additional modeling assumptions the CPUC provides to the CAISO's TPP, besides the portfolio and busbar mapping assumptions described in the rest of this Report.

8.1 Gas Capacity Not Retained

The RESOLVE model reports the aggregate amount of thermal generation not retained by resource category. Unit-specific information is not modeled. Because the TPP studies require modeling of specific units and locations, CPUC staff provide information to the CAISO regarding which units should be assumed as retired for transmission planning purposes. The base case portfolio includes RESOLVE selected gas capacity not retained due to economic optimization while the high gas retirement sensitivity portfolio has gas retirements forced in.

The Busbar Mapping Methodology (Appendix A) outlines criteria for selecting which specific units to model as not retained. Through the portfolio development and mapping process the specific data utilized and criteria implemented were finalized. The factors and selection criteria are described in more detail in the Overview Slides in Appendix H and the data for each factor is found in Retirement List of Thermal Generation Units (Appendix G). In total, staff used six plant-specific factors organized into three categories. For each factor, individual plants are given an integer score from 1 to 4, with 4 being the highest priority for selection. The six factors and three criteria are:

Environmental & Community Impact Factors

1. Proximity to Disadvantaged Communities: Factor will prioritize not retaining resources located within a disadvantaged community (DAC). Resources within DACs receive the highest score of 4, those within 5 miles receive a score of 3, those between 5 and 10 miles away receive a score of 2, and those beyond 10 miles from a DAC receive a score of 1.
2. NOx Emissions Rate: Factor will prioritize not retaining resources with higher NOx emission rates weighted by the plant's capacity factor. Resources will be sorted into quartiles by plant type (i.e., CCGTs will rank only amongst other CCGTs) based on weighted NOx emission rates. Resources will be scored by quartile with the highest emission rates having the highest score of 4. Emission rates are calculated based on publicly available EIA emissions data.
3. Location in Air Quality Non-Attainment Zones: Factor will prioritize not retaining resources located within Ozone and PM2.5 EPA Non-Attainment Areas (NAAs) with a score of 4 going to resources located within the highest non-attainment status for both Ozone and PM2.5.

Performance Related Factors

4. Plant Heat Rate: Factor will prioritize not retaining resources with higher heat rates. Resources will be sorted into quartiles based on their heat rates by plant type (i.e., CCGTs will rank only amongst other CCGTs) and will be given a score based on the quartile with a score of 4 corresponding to the highest quartile. Heat rates are derived from confidential and only the quartile score is included in the data in Appendix G.

5. Plant Age: Factor prioritizes not retaining older resources. Resources will be sorted into quartiles based on their age by plant type and will be given a score based on quartile with a score of 4 corresponding to the oldest quartile. A generator's age is based on the CAISO's master generating list commercial online date.

Local Reliability Factors

6. Local Area Effectiveness Factor (LEF): Factor will prioritize not retaining resources with a low or no report LEF percentage. Effectiveness factors are published in the CAISO's Local Capacity Technical Studies and note the effectiveness of local resources in meeting temporal local reliability needs. Resources will be sorted into quartiles based on LEF percentages and given a score between 1 and 3, with highest quartile receiving a 1, the middle two quartile receiving a 2, and the lowest quartile receiving a 3. Resources with no LEF percentage will be given the highest score of 4. This ranking will be done across both all resources.

Appendix H includes a summary of the existing CAISO gas fleet's breakdown by these six factors and other information.

CPUC staff implemented selection criteria by weighting the six factors above to develop a score for each unit. The scores were calculated by weighting the three categories as follows:

- 50% for Environmental & Community Impact Factors, all three combined,
- 25% for Performance related factors, both combined, and
- 25 % for the Local Reliability Factor.

Staff included two additional exclusions, with generators meeting the following criteria not being selected:

1. Exclude generators that are the youngest (units with a Age factor score of 1).
2. Exclude generators that have the highest LEFs (units with a LEF factor score of 1)

Units are selected highest scores first until the selected plants have a combined MW capacity roughly equal to the amount retired in the selected model year. When selecting between plants with the same score, staff generally narrowed comparison to Age, LEF, and DAC scores. As the portfolio assumptions have combined heat and power units (CHPs) with a separate forced in retirement, CHP unit section was conducted separately using the same criteria scoring process.

The base case portfolio gas reductions include the assumed retirement of the Once Through Cooling (OTC) plants and the forced in phase out of 1.9 GW of in front of meter CHPs between 2031 and 2040. The base case portfolio also includes 2.7 GW of gas capacity selected by RESOLVE as not retained for economic optimization in both 2034 and 2039 models. The total amount of gas not retained in the two base case model years is summarized in Table 102.

Table 102: Gas capacity amounts not retained in the 24-25 TPP base case.

Unit Type	Amount in 2034 model year	Amount in 2039 model year
OTCs	3.7 GW	3.7 GW
CHPs	0.76 GW	1.7 GW
CCGT & Peakers	2.7 GW	2.7 GW
All Types Combined:	7.1 GW	8.1 GW

The high gas retirement sensitivity portfolio includes the same OTC retirements and CHP phaseout assumptions. On top of that, the portfolio includes 4.7 GW of gas retirements forced-in in 2034 and 10.5 GW in 2039. The total amount of gas not retained in the two sensitivity portfolio model years is summarized in Table 103.

Appendix H includes a summary of the units selected in both the base case and high gas retirement sensitivity portfolios, with the full plant list for both portfolios included in Appendix G.

Table 103: Gas capacity amounts not retained in the High Gas Retirement Sensitivity Portfolio.

Unit Type	Amount in 2034 model year	Amount in 2039 model year
OTCs	3.7 GW	3.7 GW
CHPs	0.76 GW	1.7 GW
CCGT & Peakers	4.7 GW	10.5 GW
All Types Combined:	9.1 GW	15.9 GW

8.2 Demand Response

This subsection provides guidance on modeling treatment of demand response (DR) programs in network reliability studies including allocating capacity from those programs to transmission substations. The CPUC's Resource Adequacy (RA) proceeding (R. 19-11-009 or its successor R. 21-10-002) determines what resources can provide system and local resource adequacy capacity. Current RA accounting rules indicate that all existing DR programs count to the extent those program impacts are located within the relevant geographic areas being studied for system and local reliability. For its TPP studies the CAISO utilizes data from Supply-Side Resource Demand Response, which is registered in the CAISO market as either dispatchable, Emergency DR (RDRR) or Economic DR (PDR).

By nature, impacts from DR programs are distributed across large geographies. In order for these impacts to be applied in network reliability studies, DR program capacity must be allocated to

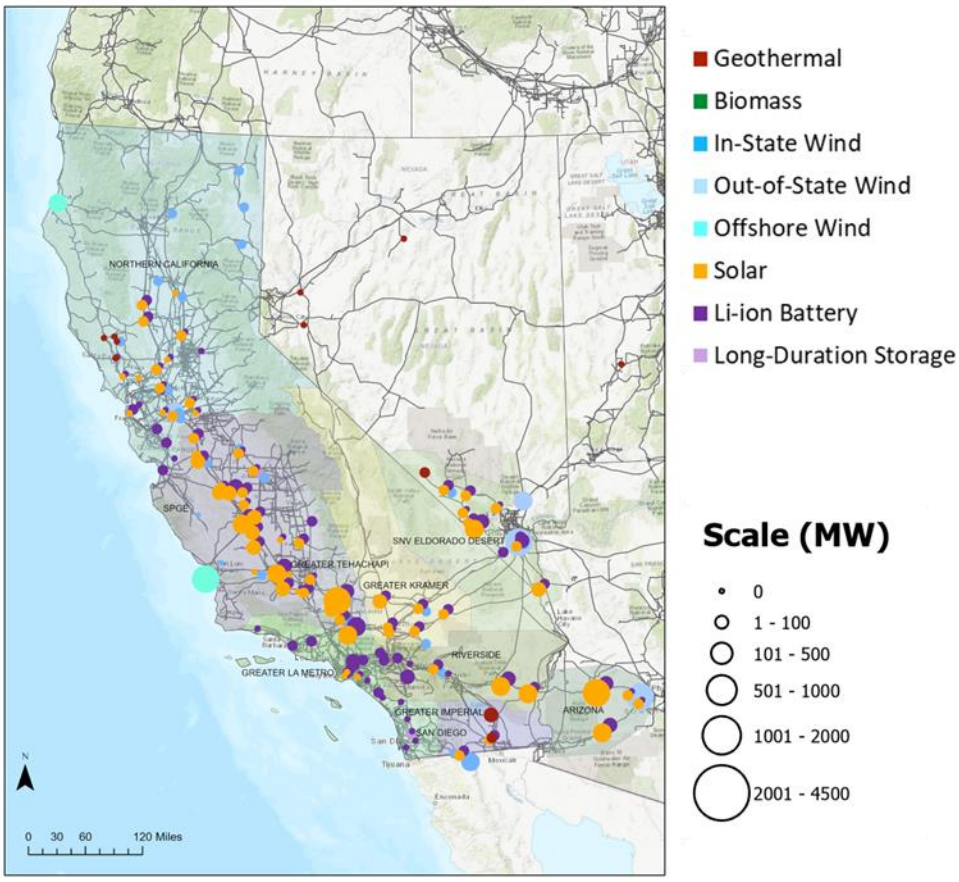
transmission substations. The 24-25 TPP portfolios do not include any model driven DR resource; however, individual LSEs may have procured DR not captured in the IRP modeling effort. To this end, CPUC staff requests the Investor-Owned Utilities (IOUs), in their capacity as Participating Transmission Owners (PTOs), to submit this information through the CAISO's annual TPP Study Plan stakeholder process. To the extent possible, this data should also allocate impacts of DR programs administered by CCAs or procured from third parties. Because the data requirements specified in both filings contain confidential information, the CPUC expects the CAISO and the IOUs to exchange data using their own non-disclosure agreements.

9. Conclusion and Next Steps

The CPUC's policy and reliability base case portfolio and the high gas retirement sensitivity portfolio have been mapped to busbars in reasonable accordance with the criteria as described in the Methodology (see Appendix A) and with consideration of state policy objectives and stakeholder feedback. Staff mapped two model years for both portfolios, 2034 and 2039, with the 15-year outlook being implemented for the first time for this cycle.

In total for the base case portfolio, Working Group staff mapped over 53,400 MW of renewables, including 9,000 MW of out-of-state wind on new out-of-state transmission and 4,500 MW of offshore wind, and 23,800 MW of storage, including 1,000 MW of long duration storage, in the 2039 portfolio to substations. Figure 16 depicts a visual map-based representation conveying the approximate locations and amounts of resources mapped for the 2039 base case portfolio.

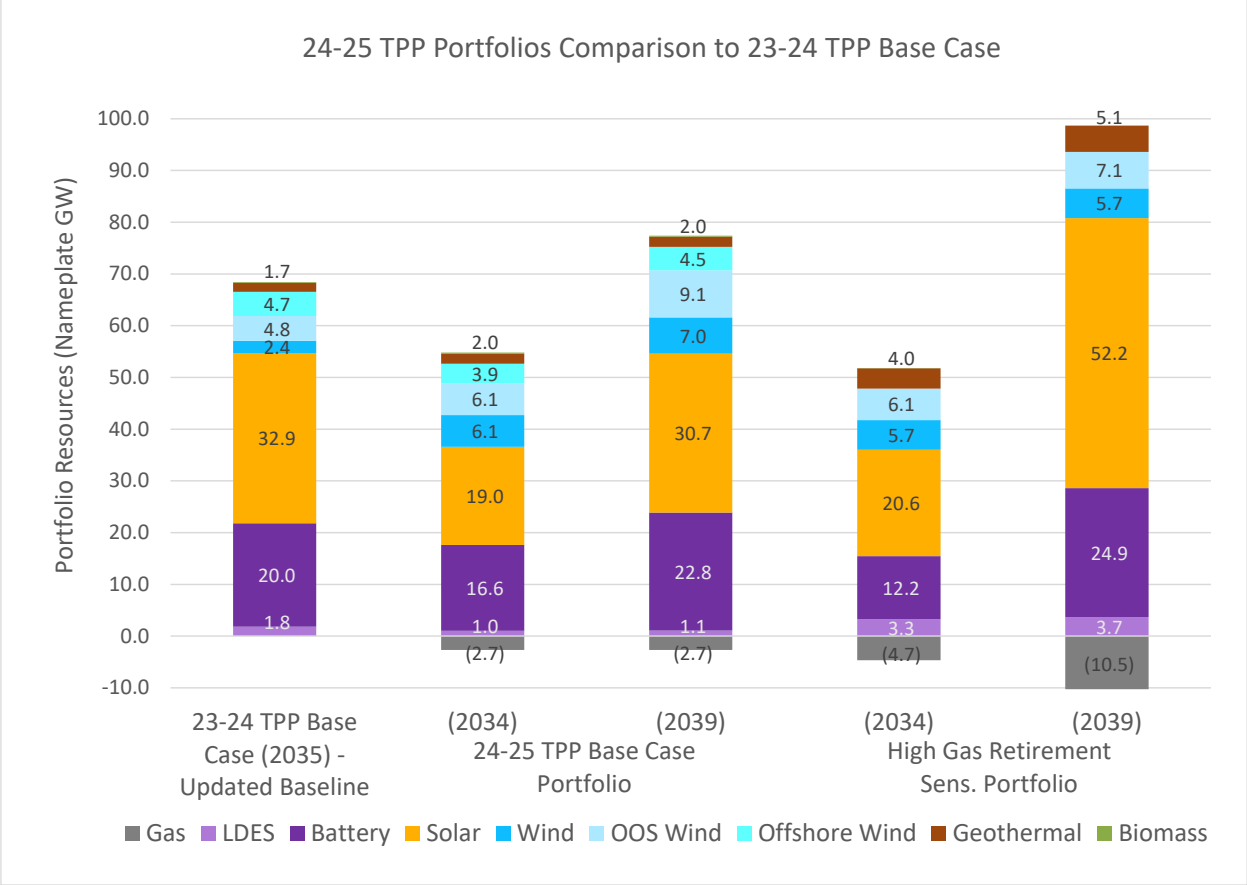
Figure 16: Map of the final busbar mapping results for the 24-25 TPP base case portfolio (2039) shown by mapped interconnection location and amount mapped by resource type.



The final mapping results of the 2034 and 2039 mapped portfolios (Appendix E) are transmitted to the CAISO for use in the reliability and policy-driven base case in the 2024-2025 TPP. Figure 17 compares the resources mapped in the 2024-2025 TPP base case portfolio for the two study years, 2034 and 2039, as well as the high gas retirement sensitivity portfolio, with the base case portfolio

for the current 2023-2024 TPP. Note, the resources in the 23-24 TPP portfolio have been adjusted to align with the updated baseline of the new portfolios.

Figure 17: Final resource comparison of the 2024-20225 TPP base case portfolio and the high gas retirement sensitivity portfolio in the 2034 and 2039 model years with the 2035 model year of the 23-24 TPP base case.



As was the case for the 23-24 TPP base case portfolio mapping results, the large number of resources mapped due to the higher load scenario, more stringent greenhouse gas emissions target, and longer modeling timeframe in the 24-25 TPP base case results in a significant amount of transmission upgrades being identified as likely needed. Based on preliminary CPUC staff estimates derived from the busbar mapping analysis, the 2034 portfolio mapping of the 24-25 TPP base case may need transmission upgrades that cost between $10 billion and $20 billion, including transmission needs for offshore wind and the full costs of likely out-of-CAISO transmission needed for OOS resources. For the 2039 portfolio, that estimated total cost projection of upgrades potentially needed increases to between $20 billion and $29 billion.

These are only rough estimates by CPUC staff of what could be needed for the base case portfolio, and an exceedance identified in busbar mapping does not determine if transmission upgrades are needed. Actual transmission needs and their costs may differ significantly once the portfolio is fully studied by the CAISO through the 24-25 TPP. Additionally, these numbers**Error! Reference source not found.** do not reflect what upgrades may be recommended for approval in the upcoming CAISO's 23-24 TPP Report. The 23-24 TPP could result in approval of upgrades that

have been identified as potentially needed for the 24-25 TPP base case and it could also identify areas where upgrades are not actually required. Furthermore, CAISO's TPP is not required to recommend approval of upgrades that address transmission needs only relevant in 2039 or can be started in future years and still be constructed in time to meet the need.

The final busbar mapping of resources results in numerous transmission exceedances, which are described in more detail in Section 7 above. The transmission constraint analysis conducted in busbar mapping is centered on only the CAISO's Balancing Area Authority (BAA). The transmission capability and potential upgrades needed in other BAAs are not fully known. For example, the geothermal resources mapped within the Imperial Irrigation District's (IID's) BAA have been assessed within the CAISO transmission system at the interties where the resources would be imported from the IID's system. As discussed in Section 7.6, the amount of geothermal mapped will likely require new transmission in the IID system for those resources to reach the CAISO intertie. Similarly, resources mapped to Nevada Energy (NVE) substations may require upgrades in NVE's area to reach their identified CAISO interties. Additionally, resources mapped in the CAISO may require transmission upgrades or expansion not included in the analysis based on the 2023 White Paper. As noted in Sections 7.1 and 7.5, both Northern California wind mapped to areas in Lassen and Modoc counties and Central Nevada geothermal are modeled as interconnecting to CAISO but will likely require significant new gen-ties or transmission expansion to interconnect.

The grid is ever evolving and for this reason the CPUC transmits portfolios to the CAISO annually for transmission planning. A key criterion for busbar mapping is consistency with prior portfolios, particularly base cases. The goal is to capture the most current available information while also ensuring continuity from year to year. Thus, the Working Group strives for the mapping of resources to remain consistent with previous portfolios and to utilize the transmission upgrades already identified in previous TPPs. This consistency also helps indicate which transmission exceedances created by the mapping results for the 2024-2025 TPP portfolio could be alleviated by upgrades being studied in current ongoing 2023-2024 TPP, thereby enhancing transmission planning.

9.1 Additional Guidance on the 2024-2025 TPP Base Case Portfolio

The mapped results, as noted above, highlight the likely need for a significant amount of transmission upgrades; however, many of the identified exceedances are similar to those observed in the 23-24 TPP base case which is still the subject of ongoing analysis. The mapping also results in a significant need for new transmission to interconnect North Coast offshore wind and new transmission beyond the CAISO's BAA to interconnect the OOS and out-of-BAA wind and geothermal resources to CAISO interties. Potential 2023 White Paper upgrades were identified as likely needed for the 2034 and 2039 mapping results in most CAISO study areas. CPUC staff estimate that the potential upgrades within the CAISO for the 2034 portfolio have costs ranging from $1.9 – $8.6 billion. In addition, new transmission needed to interconnect the offshore wind mapped could cost between $2.5 – $4.5 billion, while the new transmission beyond CAISO's borders needed for OOS wind ranges between $5 – $7 billion. In the 2039 portfolio, CPUC staff estimate that the in-CAISO upgrades potentially needed could cost between $9.1 – $14.9 billion based on 2023 White Paper costs and additional analysis, while offshore wind and out-of-state resources would likely need upgrades costing between $11 – $14 billion. Upgrades approved in the

2023-24 TPP may reduce these amounts as such upgrades would likely alleviate many of the identified exceedances. CPUC staff provide additional guidance to the potential transmission implications in each CAISO study area in Section 7.

The transmission utilization analysis conducted in busbar mapping is limited in scope and designed to highlight areas that may require transmission solutions to accommodate resources mapped. Busbar mapping and RESOLVE modeling are not power flow modeling tools and cannot identify with 100% accuracy where transmission is needed and what upgrades are required – that is the role of the full TPP analysis. Therefore, there is uncertainty in what actual transmission may be required by the portfolio mapping results and TPP analysis may identify alternative, less costly upgrades than those assumed in busbar mapping. CPUC staff encourage the CAISO to assess alternative and potentially less costly upgrades particularly for the exceedances discussed in Section 7 where the amount of resources behind the exceedances may not warrant the size and cost of the identified 2023 White Paper upgrades.

If the TPP policy-driven assessment of the base portfolio identifies the need for upgrades, the CAISO would typically recommend those upgrades to the CAISO Board of Governors for approval as policy-driven transmission upgrades. The CAISO retains more flexibility with approval of projects if they are identified only in the reliability assessments, if they are identified as needed for only the 2039 mapping results, and if the estimated build time does not necessitate immediate commencement to meet the identified resource need. CPUC staff will continue to coordinate with CAISO staff through the busbar mapping Working Group. CPUC staff will also be engaged in the CAISO's Transmission Planning Process by providing comments or additional guidance through the TPP stakeholder process.

Alignment with CAISO Queue Resources with Allocated TPD

As was done for the 23-24 TPP, CPUC staff request that the 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 policy- and reliability-driven base case portfolio, while preserving the existing transmission capacity that has been allocated to other projects earlier in the interconnection queue. Working Group staff sought to align the mapping with resources in the CAISO'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 will engage with CAISO staff to identify any TPD not already accounted for by the mapping of the portfolio's resources in these key areas. CPUC staff will compile the MW amounts and locations of these TPD resources so that the CAISO can include them in addition to the mapped portfolio resources when conducting TPP analysis.

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

The amount of OOS wind on new transmission (6,095 MW in 2034 and 9,095 MW in 2039) is significantly higher in this base case portfolio than in past TPP base cases. As was done for the 23-24 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. For the 2034 portfolio, the wind was mapped as follows: 1,060 MW of Idaho Wind interconnecting at Harry Allen and assumed to use the proposed SWIP-North line, 2,905 MW of Wyoming wind interconnecting to Harry Allen or El Dorado 500 kV and assumed to utilize the proposed TransWest line, and 2,131 MW of New Mexico Wind interconnecting at Palo Verde using the proposed SunZia line and existing

transmission. In 2039, the amount of New Mexico wind mapped to Palo Verde increases to 3,535 MW and Wyoming Wind increases to 4,500 MW. For the additional New Mexico wind, Working Group staff assumed the same interconnection at Palo Verde; but for 1,500 MW of addition Wyoming wind, staff mapped it as interconnecting using new transmission to Northern California in the Tesla area. As discussed in Section 7.1, staff aligned this 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 24-25 TPP base case portfolio, in addition to the over 9,000 MW of OOS wind on new transmission by 2039, has a significant amount of geothermal mapped to IID and areas in Nevada and Utah beyond the CAISO's Balancing Area. As was done for the 2023-2024 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 geothermal resources, Working Group staff identified the resources as requiring MIC expansion. Full details of the out-of-CAISO resources can be found on the "Out-of-CAISO_Summary" tab of the Final Mapping Dashboard (see Appendix E).

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

As with past TPP portfolio transmittals, CPUC staff acknowledge that, in some cases, more information is needed to understand the full impacts of the battery mappings, particularly in LCR areas, before new transmission projects are identified by the CAISO as needed. Accordingly, CAISO staff should consult CPUC staff 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's 2023-2024 Transmission Plan, CPUC staff would 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 these 2024-2025 TPP portfolio.

9.2 Additional Guidance on the High Gas Retirement Sensitivity

In developing the high gas retirement sensitivity and asking CAISO to study it in its TPP, the CPUC is attempting to collect planning information about the impacts and transmission requirements of potential gas plant retirements. The energy planning agencies have limited detail regarding potential transmission needs for retiring gas units and these portfolios are an early step in expanding the set of information that can be used in planning and potential procurement in the future. The high gas retirement sensitivity is an important step for identifying the transmission that would be necessary to address local reliability issues that are likely to arise with the retirement of a significant subset of the natural gas plants. The selection of generators, described in more detail in Section 8.1 and listed in Appendix G, are not projections of what plants will retire in the future but just a plausible set of network locations to enable the power flow scenario analysis. The CPUC is not directing retirement of specific gas generators via this study or attempting to assert authority to retire specific units via this study.

CPUC staff note that the breakdown of the units selected is different than those previously studied and currently being studied at a higher level in the CAISO's 20-year transmission outlooks. These differences are largely driven by additional criteria factors included in the mapping of units for these portfolios. Studying different combinations of units is a useful exercise that can provide additional information about impacts certain units have as well as potential transmission solutions common across the different scenarios. In addition to potential transmission solutions that can be used in planning and potential procurement in the future., CPUC staff encourage the CAISO to assess, where possible within the TPP analysis, the potential for battery storage or other non-transmission alternatives to serve as solutions to any potential transmission needs arising from the generators modeled as not retained.

9.3 Busbar Mapping for Future TPP Cycles

Staff appreciates the feedback and suggestions from stakeholders in comments and replies to the October 2023 Ruling and January 2024 Proposed Decision. Feedback and suggestions not already addressed in the transmittal for the 2024-2025 TPP will be a priority for consideration in the draft workplan for 2025-2026 TPP busbar mapping. The busbar mapping effort for the next cycle will seek to continue to refine the major updates implemented to the busbar mapping criteria this cycle, particularly the new transmission information from the CAISO's 2023 White Paper and the new land-use and environmental screens developed by the CEC. CPUC staff will continue to work with CAISO staff and CEC staff to improve the data used for busbar mapping and the mapping analysis itself. Furthermore, CPUC staff continue to strive to resolve the process alignment and timing issues that make it challenging to inform resource-to-busbar mapping for an upcoming TPP with the results of the ongoing TPP.

10. Appendices

A. Methodology for Resource-to-Busbar Mapping for the Annual TPP

24-25 TPP October 2023 Ruling version, 10/05/23: 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/mapping_methodology_v10_05_23_ruling.pdf

B. Dashboard for Preliminary Mapping of Proposed 24-25 TPP Base Case

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 10/26/23, Link: 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_prelimmapping_10-26-23.xlsx

C. Updated Dashboard for Preliminary Mapping of Proposed 24-25 TPP Base Case

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 10/26/23, Link: 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_prelimmapping_v2_12-08-23.xlsx

D. Dashboard for the Proposed Decision Mapping of the 24-25 TPP Base Case

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage: 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_basecase_vpd_01-10-24.xlsx.

E. Final Mapping Dashboard for the 24-25 TPP Base Case

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage. Link: 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

F. 2023 Baseline Reconciliation and In-Development Resources

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 10/26/23, Link: 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

G. Gas Capacity Not Retained Assumption List for the Base Case and Sensitivity Portfolios

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 02/15/24. Link: 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/gasnotretained_mappingresults.xlsx

H. Overview Slides for Gas Capacity Not Retained Selection Criteria and Summary

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 02/15/24. Link: 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/gasnotretained_overview.pdf

I. Commercial Interest Analysis of CAISO Interconnection Queue

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 10/26/23, Link: 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/caiso_queue_mappinganalysis_8-8-23.xlsx.

J. Dashboard for the High Gas Retirement Sensitivity

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 02/16/24. Link: 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

K. CEC Land-use and Environmental Screen Analysis workbooks

Posted to the CPUC's "Assumptions for the 2024-2025 TPP" webpage, 02/15/24. Link: 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/cec_landuse-env_screensbysub.zip

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