Modeling Assumptions for the 2025-2026 Transmission Planning Process

CPUC Staff Report

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Contents

1. Document Purpose 4
2. Scope 5
3. Report Summary 6
4. Inputs 10
   - 4.1 25 MMT Core (with 11/1/2022 LSE Plan Filing) Portfolio 10
   - 4.2 Long Lead-Time Resources Sensitivity Portfolio 19
   - 4.3 Baseline Reconciliation 26
5. Busbar Mapping Methodology Updates and Adjustments 29
6. Analysis 31
   - 6.1 Initial Mapping Results for 25-26 TPP Base Case Portfolio 31
   - 6.2 Initial System Level Transmission Criteria Alignment 34
   - 6.2.A Initial Land-use Feasibility and Environmental Implications Criteria Alignment 40
   - 6.2.B Initial Community Environmental Impacts Criteria Alignment 48
   - 6.2.C Initial Commercial Development Interest Criteria Alignment 49
   - 6.2.D Initial Prior TPP Base Case Criteria Alignment 57
   - 6.3 Post-Ruling Portfolio Modeling and Busbar Mapping Adjustments 63
   - 6.3.A Net Mapping Adjustments for 2035 Base Case Portfolio 64
   - 6.3.B Net Mapping Adjustments for 2040 Base Case Portfolio 66
   - 6.3.C Net Mapping Adjustments by CAISO Study Area 68
   - Northern California – PG&E North of Greater Bay and Greater Bay Study Areas 68
   - Southern PG&E – PG&E Fresno and Kern Study Areas 70
   - Greater Tehachapi & LA Metro — SCE Northern and SCE Metro Study Areas 71
   - Greater Kramer – SCE North of Lugo Study Area 72
   - Southern Nevada – East of Pisgah Study Area 73
   - Riverside and Arizona – SCE Eastern Study Area 74
   - San Diego, Imperial, and Arizona – San Diego Gas & Electric Study Area 74
   - 6.4 Mapping Criteria Alignment, Post-Remapping 76
   - 6.4.A Updated System Level Transmission Criteria Alignment 79
   - 6.4.B Updated Substation Interconnection Viability Criteria Alignment 88
   - 6.4.C Updated Land-use Feasibility and Environmental Implications Criteria Alignment 93
   - 6.4.D Updated Community and Societal Environmental Impacts Criteria Alignment 100
   - 6.4.E Updated Commercial Development Interest Criteria Alignment 102
   - 6.4.F Updated Prior TPP Base Case Criteria Alignment 109
7. Results 116

7.1 Transmission Exceedances in Busbar Mapping and RESOLVE Modeling 117
7.2 Northern California: PG&E Greater Bay and PG&E North of Greater Bay Study Areas 118
7.3 Southern PG&E: PG&E Fresno and Kern Study Areas 124
7.4 Greater Tehachapi and LA Metro: SCE Northern and Metro Study Areas 128
7.5 Greater Kramer and Southern Nevada: SCE North of Lugo Study Area and East of Pisgah Study Area 130
7.6 Riverside, Arizona, San Diego, and Imperial: SCE Eastern and San Diego Gas & Electric Study Areas 134
7.7 Long Lead-time Resources Sensitivity Portfolio 138
7.7.A Comparison to Base Case Mapping 142
7.7.B Transmission Implications 143
8. Other Assumptions for TPP 148
8.1 Gas Capacity Not Retained 148
8.2 Demand Response 148
9. Conclusion and Next Steps 150
9.1 Guidance on the 2025-2026 TPP Base Case Portfolio 153
9.2 Guidance on the Long Lead-Time Resources Sensitivity Portfolio 156
9.3 Busbar Mapping for Future TPP Cycles 156
10. Appendices 157

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 busbar mapping Working Group – CPUC, CAISO and California Energy Commission (CEC) staff – and transmitted to the CAISO for input into the 2025-2026 TPP. 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 performed to obtain those results. While transmission constraint information and analysis are incorporated into this analysis, busbar mapping and the CPUC does 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, in its transmittal of the TPP portfolios to the CAISO, also provides additional guidance and requests on how to use the mapped results and other information in the CAISO's TPP analyses.

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.[1]

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] Previous busbar mapping Reports for earlier TPP cycles are posted to the IRP webpage. The previous Report for the 24-25 TPP is at the Assumptions for the 24-25 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/assumptions-for-the-2024-2025-tpp

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 2025-2026 TPP, as outlined in Table 1 below.

Table 1: Modeling Assumptions Reported in this Document

IRP Portfolio	**2025-2026 TPP Portfolio Use Case(s)**	**Modeling Assumptions**
2025-26 TPP portfolio (25 MMT GHG target by 2035 Core portfolio using the 2023 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 2035 and 2040 model years • Baseline reconciliation between the 2023 IRP baseline and the CAISO's 2024 White Paper baseline. • Thermal units not retained assumptions
25 MMT long lead-time sensitivity portfolio using the 2023 CEC IEPR Planning Forecast— long lead-time (LLT) sensitivity portfolio	• Policy-driven sensitivity assessment	• Busbar allocations of non-battery resources and battery resources for 2035 and 2040 model years • Baseline reconciliation between the new 2022-23 IRP baseline and the CAISO's 2024 White Paper baseline. • Thermal units not retained assumptions

3. Report Summary

The September 12, 2024, Ruling Seeking Comments on Electricity Resource Portfolios for 2025-2026 Transmission Planning Process (September 2024 Ruling)[2] proposed the 25 MMT GHG target by 2035 Core portfolio using the 2023 CEC Integrated Energy Policy Report (IEPR) Planning forecast and including Load Serving Entities' (LSEs) individual 2022 IRP resources as the reliability and policy-driven base case portfolio for the 25-26 TPP. The ruling proposed mapping and transmitting two study years: 2035 and 2040 for the portfolios in compliance with the requirements of SB 887 (Stats. 2022, Ch. 358).[3] The ruling also proposed transmitting a policy-driven sensitivity portfolio, the Long Lead-Time (LLT) resources sensitivity portfolio, which includes 2.1 GW geothermal, 7.6 GW offshore wind, and 3 GW long duration energy storage resources in 2035. The LLT capacity amounts included in the sensitivity portfolios use the amounts reflected in D.24-08-064[4] as an upper bound, while also including the LLT resource amounts required by D.21-06-035[5].

The base case portfolio includes over 43 GW of new renewable resources and over 20 GW of storage in the 2035 model year. The portfolio's 2040 model year includes nearly 70 GW of renewables, including 1.64 GW of geothermal, 10.7 GW of out-of-state wind on new out-of-state transmission, and 4.5 GW of offshore wind, as well as over 29 GW of storage, including 1.26 GW of long duration storage. These new resources are incremental to the resources included in the 2023 IRP Inputs and Assumptions modeling baseline, which includes both existing resources and new resources not yet online.

Initial busbar mapping results for the proposed base case portfolio were released with the October 30, 2024, Ruling Seeking Coming on Busbar Mapping of Electricity Resource Portfolios for the 2025-2026 Transmission Planning Process (October 2024 Ruling).[6] Working Group staff conducted an additional round of mapping taking into consideration parties' comments to the September 2024 and October 2024 Rulings. The updated mapping results for the base case portfolio and the LLT resources sensitivity portfolio were released with the January 10, 2025, Proposed Decision Transmitting Electricity Resource Portfolios to the California Independent System Operator for the 2025-2026 Transmission Planning Process.[7]

Figure 1 below, includes a graph and map which provide a geographic overview of the updated mapped results for base case portfolio's 2035 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 mapped by general region. Figure 2 shows the same overview for the base case portfolio's 2040 model year updated mapping results. Figure 3 shows the mapping results overview for the LLT resources sensitivity portfolio's 2040 model year.

[2] https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=544973870
[3] SB 887 established PUC § 454.57 which requires, amongst other things, the CPUC to transmit to the CAISO for its TPP resource portfolios for at least 15 years into the future to ensure adequate lead-time for transmission planning and development.
[4] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M539/K202/539202613.PDF
[5] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M389/K603/389603637.PDF
[6] https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M544/K973/544973870.PDF
[7] https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M553/K678/553678610.PDF

Figure 1: Updated busbar mapping results of the 25-26 TPP base case portfolio 2035 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region. Resources shown in MWs.

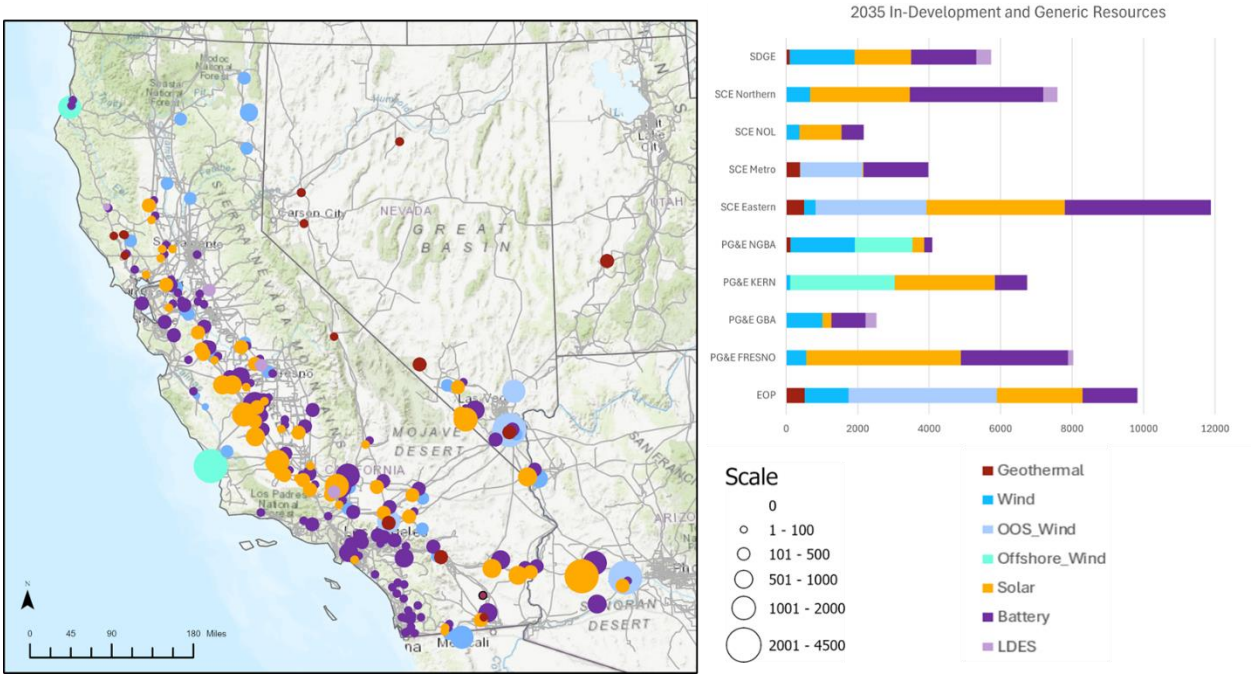


Figure 2: Updated busbar mapping results of the 25-26 TPP base case portfolio 2040 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region. Resources shown in MWs.

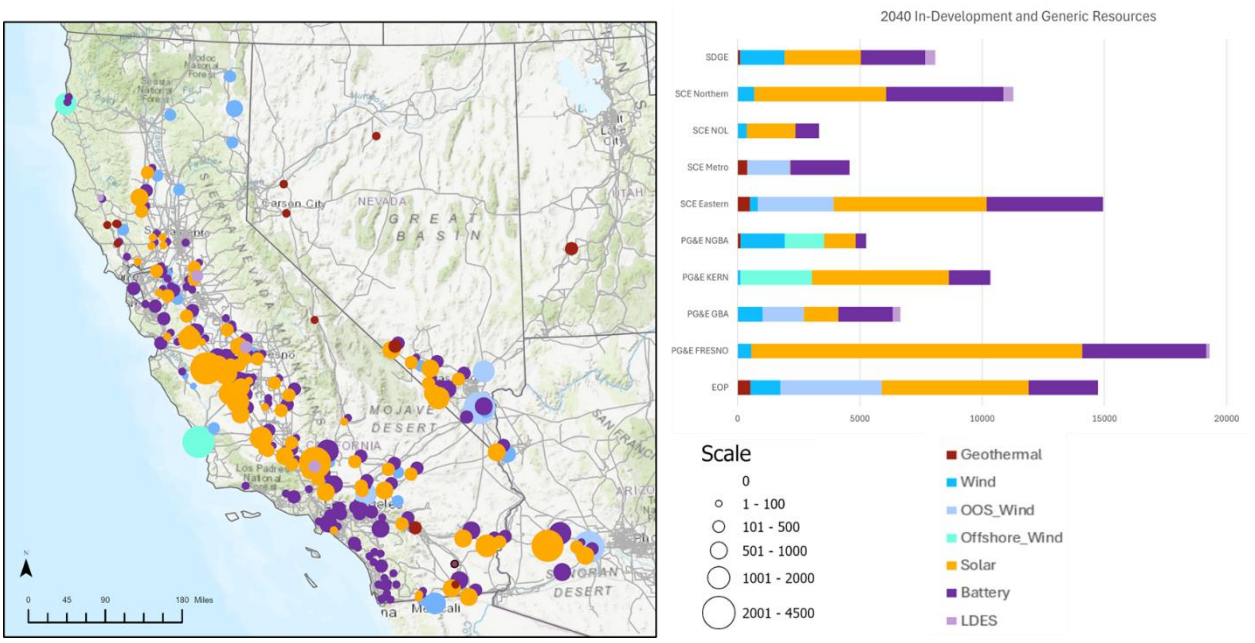
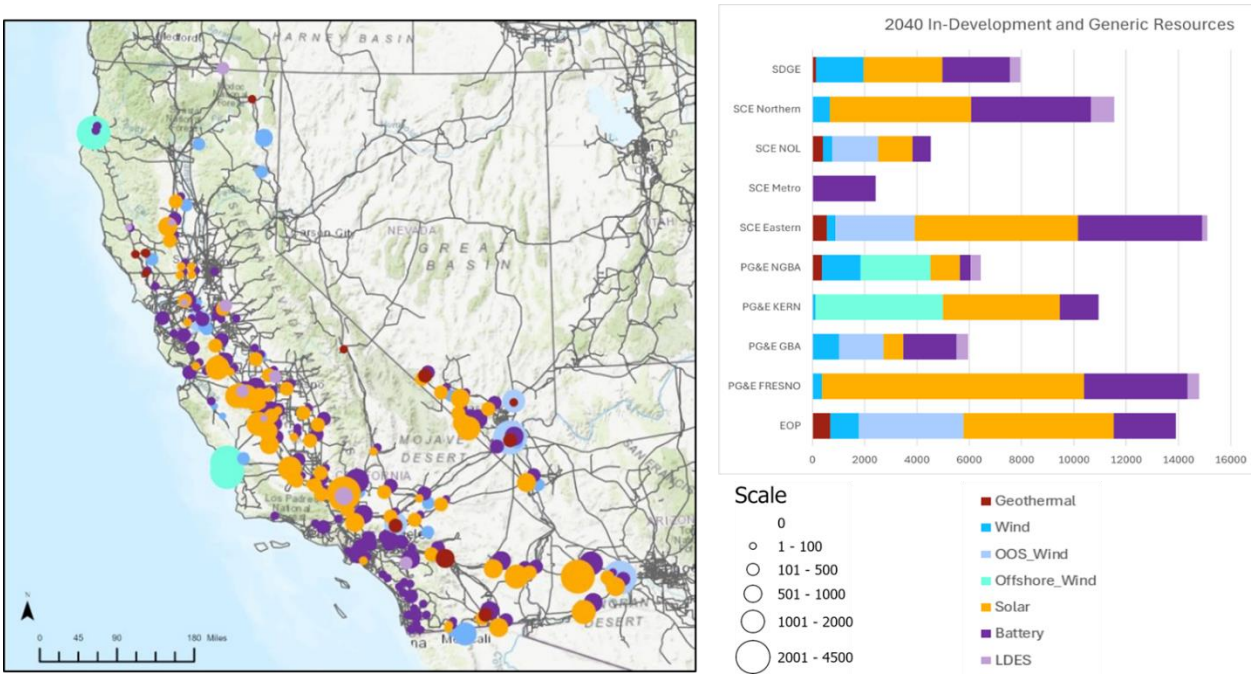


Figure 3: Busbar mapping results of the 25-26 TPP LLT resources sensitivity portfolio 2040 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region. Resources shown in MWs.



This Report describes the proposed base case portfolio, the initial mapping results released with the October 2024 Ruling and its alignment with the busbar mapping criteria, the mapping adjustments made subsequently, the updated mapping results and its alignment with the busbar mapping criteria, and CPUC staff's analysis on the potential transmission implications of the mapped portfolio. It also provides additional inputs, and guidance for modeling the mapped portfolios and assessing potential transmission solutions in the CAISO's 25-26 TPP. This Report describes the LLT resources sensitivity portfolio and has been updated to include the key mapping results. It incorporates final results based on earlier referenced adjustments that considered stakeholder feedback.

This Report is structured as follows:

> **Section 4** states the objectives of studying the base case and sensitivity portfolios, summarizes the portfolios themselves, and details the RESOLVE model's resource and transmission outputs for the portfolios.

Section 5 summarizes the updates made to the mapping methodology[8] used by CPUC, CAISO and CEC staff to conduct busbar mapping and to produce other inputs and assumptions for the 25-26 TPP.

Section 6 details the initial busbar mapping criteria analysis, remapping steps taken by the Working Group to improve the mapping allocations to meet the criteria, and the updated mapping results and its alignment with the criteria.

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

Section 8 presents other information about the portfolios required for TPP modeling including gas retirement assumptions.

Section 9 draws conclusions regarding mapping the portfolios for the 25-26 TPP and provides guidance to the CAISO for its 25-26 TPP analysis.

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.

[8] Referring to the version attached to the September 2024 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/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/mapping_methodology_vruling_2024-09-06.pdf

4. Inputs

In order to complete the busbar mapping, the following input is needed: Portfolios of selected resources for 2035 and 2040 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 LLT resources sensitivity portfolio (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 baselines used for CAISO's transmission constraint assumptions and the CEC's geospatial analysis for the land-use and environmental impact criteria datasets.

4.1 25 MMT Core (with 11/1/2022 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, IRP capacity expansion modeling, and other policy goals. This 25 MMT Core with the 2023 IEPR 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 25-26 TPP extends to 2040, the emissions of the portfolio in 2040 are lower than 25 MMT. This is described in more detail under the Description of Portfolio section below. The 2023 IEPR planning load scenario utilized in the portfolio is designed to reflect a higher electrification future with increased retail sales and gross peak driven by expanded building electrification and lower energy efficiency impacts compared to the 2022 IEPR.

To improve the degree of accuracy of the transmission upgrade information that comes out of the RESOLVE analysis for the 24-25 TPP and the 2023 Preferred System Plan, CPUC staff updated the modeling of transmission deliverability using data from the 2023 CAISO White Paper: Transmission Capability Estimates for Use in the CPUC's Integrated Resource Planning Process (2023 White Paper)[9]and supplemented it with data from CAISO's 2022-2023 TPP Board approved Transmission Plan.[10] 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 2022 IRP

[9] "Transmission Capability Estimates for Use in the CPUC's Integrated Resource Planning Process." CAISO, (June 29, 2023). White Paper and support documents: https://www.caiso.com/library/transmission-capability-estimate-inputes-for-cpuc-integrated-resource-plan-jul-05-2023

[10] CAISO Board Approved 2022-2023 Transmission Plan (May 18, 2023). https://www.caiso.com/documents/iso-board-approved-2022-2023-transmission-plan.pdf https://www.caiso.com/documents/iso-board-approved-2022-2023-transmission-plan.pdf

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 resources contained in the LSE plans.

For the development of the proposed 25-26 TPP portfolios, CPUC staff made minor changes to RESOLVE's modeling capabilities and input assumptions. These were: new transmission cluster constraints representation, new geothermal resource costs, and new Arizona solar profiles to account for daylight savings. These updates are discussed in the supporting documentation[11] released with the September 2024 Ruling. CAISO released an updated White Paper in August 2024 (2024 White Paper),[12] but CPUC staff could not incorporate the updated transmission information or the approved 23-24 TPP into RESOLVE in time for developing the proposed 25-26 TPP portfolios. The updated transmission information from the 2024 White Paper is, however, used in the busbar mapping and criteria analysis.

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 proposed 25-26 TPP base case portfolio indicates the need for 7,823 MW of partial or full transmission upgrades by 2035 and 15,187 MW by 2040 to accommodate the full number of resources selected in 2035 and 2040 that could not be accommodated by the existing transmission system, in addition to 13,938 MW of capacity increases corresponding to 2023 White Paper transmission projects that have already been approved by the CAISO.

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 help limit the risk of stranded generation assets later being discovered to be undeliverable to load due to a lack of available transmission capability.

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[11] "2025-2026 Transmission Planning Process RESOLVE Analysis," (9/12/24), https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/25-26-proposed-tpp-resolve-analysis-slide-deck_final_ver2.pdf

[12] "Transmission Capability Estimates for Use in the CPUC's Integrated Resource Planning Process." CAISO, (August 29, 2024). White Paper and support documents: https://www.caiso.com/library/transmission-capability-estimate-inputs-for-cpuc-integrated-resource-plan-aug-29-2024

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 TPP 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 2035, the generic and in-development portfolio comprises 18,541 MW of new battery storage (15,707 MW of 4-hr storage, 2,834 MW of 8-hr storage), 1,264 MW of long-duration storage (756 MW of pumped hydro storage, 508 MW of compressed-air storage), 34,068 MW of new in-state renewable resources (which includes 4,531 MW of offshore wind), and 9,000 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources. For the planning year 2040, the portfolio comprises 27,718 MW of new battery storage (15,707 MW of 4-hr storage, 12,011 MW of 8-hr storage), 1,264 MW of long-duration storage (756 MW of pumped hydro storage, 508 MW of compressed-air storage), 59,128 MW of new in-state renewable resources (which includes 4,531 MW of offshore wind), and 10,707 MW of new out-of-state (OOS) wind resources on new OOS transmission, among other resources.[13]

Table 2 summarizes the resource build out in 2035 and 2040, which are the resource planning years needed specifically for the 25-26 TPP. The GHG targets modeled in 2035 and 2040 were 25 MMT and 17 MMT respectively.[14]

[13] Full RESOLVE results can be found on the CPUC's Portfolios and Modeling Assumptions for the 2025-2026 Transmission Planning Process website: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2024-26-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp

[14] This represents the CAISO contribution extrapolated from a 25 MMT by 2035 target to the 8 MMT by 2045 target adopted in the 2023 CARB Scoping Plan.

Table 2. Cumulative Capacity Additions in 2035 and 2040 in the Base Case Portfolio

RESOLVE 25-26 TPP Base Case Portfolio (2035 and 2040 Results) - Ruling Vintage			
		11/5 Ruling Vintage	11/5 Ruling Vintage
Resource Type	**Unit**	**2035**	**2040**
Natural Gas	MW	-	-
Geothermal	MW	1,639	1,639
Biomass	MW	171	171
In-State Wind	MW	7,894	7,894
Out-of-State Wind	MW	9,000	10,707
Offshore Wind	MW	4,531	4,531
Solar	MW	19,833	44,893
Customer Solar	MW	-	-
Li-ion Battery (BTM)	MW	-	-
Li-ion Battery (4-hr)	MW	15,707	15,707
Li-ion Battery (8-hr)	MW	2,834	12,011
Pumped Hydro Storage	MW	756	756
Long Duration Storage	MW	508	508
Shed DR	MW	-	-
Gas Capacity Not Retained	MW	-	-
In-State Renewables	**MW**	**34,068**	**59,128**
Out-of-State Renewables	**MW**	**9,000**	**10,707**

In addition to the resource selection information from RESOLVE, transmission upgrade results are used to inform the mapping analysis. Figure 4, Figure 5, and Figure 6 summarize the selected upgrades triggered in RESOLVE in the 2035, 2040, and 2045 snapshot years. The transmission upgrades selected by RESOLVE include projects already approved by the CAISO board but not yet online, as well as potential new upgrades. Information on transmission upgrades available in RESOLVE are based on the 2023 White Paper. As part of the least-cost optimization in RESOLVE, upgrades are selected based on their size and cost, construction lead-time, and the quantity and quality of additional resources that can be delivered by the upgrade, among other factors. For the TPP years under consideration, a total of 21,761 MW by 2035 and 29,125 MW by 2040 of partial and full transmission upgrades are selected by the portfolio.

By 2035 and 2040, RESOLVE selects 14 and 19 upgrades, respectively. Of the selected upgrades in 2035, eight of them are approved upgrades modeled with a cost of $0/kW-yr (this models the fact that they have already been approved and will increase transmission capability but will not do so until their estimated online year), altogether representing 13,938 MW of the total upgrades selected in this model year. For 2035, there are six upgrades that are fully selected and eight upgrades that are partially selected. The fully selected upgrades include the 500kV Colorado River-Red Bluff line upgrade, the 500 kV Devers-Red Bluff line upgrade, the 500kV Trout Canyon-Sloan Canyon line upgrade, an additional 500kV/230kV transformer at the Lugo substation, several upgrades within the Serrano-Alberhill-Valley area including line upgrades within the Southern California Transmission Project, and the VEA 230 kV conversion project (all 2023 White Paper Upgrades). The partially selected upgrades include a re-conductor of the four Lugo-Victor 230 kV lines, a new 500kV/230kV transformer at the Red Bluff substation, an additional 500kV Eldorado-Lugo line, a 230kV Kramer-Victor line upgrade, additional reconductoring in the Internal San Diego area, and

the development of the Humboldt Bay transmission and Morro Bay substation for offshore wind. The latter two are modeled upgrades for offshore wind resources based on potential projects identified in the 21-22 TPP offshore wind sensitivity study.[15]

Of the 19 upgrades selected in 2040, 15 of the projects are projects specified in the CAISO White Paper, two are the offshore wind upgrades noted above, while the remaining two are generic upgrades. The generic upgrades represent non-specific 500 kV transmission line projects, with costs informed by comparable projects from the CAISO White Paper and 2022-2023 CAISO Transmission Plan. One generic upgrade is represented for each CAISO Study Area in the RESOLVE optimization model to provide additional options to deliver high-quality, locationally specific resources that otherwise could not be selected due to the CAISO transmission constraints. 4,500 MW of transmission capability per study area are made available in RESOLVE starting in 2037.

In addition to the 14 projects fully or partially selected by RESOLVE in 2035, five new upgrades are partially selected by 2040. These include a new 500kV/230kV transformer at the Colorado River substation, a re-conductor and reconfiguration of the Gates-Arco-Midway 230kV lines, and a new 3-ohm series reactor on the Silvergate-Bay Boulevard line. Additionally, between 2035 and 2040, additional incremental capacity on partial upgrades are selected for the new 500kV/230kV transformer at the Red Bluff substation, the additional Eldorado-Lugo 500 kV line, and reconductoring in the Internal San Diego area. The two generic upgrades partially selected by 2040 are new 500-kV lines in SCE East of Pisgah and SCE Eastern Study Areas.

[15] CAISO Board Approved 2021-2022 Transmission Plan (March 17, 2022). https://www.caiso.com/documents/iso-board-approved-2022-2023-transmission-plan.pdf

Table 3: All resources selected in the 25 MMT Core portfolio (2035 and 2040 cumulative)

Pre-Round 1 - CAISO RESOLVE Selections		2035 Selected Resource, MW			2040 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	1,217	-	1,217	1,217	-	1,217
	Inyokern_North_Kramer_Geothermal	7	-	7	7	-	7
	Northern_California_Geothermal	314	-	314	314	-	314
	Northern_Nevada_Geothermal	-	-	-	-	-	-
	Pacific_Northwest_Geothermal	60	-	60	60	-	60
	Utah_Geothermal	-	-	-	-	-	-
Solar	Arizona_Solar	3,707	-	3,707	4,117	-	4,117
	Greater_Imperial_Solar	39	-	39	5,171	-	5,171
	Greater_Kramer_Solar	1,012	-	1,012	4,052	-	4,052
	Greater_LA_Solar	-	-	-	375	-	375
	Northern_California_Solar	26	100	126	26	100	126
	Riverside_Solar	659	-	659	8,688	-	8,688
	Southern_NV_Eldorado_Solar	9,111	330	9,441	12,246	330	12,576
	Southern_PGAE_Solar	247	-	247	2,854	-	2,854
	Tehachapi_Solar	4,602	-	4,602	6,934	-	6,934
Wind	Baja_California_Wind	2,473	-	2,473	2,473	-	2,473
	Central_Valley_North_Los_Banos_Wind	153	-	153	153	-	153
	Greater_Imperial_Wind	133	-	133	133	-	133
	Idaho_Wind	300	-	300	300	-	300
	New_Mexico_Wind	6,000	-	6,000	6,000	-	6,000
	Northern_California_Wind	1,988	300	2,288	1,988	300	2,288
	Solano_Wind	405	-	405	405	-	405
	Southern_NV_Eldorado_Wind	711	-	711	711	-	711
	Tehachapi_Wind	1,732	-	1,732	1,732	-	1,732
	Utah_Wind	-	-	-	-	-	-
	Wyoming_Wind	2,700	-	2,700	4,407	-	4,407
	Cape_Mendocino_Offshore_Wind	-	-	-	-	-	-
	Del_Norte_Offshore_Wind	-	-	-	-	-	-
	Diablo_Canyon_Offshore_Wind	-	-	-	-	-	-
	Humboldt_Bay_Offshore_Wind	1,607	-	1,607	1,607	-	1,607
	Morro_Bay_Offshore_Wind	2,924	-	2,924	2,924	-	2,924
Subtotal - Renewables		**42,338**	**730**	**43,068**	**69,105**	**730**	**69,835**
Li-ion Battery	Arizona_Li_Battery_4hr	870	-	870	870	-	870
	Arizona_Li_Battery_8hr	-	-	-	-	-	-
	Greater_Imperial_Li_Battery_4hr	571	-	571	571	-	571
	Greater_Imperial_Li_Battery_8hr	-	-	-	637	-	637
	Greater_Kramer_Li_Battery_4hr	664	-	664	664	-	664
	Greater_Kramer_Li_Battery_8hr	100	-	100	100	-	100
	Greater_LA_Li_Battery_4hr	2,078	-	2,078	2,078	-	2,078
	Greater_LA_Li_Battery_8hr	-	-	-	5,647	-	5,647
	Northern_California_Li_Battery_4hr	3,751	-	3,751	3,751	-	3,751
	Northern_California_Li_Battery_8hr	1,191	-	1,191	1,885	-	1,885
	Riverside_Li_Battery_4hr	520	-	520	520	-	520
	Riverside_Li_Battery_8hr	485	-	485	485	-	485
	Southern_NV_Eldorado_Li_Battery_4hr	3,602	-	3,602	3,602	-	3,602
	Southern_NV_Eldorado_Li_Battery_8hr	-	-	-	1,043	-	1,043
	Southern_PGAE_Li_Battery_4hr	2,395	-	2,395	2,395	-	2,395
	Southern_PGAE_Li_Battery_8hr	1,058	-	1,058	2,214	-	2,214
	Tehachapi_Li_Battery_4hr	1,256	-	1,256	1,256	-	1,256
	Tehachapi_Li_Battery_8hr	-	-	-	-	-	-
Flow Battery	Arizona_Flow_Battery	-	-	-	-	-	-
	Greater_Imperial_Flow_Battery	-	-	-	-	-	-
	Greater_Kramer_Flow_Battery	-	-	-	-	-	-
	Greater_LA_Flow_Battery	-	-	-	-	-	-
	Northern_California_Flow_Battery	308	-	308	308	-	308
	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	477	-	477	477	-	477
	Riverside_West_Pumped_Storage	279	-	279	279	-	279
	San_Diego_Pumped_Storage	-	-	-	-	-	-
	Tehachapi_Pumped_Storage	-	-	-	-	-	-
Adiabatic CAES	Southern_PGAE_Adiabatic_CAES	-	-	-	-	-	-
	Tehachapi_Adiabatic_CAES	200	-	200	200	-	200
Subtotal - Storage		**19,805**	**-**	**19,805**	**28,982**	**-**	**28,982**
Total		**62,143**	**730**	**62,873**	**98,087**	**730**	**98,817**

Figure 4. 25 MMT Core Portfolio - Summary of RESOLVE-triggered transmission expansion by 2035 and 2040, by transmission constraint.

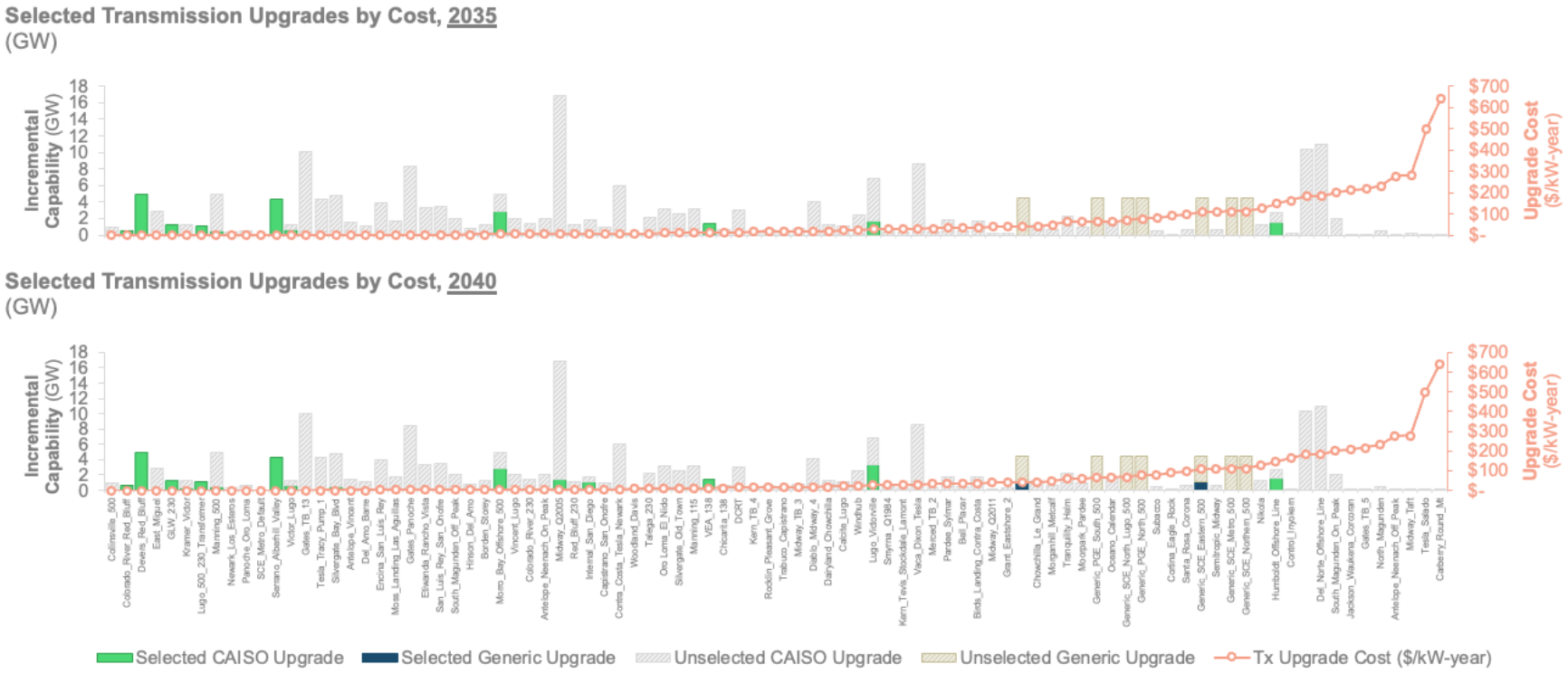


Figure 5. 25 MMT Core Portfolio - Summary of RESOLVE-triggered transmission expansion by 2045, by study area.

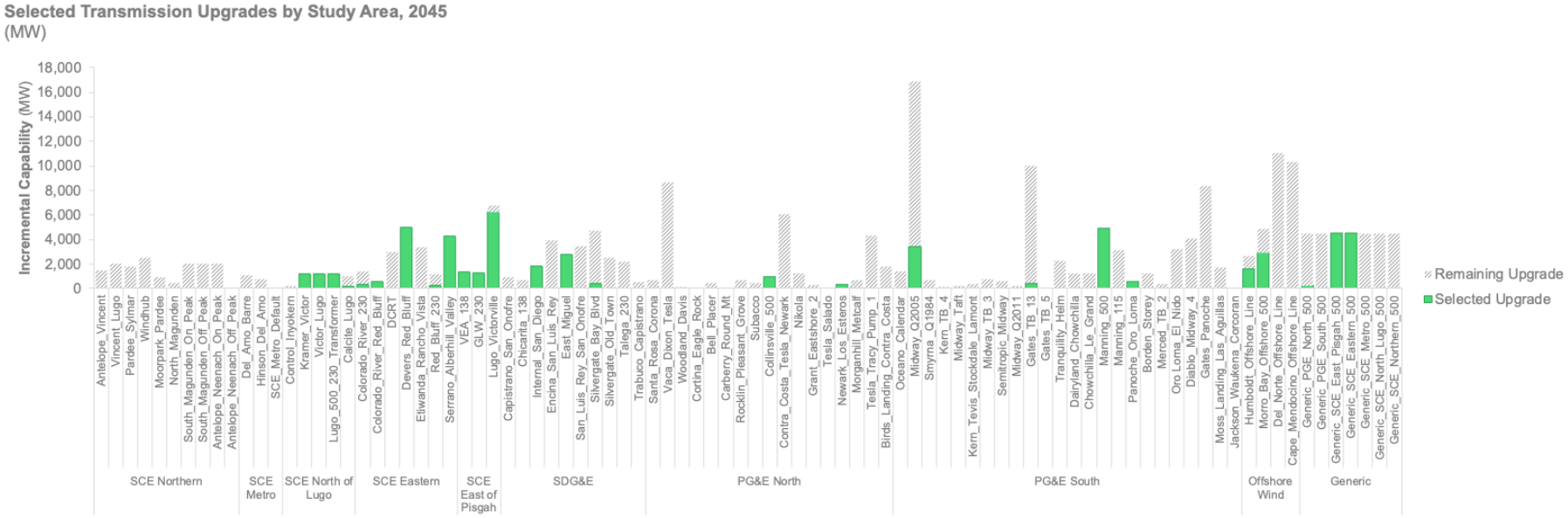
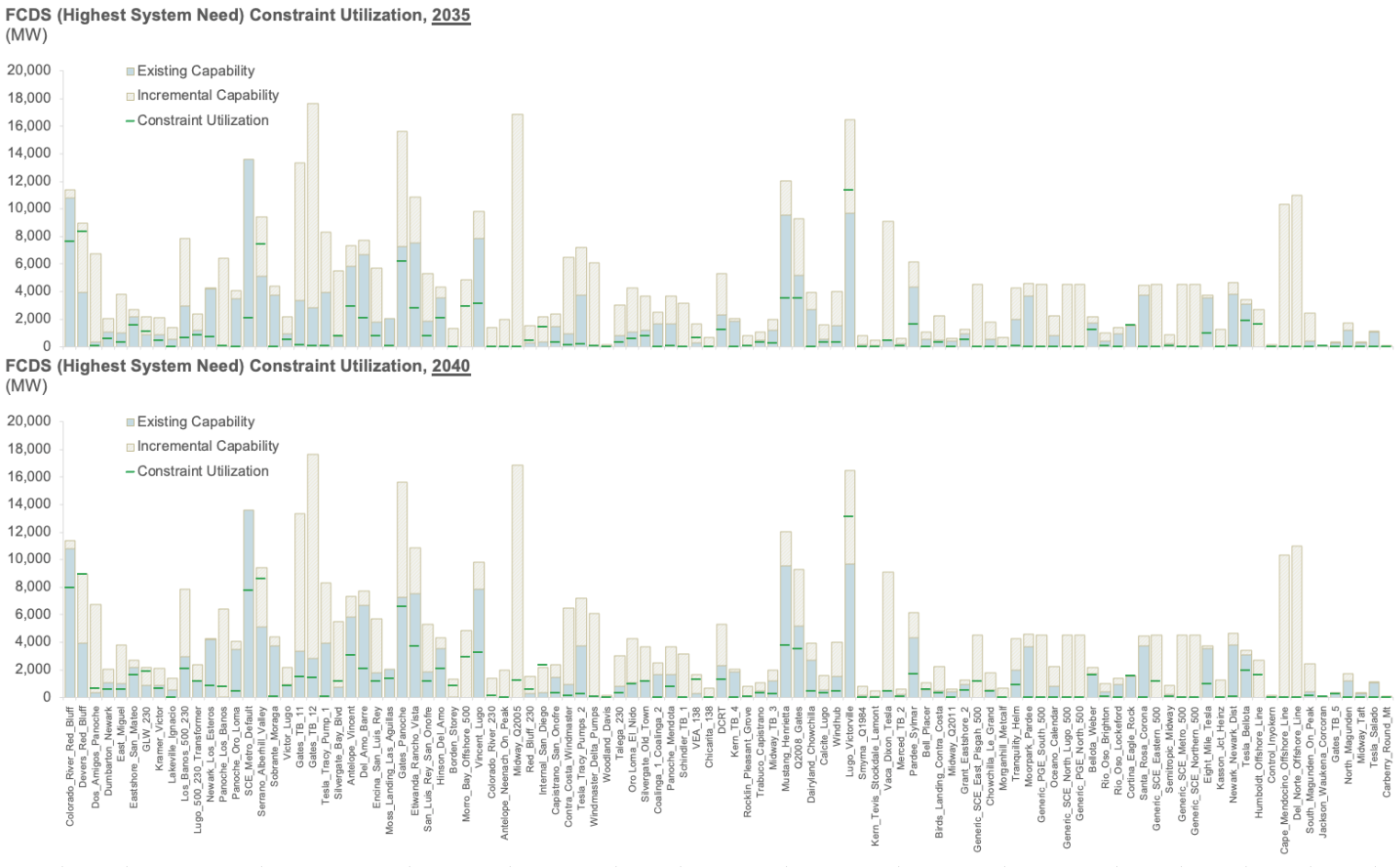


Figure 6. 25 MMT Core Portfolio - Summary of FCDS Highest System Need transmission capacity utilization by 2035 and 2040.



4.2 Long Lead-Time Resources Sensitivity Portfolio

Objective and Rationale

The objective of transmitting the long lead-time (LLT) resources portfolio to the CAISO for the 25-26 TPP as a policy-driven sensitivity is to collect planning information about the impacts and transmission requirements of forcing in a total of 2,100 MW of geothermal, 2,700 MW long duration energy storage modeled in RESOLVE as 900 MW of adiabatic compressed air energy storage (A-CAES) and 1,800 MW of pumped hydro, and 7,560 MW of offshore wind by 2035. In these total amounts of the specific LLT resources, the portfolio assumes little to no additional deployment of these resources beyond the capacity reflected in D.24-08-064 and the D.21-06-035 requirements (e.g., the 7.6 GW of offshore wind, OSW, reflects the upper bound of the initial need determination in D.24-08-064 and is inclusive of the 4.5 GW of OSW included in the LSE individual IRPs). The energy planning agencies have limited detail regarding potential transmission needs from forcing in these LLT resources 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 2040 targets of 25 MMT and 17 MMT respectively. The portfolio includes the LSE Plans through 2030. All other assumptions remain constant.

Description of Portfolio

For the planning year 2035, compared to the base 25-26 TPP portfolio, the forced-in LLT resources portfolio with LSE plans until 2030 displaces 971 MW of in-state wind, 2000 MW of out-of-state wind, 2,156 MW of solar, 4,126 MW of 4-hr li-ion battery, 697 MW of 8-hr li-ion battery, and 200 MW of 8-hr flow battery. For the 2040 planning year, compared to the base 25-26 TPP portfolio, the forced-in LLT resources portfolio with LSE plans until 2030 displaces 655 MW of in-state wind, 216 MW of out-of-state wind, 6,472 MW of solar, 4,126 MW of 4-hr li-ion battery, 1,816 MW of 8-hr li-ion battery, and 200 MW of 8-hr flow battery.[16]

Table 4 summarizes the resource build out in 2035 and 2040, the resource planning years needed specifically for the 25-26 TPP. As previously mentioned, the GHG targets modeled in 2035 and 2040 were 25 MMT and 17 MMT respectively.

[16] Full RESOLVE results can be found on the CPUC's Portfolios and Modelling Assumptions for the 24-25 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 2035 and 2040 in the LLT resources sensitivity portfolio for the Ruling and Proposed Decision

RESOLVE 25-26 TPP LLT Sensitivity Portfolio (2035 and 2040 Results) - Ruling Vintage			
		11/5 Ruling Vintage	11/5 Ruling Vintage
Resource Type	**Unit**	**2035**	**2040**
Natural Gas	MW	-	-
Geothermal	MW	2,139	2,139
Biomass	MW	171	171
In-State Wind	MW	6,923	7,240
Out-of-State Wind	MW	7,000	10,491
Offshore Wind	MW	7,555	7,555
Solar	MW	17,677	38,421
Customer Solar	MW	-	-
Li-ion Battery (BTM)	MW	-	-
Li-ion Battery (4-hr)	MW	11,581	11,581
Li-ion Battery (8-hr)	MW	2,137	10,195
Pumped Hydro Storage	MW	1,777	1,777
Long Duration Storage	MW	1,008	1,008
Shed DR	MW	-	-
Gas Capacity Not Retained	MW	-	-
In-State Renewables	**MW**	**34,466**	**55,525**
Out-of-State Renewables	**MW**	**7,000**	**10,491**

This portfolio also meets the RESOLVE Planning Reserve Margin (PRM) constraint which includes the adjustments made to incorporate the mid-term reliability procurement 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 used to inform the mapping analysis. Figure 7, Figure 8, and Figure 9 summarize the selected upgrades triggered in RESOLVE for the 2035, 2040, and 2045 snapshot years. The transmission upgrades selected by RESOLVE include projects already approved by the CAISO board, as well as new upgrades. Information on transmission upgrades available in RESOLVE are provided based on the CAISO White Paper, which is the version of the White Paper incorporated into the RESOLVE Model. As part of the least-cost optimization in RESOLVE, upgrades are selected based on their size and cost, construction lead-time, and the quantity and quality of additional resources that can be delivered by the upgrade, among other factors. For the TPP years under consideration, a total of 24,289 MW by 2035 and 31,471 MW by 2040 of partial and full transmission upgrades are utilized by the portfolio, but most of these are already approved in previous TPPs.

By 2035 and 2040, RESOLVE selects 13 and 20 upgrades, respectively. Of the selected upgrades in 2035, seven of them are approved upgrades modeled with a cost of $0/kW-yr (this models the fact that they have already been approved and will increase transmission capability but will not do so until their estimated online year), altogether representing 24,289 MW of the total upgrades selected in this model year. For 2035, there are seven upgrades that are fully selected and six upgrades that are partially selected. The fully selected upgrades include the 500kV Colorado River-Red Bluff line upgrade, the 500 kV Devers-Red Bluff line upgrade, the additions and upgrades to buses and transformers at the Trout Canyon substation, an additional 500kV/230kV transformer at the Lugo

substation, several upgrades within the Serrano-Alberhill-Valley area including line upgrades within the Southern California Transmission Project, and the development of the both the Humboldt Bay line and Morro Bay substation for offshore wind (all 2023 White Paper Upgrades). The latter two are modeled upgrades for offshore wind resources based on potential projects identified in the 21-22 TPP offshore wind sensitivity study.[15] The partially selected upgrades include additional reconductoring in the Internal San Diego area, a 230kV Kramer-Victor line upgrade, a new 500kV/230kV transformer at the Manning substation, a reconductor and reconfiguration of the Gates-Arco Midway 230kV lines, a new 500kV/230kV transformer at the Red Bluff substation, and the VEA 230 kV conversion project.

The upgrades selected in the 2040 model year represent 31,472 MW. Of the 20 upgrades selected in 2040, 16 of the projects are projects specified in the CAISO White Paper, two are the offshore wind upgrades noted above, while the remaining two are generic upgrades. The generic upgrades represent non-specific 500 kV transmission line projects, with costs informed by comparable projects from the CAISO White Paper and 2022-2023 CAISO Transmission Plan. One generic upgrade is represented for each CAISO Study Area in the RESOLVE optimization model to provide additional options to deliver high-quality, locationally specific resources that otherwise could not be selected due to the CAISO transmission constraints. 4,500 MW of transmission capability per study area are made available in RESOLVE starting in 2037. The two generic upgrades partially selected by 2040 are new 500-kV lines in SCE East of Pisgah and SCE Eastern Study Areas.

In addition to the 13 projects fully or partially selected by RESOLVE in 2035 and the generic upgrades mentioned, five additional upgrades are partially selected by 2040. These include a new 500kV/230kV transformer at the Colorado River substation, upgrades and additions to the lines between Cielo Azul and Colorado River, an additional Eldorado-Lugo 500 kV line, a new 3-ohm series reactor on the Silvergate-Bay Boulevard line, and a re-conductor of the four Lugo-Victor 230 kV lines. Additionally, between 2035 and 2040, additional incremental capacity on partial upgrades is selected for a reconductor and reconfiguration of the Gates-Arco Midway 230kV lines and a new 500kV/230kV transformer at the Red Bluff substation.

Table 5. All resources selected in the LLT resources sensitivity portfolio (2035 and 2040 cumulative)

Pre-Round 1 - CAISO RESOLVE Selections		2035 Selected Resource, MW			2040 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	1,717	-	1,717	1,717	-	1,717
	Inyokern_North_Kramer_Geothermal	7	-	7	7	-	7
	Northern_California_Geothermal	314	-	314	314	-	314
	Northern_Nevada_Geothermal	-	-	-	-	-	-
	Pacific_Northwest_Geothermal	60	-	60	60	-	60
	Utah_Geothermal	-	-	-	-	-	-
Solar	Arizona_Solar	2,064	-	2,064	5,065	-	5,065
	Greater_Imperial_Solar	39	-	39	997	-	997
	Greater_Kramer_Solar	1,012	-	1,012	4,438	-	4,438
	Greater_LA_Solar	-	-	-	375	-	375
	Northern_California_Solar	21	100	121	21	100	121
	Riverside_Solar	659	-	659	8,688	-	8,688
	Southern_NV_Eldorado_Solar	9,178	330	9,508	9,690	330	10,020
	Southern_PGAE_Solar	247	-	247	2,958	-	2,958
	Tehachapi_Solar	4,027	-	4,027	5,760	-	5,760
Wind	Baja_California_Wind	1,573	-	1,573	1,889	-	1,889
	Central_Valley_North_Los_Banos_Wind	32	-	32	32	-	32
	Greater_Imperial_Wind	133	-	133	133	-	133
	Idaho_Wind	300	-	300	300	-	300
	New_Mexico_Wind	4,000	-	4,000	6,000	-	6,000
	Northern_California_Wind	1,988	300	2,288	1,988	300	2,288
	Solano_Wind	454	-	454	454	-	454
	Southern_NV_Eldorado_Wind	711	-	711	711	-	711
	Tehachapi_Wind	1,732	-	1,732	1,732	-	1,732
	Utah_Wind	-	-	-	-	-	-
	Wyoming_Wind	2,700	-	2,700	4,191	-	4,191
	Cape_Mendocino_Offshore_Wind	-	-	-	-	-	-
	Del_Norte_Offshore_Wind	-	-	-	-	-	-
	Diablo_Canyon_Offshore_Wind	-	-	-	-	-	-
	Humboldt_Bay_Offshore_Wind	2,680	-	2,680	2,680	-	2,680
	Morro_Bay_Offshore_Wind	4,875	-	4,875	4,875	-	4,875
Subtotal - Renewables		**40,736**	**730**	**41,466**	**65,287**	**730**	**66,017**
Li-ion Battery	Arizona_Li_Battery_4hr	-	-	-	-	-	-
	Arizona_Li_Battery_8hr	906	-	906	935	-	935
	Greater_Imperial_Li_Battery_4hr	-	-	-	-	-	-
	Greater_Imperial_Li_Battery_8hr	21	-	21	569	-	569
	Greater_Kramer_Li_Battery_4hr	665	-	665	665	-	665
	Greater_Kramer_Li_Battery_8hr	232	-	232	232	-	232
	Greater_LA_Li_Battery_4hr	1,193	-	1,193	1,193	-	1,193
	Greater_LA_Li_Battery_8hr	333	-	333	6,037	-	6,037
	Northern_California_Li_Battery_4hr	2,198	-	2,198	2,198	-	2,198
	Northern_California_Li_Battery_8hr	645	-	645	645	-	645
	Riverside_Li_Battery_4hr	445	-	445	445	-	445
	Riverside_Li_Battery_8hr	-	-	-	-	-	-
	Southern_NV_Eldorado_Li_Battery_4hr	3,591	-	3,591	3,591	-	3,591
	Southern_NV_Eldorado_Li_Battery_8hr	-	-	-	186	-	186
	Southern_PGAE_Li_Battery_4hr	2,233	-	2,233	2,233	-	2,233
	Southern_PGAE_Li_Battery_8hr	-	-	-	1,590	-	1,590
	Tehachapi_Li_Battery_4hr	1,256	-	1,256	1,256	-	1,256
	Tehachapi_Li_Battery_8hr	-	-	-	-	-	-
Flow Battery	Arizona_Flow_Battery	-	-	-	-	-	-
	Greater_Imperial_Flow_Battery	-	-	-	-	-	-
	Greater_Kramer_Flow_Battery	-	-	-	-	-	-
	Greater_LA_Flow_Battery	-	-	-	-	-	-
	Northern_California_Flow_Battery	54	-	54	54	-	54
	Riverside_Flow_Battery	-	-	-	-	-	-
	Southern_NV_Eldorado_Flow_Battery	-	-	-	-	-	-
	Southern_PGAE_Flow_Battery	54	-	54	54	-	54
	Tehachapi_Flow_Battery	-	-	-	-	-	-
Pumped Storage	Northern_California_Pumped_Storage	-	-	-	-	-	-
	Riverside_East_Pumped_Storage	1,277	-	1,277	1,277	-	1,277
	Riverside_West_Pumped_Storage	500	-	500	500	-	500
	San_Diego_Pumped_Storage	-	-	-	-	-	-
	Tehachapi_Pumped_Storage	-	-	-	-	-	-
Adiabatic CAES	Southern_PGAE_Adiabatic_CAES	400	-	400	400	-	400
	Tehachapi_Adiabatic_CAES	500	-	500	500	-	500
Subtotal - Storage		**16,503**	**-**	**16,503**	**24,561**	**-**	**24,561**
Total		**57,239**	**730**	**57,969**	**89,848**	**730**	**90,578**

Figure 7. LLT resources sensitivity - Summary of RESOLVE triggered transmission expansion by 2035 and 2040; by transmission constraint.

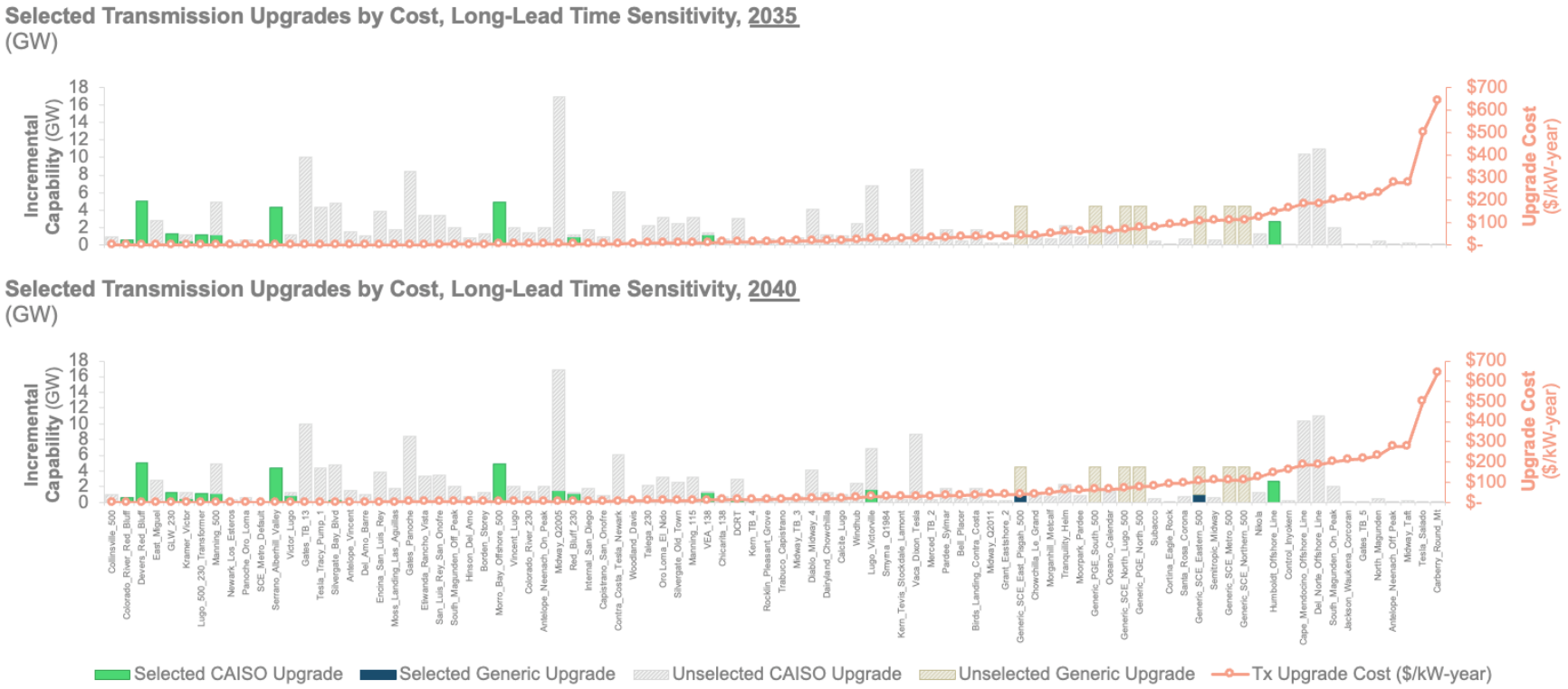


Figure 8. LLT resources sensitivity - Summary of RESOLVE triggered transmission expansion by 2045; by study area.

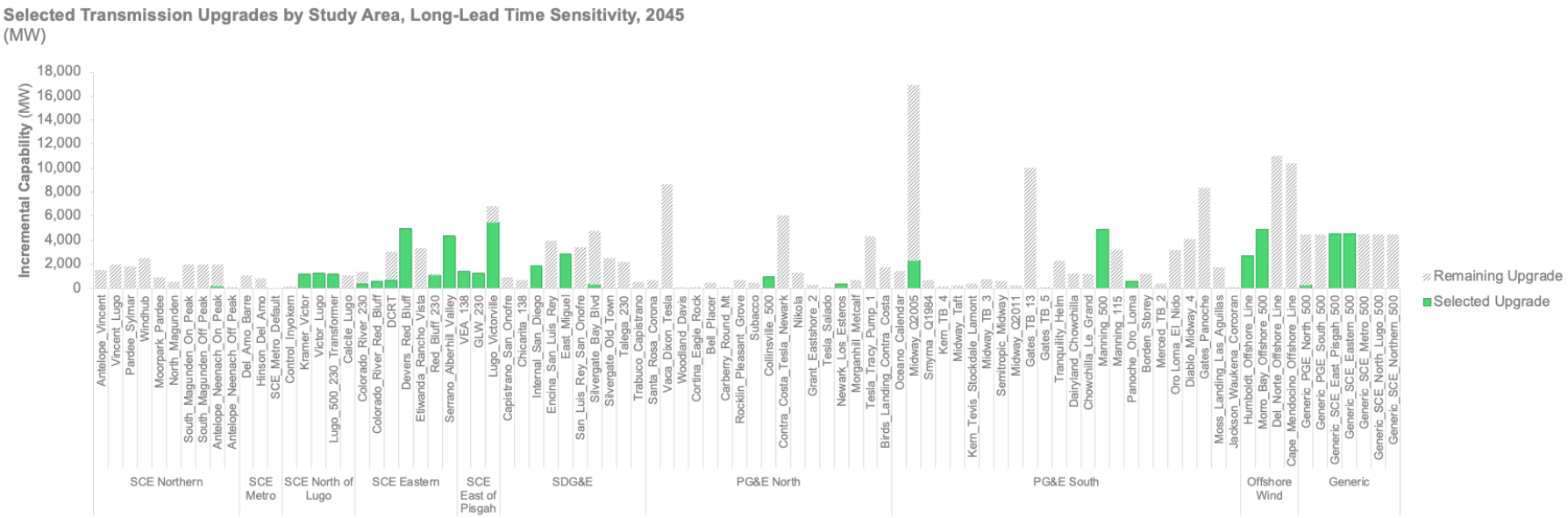
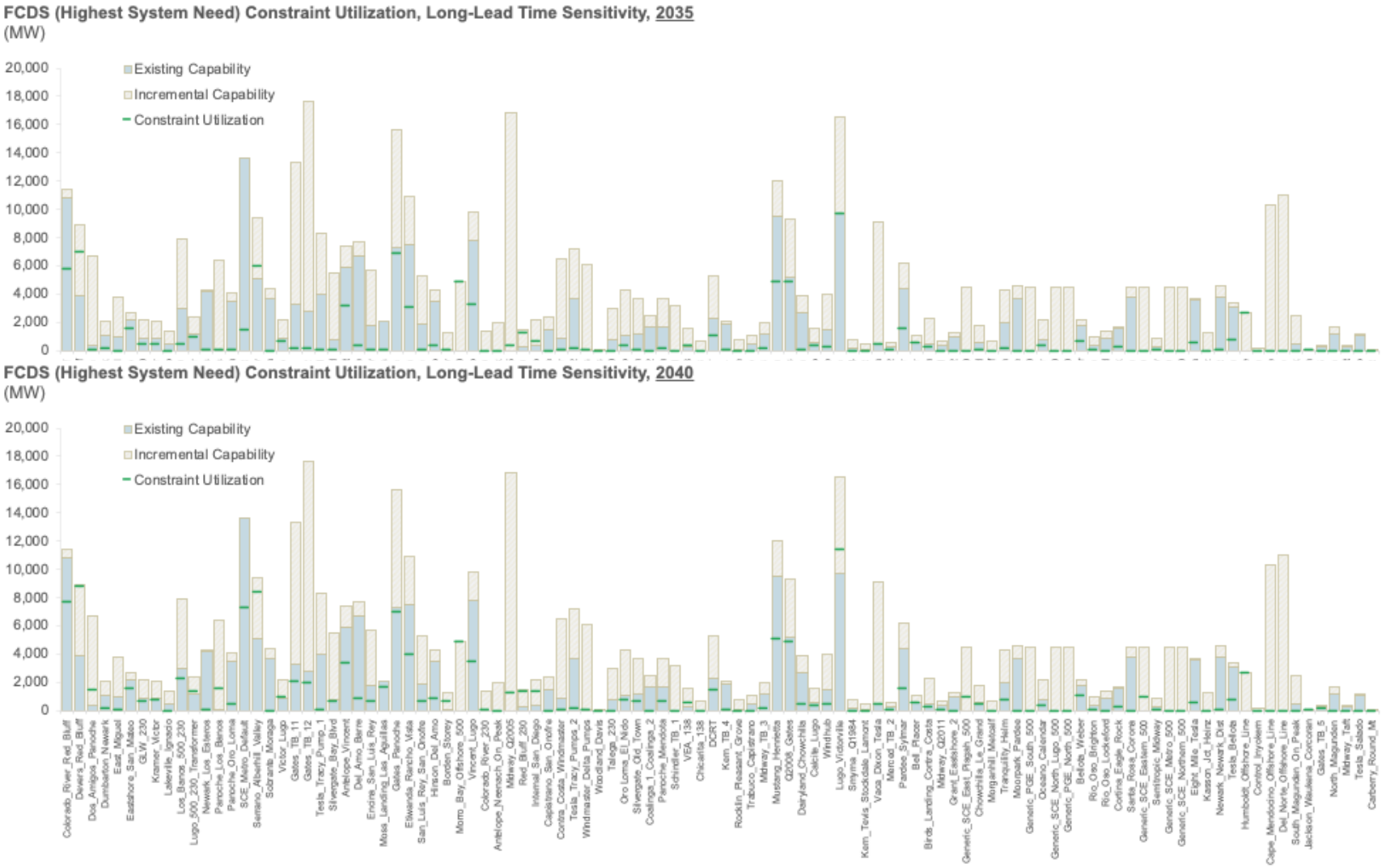


Figure 9. LLT resources sensitivity - Summary of FCDS Highest System Need transmission capacity utilization by 2035 and 2040.



4.3 Baseline Reconciliation

For the 25-26 TPP, the list of baseline resources assumed in IRP modeling is identical to the list used in the 24-25 TPP, which was developed as part of the 2023 IRP Inputs and Assumptions.[17]

The Working Group is using CAISO's 2024 White Paper for the busbar mapping system transmission criteria analysis. The 2024 White Paper uses a baseline that included resources online by 01/1/2024, to calculate available transmission capability on the constraints.

CPUC staff conducted baseline reconciliation both between the new CAISO 2024 White Paper assumptions and the IRP modeling baseline to ensure accurate representations of resources' impacts on transmission constraints calculation. To reconcile between the 2024 White Paper baseline and the 2023 IRP baseline, staff identified all resources in the IRP baseline with online dates after 01/01/2024. These baseline resources are not part of the published 25-26 TPP portfolio resources amounts and are not busbar mapped but need to be identified for the CAISO's TPP analysis and they still need to be accounted for in the busbar mapping transmission calculations as the constraint information is based on the 2024 White Paper's 01/01/2024 commercial operation date (COD) baseline.

The full list of resources needing to be included in the transmission calculations can be seen in the Updated Baseline Reconciliation and In-Development Resources workbook (Appendix F). Table 6 below summarizes these resources by CAISO study area. These not yet online by 01/01/2024 resources included in the baseline will also need to be captured in the CAISO's TPP analysis.

Table 6: Summary by CAISO study area of IRP-baseline resources in-development or online after 01/01/2024 and thus need to be included in Tx constraint calculations.

Resources in IRP Modeling Baseline not in Tx White Paper Baseline (i.e., In-Dev. or Online after 01/01/24)									
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind - New Tx (MW)	Offshore Wind (MW)	Solar (MW)	Battery_4hr (MW)	Battery_8hr (MW)	LDES (MW)
PG&E North of Greater Bay	65	2.9	-	-	-	-	300	-	-
PG&E Greater Bay	-	2.8	-	-	-	20	500	32	-
PG&E Fresno	-	2.4	76	-	-	250	125	-	-
PG&E Kern	-	-	-	-	-	225	73	-	-
SCE Northern Area	-	-	-	-	-	428	370	69	-
SCE Metro	33	-	-	-	-	-	101	-	-
SCE North of Lugo	44	-	-	-	-	150	38	-	-
East of Pisgah	45	-	-	-	-	-	-	-	-
SCE Eastern	30	-	-	-	-	130	700	-	-
SDG&E	25	-	-	-	-	-	406	50	-
Total by Type:	**242**	**8**	**76**	**-**	**-**	**1,203**	**2,613**	**151**	**-**

CPUC staff conducted analysis to identify what resources need to be captured as in-development in the mapped portfolios. In-development resources are resources that are recently online, contracted,

[17] "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

under construction, or have advanced along the new resource interconnection process (e.g., received a CAISO resource ID) and are not included in the IRP baseline. Per the Busbar Mapping Methodology, staff prioritize mapping resources in alignment with in-development resources first. To identify in-development resources, staff sought to identify new resources operational in the CAISO Master Generating Capability List (accessed 11/25/2024) with listed CODs as of November 2024, not yet online resources in the CAISO New Resources Interconnection Process's Generator Interconnection Resource ID Report (accessed 11/24/2024), generators contracted to CPUC jurisdictional Load Serving Entities (LSEs) not yet online and other resources identified through various IRP filings, and feedback from PTOs and stakeholders, which were not included in the 2023 IRP baseline. These resources are not part of the IRP baseline and instead are assumed to be imbedded in the published 25-26 TPP portfolio amounts. Table 7 below shows the summary of these resources identified. In-development resources are discussed in the commercial interest mapping alignment criteria analysis in Section 6.2.C and Section 6.4.E.

Table 7: Summary by CAISO study area of updated in-development resources not included in the 2023 IRP baseline.

In-Development Resources not in IRP Baseline (i.e., resources recently online, contracted, under construction, or undergoing the interconnection process)									
CAISO Study Area	**Geothermal (MW)**	**Biomass (MW)**	**Wind (MW)**	**OOS Wind - New Tx (MW)**	**Offshore Wind (MW)**	**Solar (MW)**	**Battery_4hr (MW)**	**Battery_8hr (MW)**	**LDES (MW)**
PG&E North of Greater Bay	25	3.2	-	-	-	49	125	-	5
PG&E Greater Bay	-	3.0	91	-	-	110	719	-	-
PG&E Fresno	-	2.0	61	-	-	1,971	2,308	35	-
PG&E Kern	-	-	-	-	-	882	493	-	-
SCE Northern Area	-	-	-	-	-	1,834	3,224	454	200
SCE Metro	366	5.6	-	-	-	33	1,891	10	-
SCE North of Lugo	10	-	-	-	-	532	507	6	-
East of Pisgah	-	-	-	51	-	775	1,210	-	-
SCE Eastern	-	2.6	57	1,685	-	3,874	3,985	100	-
SDG&E	-	-	300	-	-	1,192	1,727	50	-
Total by Type:	**401**	**16**	**508**	**1,736**	**-**	**11,251**	**16,189**	**655**	**205**

As noted above, some of these in-development resources are already online but just not captured in the 2023 IRP baseline. Table 8 below shows the portion of those already online resources with COD's before 01/01/2024 and thus are assumed to be already included in the 2024 White Paper baseline. These resources are imbedded in the total portfolio resources but need to be excluded from busbar mappings transmission capability calculations.

Table 8: Summary by CAISO study area of in-development resources with CODs before 01/01/24 and thus need to be excluded from mapping transmission capability calculations.

Resources in Tx Constraint Baseline, but not in IRP Baseline (i.e., resources online before 1/1/24 or in-development resources using existing interconnection deliverability)									
CAISO Study Area	**Geothermal (MW)**	**Biomass (MW)**	**Wind (MW)**	**OOS Wind - New Tx (MW)**	**Offshore Wind (MW)**	**Solar (MW)**	**Battery_4hr (MW)**	**Battery_8hr (MW)**	**LDES (MW)**
PG&E North of Greater Bay	25	-	-	-	-	3	3	-	-
PG&E Greater Bay	-	-	-	-	-	-	-	-	-
PG&E Fresno	-	-	-	-	-	657	793	-	-
PG&E Kern	-	-	-	-	-	-	-	-	-
SCE Northern Area	-	-	-	-	-	231	28	-	-
SCE Metro	-	5.6	-	-	-	10	82	-	-
SCE North of Lugo	-	-	-	-	-	75	45	-	-
East of Pisgah	-	-	-	-	-	-	15	-	-
SCE Eastern	-	2.6	-	-	-	250	125	-	-
SDG&E	-	-	-	-	-	250	228	-	-
Total by Type:	**25**	**8**	**-**	**-**	**-**	**1,476**	**1,319**	**-**	**-**

5. Busbar Mapping Methodology Updates and Adjustments

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

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

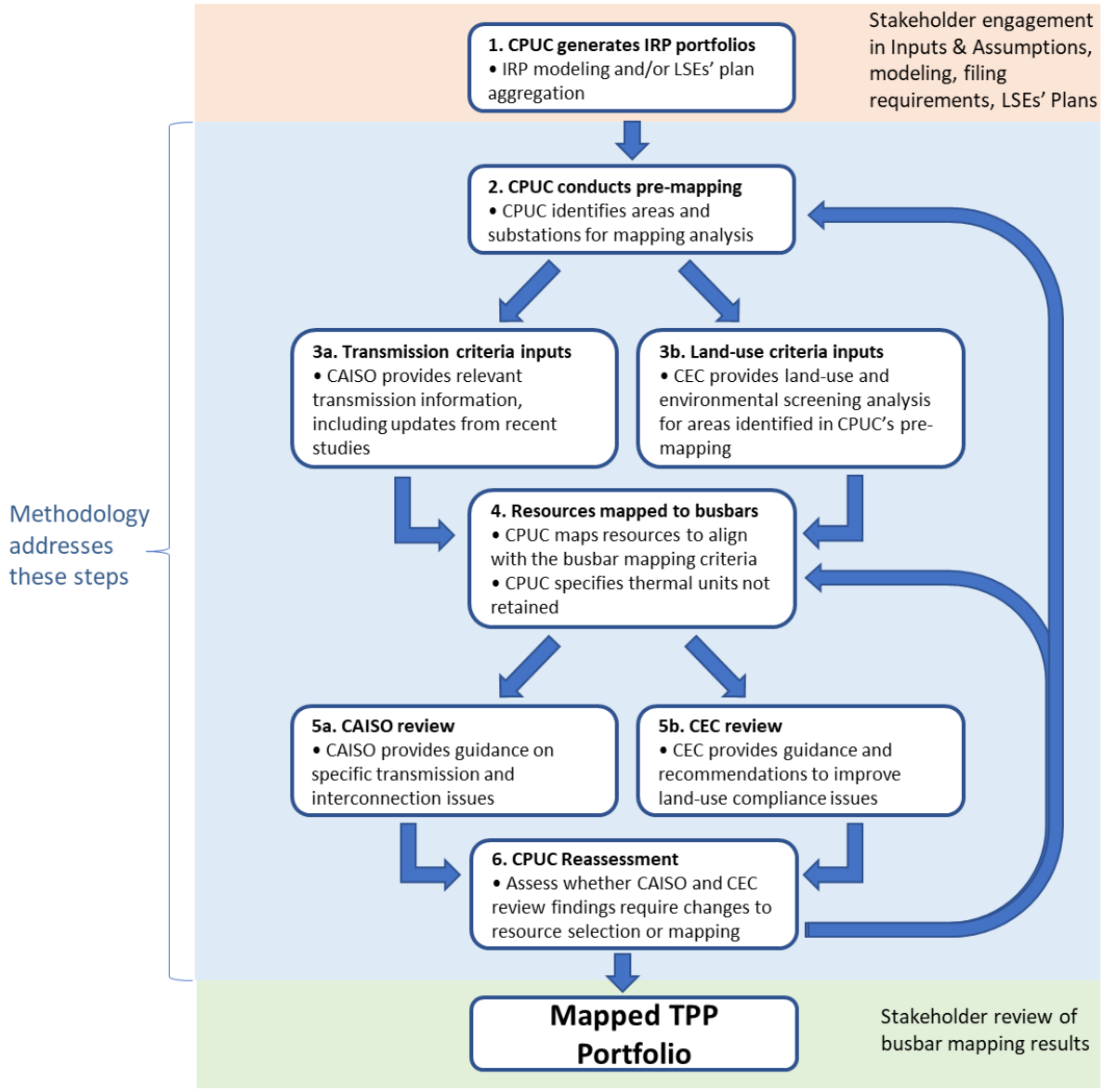


Figure 10 outlines the busbar mapping process, which underwent some revisions prior to the September 2024 Ruling to refine the process and criteria alignment analysis and incorporate new and updated datasets. These changes included incorporating the thermal plants not retained selection criteria, new environmental impacts criteria for Pumped Storage Hydro (PSH), clarification of in-development resources, updating the commercial development interest criteria, and other process improvements. Section 4 of the Busbar Mapping Methodology (Appendix A) has a more detailed breakdown of changes compared to the Methodology used in the 24-25 TPP.

Minor changes to the Methodology and general mapping updates were made based on stakeholder feedback in comments and replies to the September 2024 and October 2024 Rulings and recommendations from CEC and CAISO staff, as follows:

- Methodology update: Working Group staff have added the protected-areas layer dataset screen to the analysis for mapping of LDES as PSH to improve the screening for potential PSH locations.

- Methodology clarification: Staff note that the methodology does not mention an environmental impacts dataset utilized in the mapping analysis. That dataset is the Areas of Conservation Emphasis (ACE) All Criteria and is utilized like the other environmental (conservation and biological) impact factors. The ACE All dataset represents the land area that has a high implication value for any of three ACE datasets used in the analysis: Terrestrial Connectivity, Biodiversity, and Irreplaceability.

- Methodology clarification: Staff did not include individual substation accessibility analysis given the incompleteness of the specific substation information, concerns over confidentiality for some of the info, and uncertainty in how best to systematically assess it. Working Group staff did seek to factor the info available including fault duty limit, space limitations, and position availability, into the mapping effort, but the data and alignment results themselves are not included.

- Mapping update: Staff have updated the substations within the Collinsville -Tesla 500 kV Line constraint from the 2024 White Paper to include the planned Humboldt 500 kV substation per CAISO staff feedback.

- Mapping update: Staff used the CAISO interconnection queue accessed 11/25/24 to update the commercial development interest. Additionally, staff used updated in-development sources to identify additional in-development resources.

6. Analysis

This section outlines the results of the mapping process and notes mapping adjustments made after the initial mapping released with the October 2024 Ruling for the base case portfolio proposed in the September 2024 Ruling. 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 2024 Ruling. Full initial results for both the 2035 and 2040 mapped years at a substation level and the mapped resources compliance with the busbar mapping criteria are detailed in the Dashboard for Initial Mapping of Proposed 25-26 TPP Base Case, included as Appendix B.

Section 6.3 presents the adjustments made to the mapping post the October 2024 Ruling. Working Group staff made these adjustments to improve compliance with the busbar mapping criteria and portfolio policy goals, to account for updated information on transmission, commercial interest, and in-development resources, and to incorporate feedback stakeholders provided through comments and replies to the September 2024 and October 2024 Rulings. These mapping adjustments are summarized by resource area in this section.

Section 6.4 summarizes the updated busbar mapping analysis and criteria analysis following the mapping changes outline in Section 6.3. A full accounting of the adjustments by resource type and substation is in the Dashboard for the Proposed Decision Mapping of the 25-26 TPP Base Case released with this report as Appendix C. The Final Dashboard for the Mapping of the 25-26 TPP Base Case (Appendix D), transmitted with the Decision to the CAISO, includes no mapping adjustments compared to the results released with the Proposed Decision and only corrects minor errors to tables and text.

6.1 Initial Mapping Results for 25-26 TPP Base Case Portfolio

This section summarizes the mapping results and their criteria alignment following the initial rounds of mapping that the busbar mapping Working Group conducted for the base case portfolio and released with the October 2024 Ruling. This section summarizes the initial mapping information included in the Initial Mapping Dashboard (Appendix B).

Table 9 and Table 10 below show a comparison of the RESOLVE-selected base case portfolio resources and the initial mapping result for model years 2035 and 2040 respectively. Additionally, the tables compare these resources to the final mapped results for the 24-25 TPP Base Case model years 2034 and 2039 respectively.

Table 9: Summary of the proposed base case portfolio RESOLVE results and initial mapping for 2035 compared to the 24-25 TPP base case (2034 model year) by RESOLVE resource area.

RESOLVE Resource Name	RESOLVE Output (2035)			Initial Mapping Total (2035)			24-25 TPP (2034)		
	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	171	-	**171**	171	-	**171**	171	-	**171**
Central_Nevada_Geothermal	40	-	**40**	400	-	**400**	500	-	**500**
Greater_Imperial_Geothermal	1,217	-	**1,217**	600	-	**600**	950	-	**950**
Inyokern_North_Kramer_Geothermal	7	-	**7**	10	-	**10**	-	-	**-**
Northern_California_Geothermal	314	-	**314**	123	-	**123**	144	-	**144**
Northern_Nevada_Geothermal	-	-	**-**	117	-	**117**	299	-	**299**
Pacific_Northwest_Geothermal	60	-	**60**	-	-	**-**	-	-	**-**
Utah_Geothermal	-	-	**-**	389	-	**389**	76	-	**76**
Distributed Solar	-	-	**-**	-	288	**288**	260	-	**260**
Arizona_Solar	3,707	-	**3,707**	920	2,364	**3,284**	610	2,240	**2,850**
Greater_Imperial_Solar	39	-	**39**	20	222	**242**	200	182	**382**
Greater_Kramer_Solar	1,012	-	**1,012**	657	624	**1,281**	672	910	**1,582**
Greater_LA_Solar	-	-	**-**	10	10	**20**	-	-	**-**
Northern_California_Solar	26	100	**126**	75	358	**433**	275	420	**695**
Riverside_Solar	659	-	**659**	475	1,774	**2,249**	700	1,109	**1,809**
Southern_NV_Eldorado_Solar	9,111	330	**9,441**	886	1,525	**2,411**	1,075	1,565	**2,640**
Southern_PGAE_Solar	247	-	**247**	2,076	4,232	**6,308**	3,316	2,170	**5,486**
Tehachapi_Solar	4,602	-	**4,602**	1,437	1,883	**3,320**	1,633	1,653	**3,286**
Baja_California_Wind	900	1,573	**2,473**	700	653	**1,353**	915	185	**1,100**
CentralValley_North_LosBanos_Wind	-	153	**153**	491	70	**561**	494	96	**590**
Greater_Imperial_Wind	133	-	**133**	360	103	**463**	410	54	**464**
Greater_Kramer_Wind	-	-	**-**	250	112	**362**	310	50	**360**
Kern_Greater_Carrizo_Wind	-	-	**-**	219	-	**219**	300	10	**310**
Northern_California_Wind	334	1,954	**2,288**	1,705	98	**1,803**	678	210	**887**
Riverside_Palm_Springs_Wind	-	-	**-**	288	37	**325**	224	100	**324**
Solano_Wind	220	185	**405**	721	187	**908**	688	200	**888**
Southern_NV_Eldorado_Wind	711	-	**711**	858	371	**1,229**	620	-	**620**
Tehachapi_Wind	1,732	-	**1,732**	674	-	**674**	564	16	**580**
Idaho_Wind	300	-	**300**	1,100	-	**1,100**	1,060	-	**1,060**
New_Mexico_Wind	6,000	-	**6,000**	4,849	-	**4,849**	2,131	-	**2,131**
Wyoming_Wind	2,700	-	**2,700**	3,000	-	**3,000**	2,905	-	**2,905**
SW_Ext_Tx_Wind		-	**-**	51	-	**51**	-	-	**-**
Humboldt_Bay_Offshore_Wind	1,607	-	**1,607**	1,607	-	**1,607**	931	-	**931**
Morro_Bay_Offshore_Wind	2,924	-	**2,924**	2,924	-	**2,924**	2,924	-	**2,924**
Renewable Resource Total	**38,774**	**4,295**	**43,069**	**28,160**	**14,909**	**43,069**	**26,034**	**11,168**	**37,202**
Arizona_Li_Battery_4hr	870		**870**	1,925	-	**1,925**	910		**910**
Arizona_Li_Battery_8hr	-		**-**	-	-	**-**	250		**250**
Greater_Imperial_Li_Battery_4hr	571		**571**	575	-	**575**	341		**341**
Greater_Imperial_Li_Battery_8hr	-		**-**	-	-	**-**	-		**-**
Greater_Kramer_Li_Battery_4hr	664		**664**	403	-	**403**	716		**716**
Greater_Kramer_Li_Battery_8hr	100		**100**	148	-	**148**	90		**90**
Greater_LA_Li_Battery_4hr	2,078		**2,078**	2,632	-	**2,632**	2,530		**2,530**
Greater_LA_Li_Battery_8hr	-		**-**	475	-	**475**	167		**167**
San_Diego_Li_Battery_4hr	-		**-**	377	-	**377**	689		**689**
San_Diego_Li_Battery_8hr	-		**-**	-	-	**-**	-		**-**
Northern_California_Li_Battery_4hr	3,751		**3,751**	1,073	-	**1,073**	1,122		**1,122**
Northern_California_Li_Battery_8hr	1,191		**1,191**	250	-	**250**	300		**300**
Riverside_Li_Battery_4hr	520		**520**	2,517	-	**2,517**	2,130		**2,130**
Riverside_Li_Battery_8hr	485		**485**	120	-	**120**	120		**120**
Southern_NV_Li_Battery_4hr	3,602		**3,602**	1,210	-	**1,210**	1,684		**1,684**
Southern_NV_Li_Battery_8hr	-		**-**	470	-	**470**	180		**180**
Southern_PGAE_Li_Battery_4hr	2,395		**2,395**	2,466	-	**2,466**	2,331		**2,331**
Southern_PGAE_Li_Battery_8hr	1,058		**1,058**	1,145	-	**1,145**	342		**342**
Tehachapi_Li_Battery_4hr	1,256		**1,256**	2,529	-	**2,529**	2,505		**2,505**
Tehachapi_Li_Battery_8hr	-		**-**	226	-	**226**	170		**170**
Li_Battery Total	**18,541**	**-**	**18,541**	**18,541**		**18,541**	**16,576**	**-**	**16,576**
Southern_PGAE_Pumped_Storage	-		**-**	450	-	**450**	130		**130**
Riverside_East_Pumped_Storage	477		**477**	-	-	**-**	-		**-**
Riverside_West_Pumped_Storage	279		**279**	-	-	**-**	-		**-**
San_Diego_Pumped_Storage	-		**-**	409	-	**409**	437		**437**
Tehachapi_Adiabatic_CAES	200		**200**	400	-	**400**	458		**458**
Northern_California_Flow_Battery	308		**308**	5	-	**5**	5		**5**
Other Storage Total	**1,264**	**-**	**1,264**	**1,264**		**1,264**	**1,030**		**1,030**
Storage Total	**19,805**	**-**	**19,805**	**19,805**		**19,805**	**17,606**		**17,606**
Total Storage+Resources	**58,579**	**4,295**	**62,874**	**47,965**	**14,909**	**62,875**	**43,640**	**11,168**	**54,808**

Table 10: Summary of the proposed base case portfolio RESOLVE results and initial mapping results for 2040 compared to the 24-25 TPP base case (2039 model year) by RESOLVE resource area.

RESOLVE Resource Name	RESOLVE Output (2040)			Initial Mapping Total (2040)			24-25 TPP (2039)		
	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	171	-	**171**	171	-	**171**	171	-	**171**
Central_Nevada_Geothermal	40	-	**40**	400	-	**400**	500	-	**500**
Greater_Imperial_Geothermal	1,217	-	**1,217**	600	-	**600**	950	-	**950**
Inyokern_North_Kramer_Geothermal	7	-	**7**	10	-	**10**	-	-	**-**
Northern_California_Geothermal	314	-	**314**	123	-	**123**	144	-	**144**
Northern_Nevada_Geothermal	-	-	**-**	117	-	**117**	299	-	**299**
Pacific_Northwest_Geothermal	60	-	**60**	-	-	**-**	-	-	**-**
Utah_Geothermal	-	-	**-**	389	-	**389**	76	-	**76**
Distributed Solar	-	-	**-**	-	288	**288**	283	-	**283**
Arizona_Solar	4,117	-	**4,117**	2,020	4,084	**6,104**	1,210	3,065	**4,275**
Greater_Imperial_Solar	5,171	-	**5,171**	520	1,072	**1,592**	200	344	**544**
Greater_Kramer_Solar	4,052	-	**4,052**	997	1,138	**2,135**	752	1,258	**2,010**
Greater_LA_Solar	375	-	**375**	10	160	**170**	-	-	**-**
Northern_California_Solar	26	100	**126**	430	1,608	**2,038**	900	1,330	**2,230**
Riverside_Solar	8,688	-	**8,688**	975	2,654	**3,629**	900	2,034	**2,934**
Southern_NV_Eldorado_Solar	12,246	330	**12,576**	2,736	4,075	**6,811**	1,200	3,030	**4,230**
Southern_PGAE_Solar	2,854	-	**2,854**	6,076	10,202	**16,278**	4,062	5,464	**9,526**
Tehachapi_Solar	6,934	-	**6,934**	1,937	3,913	**5,850**	1,634	3,017	**4,651**
Baja_California_Wind	900	1,573	**2,473**	700	653	**1,353**	915	185	**1,100**
CentralValley_North_LosBanos_Wind	-	153	**153**	491	70	**561**	494	96	**590**
Greater_Imperial_Wind	133	-	**133**	360	103	**463**	410	54	**464**
Greater_Kramer_Wind	-	-	**-**	250	112	**362**	310	50	**360**
Kern_Greater_Carrizo_Wind	-	-	**-**	219	-	**219**	300	10	**310**
Northern_California_Wind	334	1,954	**2,288**	1,705	98	**1,803**	1,578	210	**1,787**
Riverside_Palm_Springs_Wind	-	-	**-**	288	37	**325**	224	100	**324**
Solano_Wind	220	185	**405**	721	187	**908**	688	200	**888**
Southern_NV_Eldorado_Wind	711	-	**711**	858	371	**1,229**	620	-	**620**
Tehachapi_Wind	1,732	-	**1,732**	674	-	**674**	564	16	**580**
Idaho_Wind	300	-	**300**	1,100	-	**1,100**	1,060	-	**1,060**
New_Mexico_Wind	6,000	-	**6,000**	4,849	-	**4,849**	3,536	-	**3,536**
Wyoming_Wind	4,407	-	**4,407**	4,707	-	**4,707**	4,500	-	**4,500**
SW_Ext_Tx_Wind		-	**-**	51	-	**51**	-	-	**-**
Humboldt_Bay_Offshore_Wind	1,607	-	**1,607**	1,607	-	**1,607**	1,607	-	**1,607**
Morro_Bay_Offshore_Wind	2,924	-	**2,924**	2,924	-	**2,924**	2,924	-	**2,924**
Renewable Resource Total	**65,541**	**4,295**	**69,835**	**39,012**	**30,823**	**69,835**	**33,010**	**20,462**	**53,472**
Arizona_Li_Battery_4hr	870		**870**	1,925	-	**1,925**	910		**910**
Arizona_Li_Battery_8hr	-		**-**	715	-	**715**	700		**700**
Greater_Imperial_Li_Battery_4hr	571		**571**	575	-	**575**	341		**341**
Greater_Imperial_Li_Battery_8hr	637		**637**	350	-	**350**	63		**63**
Greater_Kramer_Li_Battery_4hr	664		**664**	403	-	**403**	746		**746**
Greater_Kramer_Li_Battery_8hr	100		**100**	378	-	**378**	265		**265**
Greater_LA_Li_Battery_4hr	2,078		**2,078**	2,632	-	**2,632**	2,580		**2,580**
Greater_LA_Li_Battery_8hr	5,647		**5,647**	1,350	-	**1,350**	447		**447**
San_Diego_Li_Battery_4hr	-		**-**	377	-	**377**	689		**689**
San_Diego_Li_Battery_8hr	-		**-**	400	-	**400**	92		**92**
Northern_California_Li_Battery_4hr	3,751		**3,751**	1,073	-	**1,073**	1,172		**1,172**
Northern_California_Li_Battery_8hr	1,885		**1,885**	1,087	-	**1,087**	1,310		**1,310**
Riverside_Li_Battery_4hr	520		**520**	2,517	-	**2,517**	2,130		**2,130**
Riverside_Li_Battery_8hr	485		**485**	560	-	**560**	520		**520**
Southern_NV_Li_Battery_4hr	3,602		**3,602**	1,210	-	**1,210**	2,188		**2,188**
Southern_NV_Li_Battery_8hr	1,043		**1,043**	1,915	-	**1,915**	696		**696**
Southern_PGAE_Li_Battery_4hr	2,395		**2,395**	2,466	-	**2,466**	2,446		**2,446**
Southern_PGAE_Li_Battery_8hr	2,214		**2,214**	4,105	-	**4,105**	2,289		**2,289**
Tehachapi_Li_Battery_4hr	1,256		**1,256**	2,529	-	**2,529**	2,505		**2,505**
Tehachapi_Li_Battery_8hr	-		**-**	1,151	-	**1,151**	734		**734**
Li_Battery Total	**27,718**	**-**	**27,718**	**27,718**		**27,718**	**22,822**	**-**	**22,822**
Southern_PGAE_Pumped_Storage	-		**-**	450	-	**450**	130		**130**
Riverside_East_Pumped_Storage	477		**477**	-	-	**-**	-		**-**
Riverside_West_Pumped_Storage	279		**279**	-	-	**-**	-		**-**
San_Diego_Pumped_Storage	-		**-**	409	-	**409**	487		**487**
Tehachapi_Adiabatic_CAES	200		**200**	400	-	**400**	458		**458**
Northern_California_Flow_Battery	308		**308**	5	-	**5**	5		**5**
Other Storage Total	**1,264**	**-**	**1,264**	**1,264**		**1,264**	**1,080**	**-**	**1,080**
Storage Total	**28,982**	**-**	**28,982**	**28,982**		**28,982**	**23,902**	**-**	**23,902**
Total Storage+Resources	**94,523**	**4,295**	**98,818**	**67,995**	**30,823**	**98,818**	**56,912**	**20,462**	**77,374**

The initial mapping is similar to the mapped results of the 24-25 TPP base case, with no significant reductions in where resources are mapped. The 25-26 TPP portfolio has generally more of each type of resources except for geothermal compared to the 24-25 TPP as the portfolios are one year further out. The differences where resource amounts are reduced compared to the 24-25 TPP portfolio results are generally driven by updated transmission constraints, environmental impacts analysis, in-development resources, and commercial interest information.

The following subsections summarize and discuss the initial base case portfolio mapping alignment with the busbar mapping criteria by category. 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 2035 and 2040 portfolio mapping results. The land-use feasibility, environmental impacts, and community impacts criteria alignment sections focus on only the 2040 portfolios, as they are the larger portfolios with more resources mapped.

6.2 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 2024 White Paper "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2024 White Paper)[18]. The 2024 White Paper expands the number of constraints and substations considered in mapping analysis compared to the previous 2023 White Paper[19] and provided additional upgrade information based on recently approved upgrades in the TPP and updated capability numbers.

Table 11 below shows the transmission constraint exceedance status for the initial mapping of the 2035 portfolio. Resources are summarized by resource type and the transmission constraint 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. Table 12 shows the same analysis for the initial mapping of the 2040 portfolio. As noted in Section 4.3, the portfolio's IRP modeling baseline and transmission baseline include different sets of resources. The total MW amounts in these tables reflect the total resources impacting the transmission constraints, thus online resources in the IRP modeling baseline only after 01/01/2024 are included in the calculations and mapped portfolio resources that are in-development resources online before 01/01/2024 are excluded. As identified by the 2024 White Paper, actual constraints are constraints with binding capability limits as identified in CAISO studies whereas default constraints have non-binding limits, which represent the largest amount of resources the CAISO has studied for it. Generally, the 2024 White Paper has identified transmission upgrades for actual constraints but not default constraints. Default constraints include capability amounts from approved upgrades that have not yet been subsequently studied to identify a binding capability limit of the upgrade.

[18] "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2024). CAISO White Paper. https://www.caiso.com/documents/transmission-capability-estimates-white-paper-2024.pdf

[19] "2023 Transmission Capability Estimates for use in the CPUC's Resource Planning Process." CAISO Revised White Paper. 6/28/23. https://www.caiso.com/Documents/White-Paper-2023-Transmission-Capability-Estimates-for-use-in-the-CPUCs-Resrouce-Planning-Process.pdf

Table 11: Initial mapping (2035 Portfolio) alignment with existing transmission capability availability by resource type.

2035 Ruling Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	547	-	1293.3
Biomass (MW)	80	2	89.63
OnshoreWind (MW)	5,883	106	1,982
OOS Wind (MW)	1,750	-	7,250
Offshore Wind (MW)	4,531	-	0
Solar (MW)	16,634	711	2,216
Li_Battery (MW)	13,269	316	6,901
LDES (MW)	809	-	455
Total by Status (MW)	**43,503**	**1,135**	**20,187**

Table 12: Initial mapping (2040 Portfolio) alignment with existing transmission capability availability by resource type.

2040 Ruling Portfolio Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	547	-	1293.3
Biomass (MW)	25	7	139
OnshoreWind (MW)	4,610	394	2,968
OOS Wind (MW)	1,750	-	8,957
Offshore Wind (MW)	1,607	-	2924
Solar (MW)	24,116	3,735	16,768
Li_Battery (MW)	15,470	3,808	10,386
LDES (MW)	809	-	455
Total by Status (MW)	**48,934**	**7,943**	**43,891**

Overall, initial mapping of the base case portfolio resulted in 11 exceedances in transmission constraints from 2024 White Paper in the 2035 model year, per Working Group staff calculations, and 21 exceedances in the 2040 model year. In 2035, all exceedances were for the on-peak constraints, with two of those constraints also having the off-peak capability exceeded. In 2040, all but one of the 21 exceeded constraints have an on-peak exceedance, with one constraint in PG&E Fresno having only an EODS exceedance. Table 13 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 2024 White Paper. The table does not reflect additional transmission needs beyond the current CAISO transmission system including approved upgrades. It does include potential upgrade needs for 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. It does not include upgrades for delivery from other balancing areas such as the Imperial Irrigation District (IID).

Table 13: Number of 2024 White Paper transmission constraint exceeded for the initial mapping results by CAISO study area for the 2035 and 2040 portfolios.

Tx Constraint Exceedances	2035		2040	
	Actual	Default	Actual	Default
PG&E North of Greater Bay	2	0	2	0
PG&E Greater Bay	2	0	3	0
PG&E Fresno	2	0	7	0
PG&E Kern	0	0	1	0
SCE North	0	0	0	0
SCE Metro	0	0	0	0
SCE North of Lugo (NOL)	1	1	2	1
East of Pisgah (EOP)	1	0	1	1
SCE East	1	0	1	1
SDG&E	1	0	1	0
Total	10	1	18	3

A calculated exceedance does not determine if the identified upgrade in the 2024 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 and provide a project of potential transmission needs and costs for the portfolio.

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

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

In 2035 and 2040, initial mapping results in two exceeded constraints in the PG&E North of Greater Bay Area: the Bellota-Weber 230kV Line constraint and the Carberry-Round Mountain 230kV Line constraint. The Carberry-Round Mountain 230kV Line Constraint has a calculated on-peak exceedance of 102 MW and an off-peak exceedance of 115 MW in both 2035 and 2040 that would likely trigger the identified 2024 White Paper upgrade that provides approximately 26 MW of additional capability for an estimated $180 million. The Bellota-Weber 230kV Line constraint has an on-peak actual exceedance of 429 MW in 2035 which increases to 951 MW in 2040. The identified 2024 White Paper upgrade for the constraint provides an estimated 460 MW of additional capability for an estimated $400 million. In both cases, TPP analysis would determine if the White Paper upgrades could accommodate the mapped resources or if alternative upgrades would be needed.

In 2035 and 2040, the mapping includes 1,150 MW 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 transmission system. These resources are modeled as

interconnecting to the CAISO system in the Malin-Round Mountain area and would likely need upgrades to the existing NVE and Bonneville Power Administration (BPA) systems or a major new CAISO transmission line to the wind area.

In 2035, initial mapping results in two exceeded constraints in the PG&E Greater Bay Area, Windmaster-Delta pumps 230 kV Line constraint and the Birds Landing-Contra Costa 230kV Line constraint. In 2040, one additional constraint, the Tesla-Bellota 230 kV line, is exceeded. The Birds Landing-Contra Costa 230kV Line constraint has an actual on-peak exceedance of 219 MW in 2035, which increases to 548 MW in 2040. The 2024 White Paper upgrade identified provides 1,766 MW of additional capability at an estimated cost of $700 million. The Windmaster-Delta pumps 230 kV Line constraint has an actual on-peak exceedance of 763 MW in 2035, which increases to ~866 MW in 2040. The 2024 White Paper upgrade provides 6,034 MW of additional capability at an estimated cost of $417 million. The exceedances in both constraints are comparable to the amounts calculated for the 24-25 TPP mapping analysis. CAISO staff feedback in the busbar mapping Working Group noted that these exceedances, particularly in the 2035 timeframe, would be unlikely to trigger the identified upgrades though the full TPP analysis will be necessary to confirm if any upgrades would be needed and the scope of such upgrades.

The Telsa-Bellota 230 kV Line constraint is exceeded in the on-peak by 1,185 MW in 2040. The identified 2024 White Paper upgrade provides 300 MW of additional capability for an estimated cost of $1,700 million. The 1,707 MW of Wyoming wind mapped to the Tesla area is a key driver of this exceedance and thus the identified White Paper constraint may not be the appropriate transmission solution. Additionally, the Wyoming Wind was mapped to Tesla based on the high-level results from the CAISO 20-year transmission outlook, thus a more optimal location for the Wyoming wind may be found in future analysis

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

In 2035, initial busbar mapping results in two actual exceedances for on-peak 2024 White Paper transmission constraints in the PG&E Fresno study area. In 2040 mapping, the number of exceedances increases to seven actual (six on-peak and one off-peak only) in the PG&E Fresno area and one actual exceedance in the PG&E Kern area. The growth in exceedances in 2040 are predominately driven by the large amounts of solar and storage mapped.

In 2035, the Chowchilla-Le Grand 115kV Line constraint, which has no available existing on-peak capability, has an on-peak actual exceedance of 617 MW, which increases to 795 MW in 2040. The other exceedance in the area in 2035 is for the Borden-Storey #1 230kV line constraint, which has a 1,070 MW exceedance in 2035 and an 1,663 MW exceedance in 2040. In addition to solar and storage, the constraints also have wind and LDES resources mapped to buses within them. The Chowchilla-Le grand 115kV Line constraint has an identified 2024 White Paper upgrade that provides 1,211 MW of additional capability for an estimated $550 million. This identified upgrade has an estimated construction time of 15-years and would not be available in 2035. In the Working Group, CAISO staff noted that if the constraint were to become binding in a TPP policy study, the CAISO would seek to identify a potentially different solution with a shorter timeline that could meet the specific policy need. The identified 2024 White Paper upgrade for the Borden-Storey #1 230kV line constraint provides an estimated 1,247 MW of additional capability for an estimated $50 million.

The additional constraints with exceedances in the Fresno study area in 2040 are:

- Tranquility-Helm 230 kV Line: On-peak actual exceedance of 315 MW with an identified 2024 White Paper upgrade that provides 2,274 MW of additional capability with an estimated cost of $1,500 million.
- Schindler 115/70kV TB #1: On-peak actual exceedance in the SSN of 81 MW and an off-peak actual exceedance of 33 MW. It has an identified 2024 White Paper upgrade that provides 3,160 MW of additional capability with an estimated cost of $370 million.
- Mustang-Henrietta 230 kV line: On-peak actual exceedance of 828 MW and an off-peak default exceedance of 1,162 MW. It has an identified 2024 White Paper upgrade that provides 2,749 MW of additional capability with an estimated cost of $830 million.
- Gates 500/230kV TB #11 and Gates 500/230kV TB #12: The former has a small on-peak actual exceedance of 9MW, while the latter has a small off-peak actual exceedance of 369 MW. The White Paper identifies a $35 million upgrade providing 14,825 MW of additional capability to Gates 500/230kV TB #11 and 10,038 MW of additional capability to Gates 500/230kV TB #12.

The Cal Flat-Gates 230 kV line constraint is the sole exceedance in the PG&E Kern area in 2040. It has an on-peak actual exceedance of 267 MW and an identified White Paper upgrade costing an estimated $1,008 million while providing 1,418 MW of additional capability.

The 2035 and 2040 portfolios have 2.9 GW of offshore wind mapped to the Morro Bay wind area. 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) will retire fully in 2025 in line with California's Public Utilities Code § 454.52 and the CAISO's 2024 White Paper available transmission capability information assumes that DCPP transmission capacity is available. Staff mapped the Morro Bay offshore wind to the Diablo Canyon 500 kV bus; however, an alternative location is 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[20]. Building and interconnecting to this new substation may be more cost-effective if interconnecting to the Diablo Canyon 500 kV bus is limited and costly.

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

Initial mapping resulted in no calculated transmission exceedances for either the 2035 or 2040 portfolios in both study areas. The preliminary 24-25 TPP policy results indicate the potential need for a transmission upgrade for the Midway-Whirlwind 500 kV line constraint, with a range of potential upgrade solutions that are ongoing further assessment as part of the 24-25 TPP. The SCE Metro study area includes ~400 MW of mostly in-development Utah geothermal which has been identified as using existing CAISO import capability on the Intermountain Power Plant (IPP) transmission system to Lugo.

The SCE Metro study area also includes 1,750 MW of New Mexico wind on new transmission in both 2035 and 2040. These resources were mapped based on the high-level transmission solutions

[20] 2021-2022 Transmission Plan. CAISO. 03/17/2022. caiso.com/Documents/ISOBoardApproved-2021-2022TransmissionPlan.pdf

from the CAISO's 20-year Transmission Outlook (2023-2024),[21] which identified a new HVDC line to Lugo with an estimated cost of $3.5-4.9 billion. CPUC staff note that this solution is not driven by any specific transmission project being planned and is not a mandate to assume this specific intertie if alternative, more effective solutions are available.

Greater Kramer — SCE North of Lugo Study Area

Resources mapped to the SCE North of Lugo (NOL) study area result a small on-peak default exceedance in the South of Kramer area constraint. This exceedance is for the approved in the 22-23 TPP transmission upgrade, a conversion of the Kramer - Victor 115 kV lines to 230 kV.

The second exceedance in 2035 is a small 13 MW on-peak exceedance in the Control to Inyokern area constraint that is the same in 2040. The upgrade identified in the 2024 White Paper is estimated to cost $329 million and provide an additional 186 MW of capability. This exceedance is caused by 13 MW of in-development Nevada geothermal in the IRP modeling baseline seeking Maximum Import Capability (MIC) expansion on the Silver Peak intertie.

The North of Lugo area has one additional exceedance in 2040, an 328 MW on-peak actual exceedance of the Calcite to Lugo Area Constraint. The 2024 White Paper identified upgrade for this constraint costs an estimated $239 million and enables 1,046 MW of additional capability.

Southern Nevada & El Dorado — East of Pisgah Study Area

Initial busbar mapping resulted in one on-peak actual exceedance in 2035. The Lugo-Victorville Area, which has an identified 2024 White Paper upgrade that provides 6,800 MW of additional capability for an estimated $2,165 million, has a 499 MW exceedance in 2035 that increases to 3,242 MW in 2040. Additional resources mapped in 2040 result in an on-peak default exceedance of 395 MW for the Sloan Canyon - Eldorado 500 kV constraint, which has a constraint capability estimate that incorporates a set of transmission upgrades approved in the 22-23 TPP.

In 2035 and 2040, 400 MW of Central Nevada geothermal is mapped to the Beatty 230 kV substation as an in-CAISO resource and 127 MW of Northern Nevada geothermal is mapped to the Eldorado 230 kV bus as an out-of-CAISO resource. Even though the Central Nevada geothermal is interconnecting directly with the CAISO system this configuration would likely still require long gen-ties (>50 miles) to interconnect the known geothermal areas. The Northern Nevada geothermal is presumed to be wheeled to CAISO intertie points in the Eldorado – Harry Allen area and is considered to need MIC expansion in the mapping results.

The 2035 and 2040 initial mapping also includes 1,060 MW of Idaho Wind on new transmission, which is mapped as utilizing the approved SWIP-North based new transmission capability from Midpoint to Harry Allen. Initial mapping also has 3,000 MW of Wyoming Wind at the Eldorado 500 kV intertie; however, CAISO staff feedback in the Working Group noted that only 1,500 MW can utilize the approved subscriber-PTO TransWest line as the lower segment of it (between Utah and Nevada) is only planned for 1,500 MW with the other 1,500 MW interconnecting with Intermountain Power Plant transmission system in Utah. Thus, the remaining 1,500 MW of

[21] https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024.

Wyoming wind would need additional new transmission to interconnect to the CAISO system.

Riverside & Arizona — SCE Eastern Study Area

In 2035 and 2040, initial busbar mapping results in an on-peak actual exceedance in the Eagle Mountain constraint. The amount mapped to substations in the Eagle Mountain constraint causes an 840 MW exceedance. The identified 2024 White Paper upgrade is a new Devers – Julian Hinds 220 kV line, estimated at $1.2 billion, with duration of 10 years, enabling an incremental 600 MW of capability.

The SCE Eastern study area includes 500 MW of Imperial geothermal mapped to 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 3,099 MW of New Mexico wind on new transmission as interconnecting at the Palo Verde 500 kV intertie in both 2035 and 2040. CPUC staff assumed the wind would utilize the approved subscriber PTO SunZia line but note that additional transmission may be necessary from the Pinal Central terminus of the SunZia line to Palo Verde for the total amount mapped.

San Diego & Greater Imperial — SDG&E

Initial busbar mapping in the SDG&E study area results in one on-peak exceedance in the 2035 and 2040 portfolio. The Chicarita 138 kV constraint has an actual on-peak exceedance of 86 MWs and is primarily driven by in-development battery storage resources, which corresponds to a project that has already been awarded deliverability.

6.2.A 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, geothermal, and pumped storage hydro (PSH) for the initial 2040 portfolio alignment with criteria is discussed below. For the onshore wind, geothermal, and PSH the portfolio amounts are the same in 2035 and 2040; only utility scale solar amounts increase in 2040. As 2040 portfolio results do not reduce resources mapped to locations compared with the 2035 mapping, the 2040 mapping criteria alignment reflects the largest potential implications of the portfolio. Full criteria alignment of the 2035 and 2040 mapping results for the initial base case portfolio can be found in the Initial Mapping Dashboard (Appendix B).

With this analysis, it is important to note that the Working Group is not siting individual projects and the analysis does not replace environmental review processes and permitting. This analysis assesses the general potential implications, competing priorities, and impacts of the resource type and amount mapped being developed on land in the analyzed area. In addition to potential direct impacts, these implications also can affect how difficult and costly to ratepayers the development of the resources in the area could be. This approach holds true even for the PSH analysis discussed below. Although the analysis focuses on and uses data from specific projects, it is not a review or

endorsement of the specific project but an assessment of the implications of PSH in the area using some of the project specific details to estimate general potential impacts.

Utility-Scale Solar

Table 14 depicts a summary of the initial 2040 portfolio's mapped solar resources alignment with the land-use implications and environmental impacts criteria. The table summarizes the MW of solar mapped and their highest non-alignment flag for the various criteria by CAISO study area. The top table 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 in-state resources and the WECC Environmental and Cultural Considerations Data Layer for out-of-state solar resources, and the other land-use implications criteria. The bottom table represents the same breakdown for the highest alignment flag amongst the environmental (conservation and biological) impacts criteria. Solar mapped to areas outside the state of California are only included in the Core Land-use Screen category analysis (again using the WECC dataset) and are not included in the summary amounts for the other criteria.

As seen in Table 14, higher non-alignment flags for land-use and environmental criteria occur in the following study areas: SCE Northern (Tehachapi), SCE Eastern (Riverside), and SCE North of Lugo (Greater Kramer). With higher non-alignment flags for smaller amounts of solar in the PG&E Greater Bay and East of Pisgah study areas.

Table 14: Summary (in MWs) of initial solar mapping results alignment with the land-use implications and environmental impacts criteria for the 2040 portfolio. Criteria alignment is +summarized by category and study area.

Land-use Implications and Feasibility																		
Initial 2040 Portfolio Mapping (MW)	Core Land-use Screen Criteria Alignment				Parcelization Criteria Alignment - Highest Flag				Cropland Index Criteria Alignment - Highest Flag				Overdrafted Groundwater		Fire Threat Criteria Alignment - Highest Flag			
Solar	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	In	Out	1 or 2	3	4	5
PG&E North of Greater Bay	1,285	-	-	-	1,260	25	-	-	1,185	100	-	-	-	1,285	1,285	-	-	-
PG&E Greater Bay	350	-	400	-	750	-	-	-	350	400	-	-	-	750	600	150	-	-
PG&E Fresno	9,652	-	-	-	9,652	-	-	-	4,032	5,620	-	-	9,652	-	9,652	-	-	-
PG&E Kern	5,610	-	-	-	5,610	-	-	-	3,675	1,935	-	-	5,219	391	5,519	-	-	91
SCE Northern Area	5,721	105	-	-	1,005	200	2,008	2,613	5,826	-	-	-	950	4,876	4,050	350	-	1,426
SCE Metro	-	-	10	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-
SCE North of Lugo	1,731	-	-	329	450	200	-	1,410	2,060	-	-	-	32	2,028	2,060	-	-	-
East of Pisgah*	6,511	300	-	-	-	-	-	-	-	-	-	-	-	6,811	-	-	-	-
SCE Eastern*	6,165	-	1,389	-	3,249	-	100	280	1,929	-	-	1,700	-	7,554	3,629	-	-	-
SDG&E*	3,771	-	-	-	1,592	-	-	-	892	700	-	-	-	3,771	1,442	90	-	60
Total:	**40,795**	**405**	**1,799**	**329**	**23,568**	**425**	**2,108**	**4,312**	**19,958**	**8,755**	**-**	**1,700**	**15,853**	**27,474**	**28,245**	**590**	**-**	**1,577**

Environmental (conservation and biological) Impact Factors																								
Initial 2040 Portfolio Mapping (MW)	ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag				ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag				Intactness Criteria Alignment - Highest Flag				Wetlands Criteria Alignment - Highest Flag			
Solar	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
PG&E North of Greater Bay	1,272	13	-	-	1,285	-	-	-	1,285	-	-	-	1,117	168	-	-	1,285	-	-	-	1,285	-	-	-
PG&E Greater Bay	350	400	-	-	750	-	-	-	650	100	-	-	250	500	-	-	750	-	-	-	750	-	-	-
PG&E Fresno	9,652	-	-	-	9,652	-	-	-	9,652	-	-	-	8,252	1,400	-	-	9,652	-	-	-	9,652	-	-	-
PG&E Kern	5,610	-	-	-	5,610	-	-	-	5,607	3	-	-	4,517	1,090	3	-	5,610	-	-	-	5,610	-	-	-
SCE Northern Area	5,826	-	-	-	5,826	-	-	-	5,826	-	-	-	5,476	350	-	-	5,826	-	-	-	5,826	-	-	-
SCE Metro	10	-	-	-	10	-	-	-	-	-	-	10	-	-	-	10	10	-	-	-	10	-	-	-
SCE North of Lugo	1,531	200	329	-	2,060	-	-	-	2,060	-	-	-	1,531	200	-	329	2,060	-	-	-	2,060	-	-	-
East of Pisgah*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern*	2,240	1,389	-	-	3,629	-	-	-	3,629	-	-	-	2,240	1,389	-	-	3,629	-	-	-	3,629	-	-	-
SDG&E*	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-
Total:	**28,082**	**2,002**	**329**	**-**	**30,413**	**-**	**-**	**-**	**30,300**	**103**	**-**	**10**	**24,974**	**5,096**	**3**	**339**	**30,413**	**-**	**-**	**-**	**30,413**	**-**	**-**	**-**

*Area Includes OOS resources

In the SCE Eastern study area, the 1,390 MW of solar mapped to the Red Bluff substation has a level-4 alignment flag for the Core Land-use screen as does the 400 MW of solar mapped to the Tesla substation in the PG&E Greater Bay study area. These flags indicate the mapped resources would require a significant portion of the lower implication resource potential available around the substation. The 329 MW mapped to the Kramer substation in the SCE North of Lugo study area has the lone level-5 alignment flag which indicates that there is little lower implication land available within the utilized radius and the amount of solar mapped would likely impact portions of the higher implication land. Also of note is the level-3 alignment flag for the 300 MW of solar mapped to Sloan Canyon in the East of Pisgah area, which is utilizing the WECC dataset as an out-of-state resource.

The key areas where mapped resources have high flags for the parcelization criteria are the SCE Northern and SCE North of Lugo study areas. Both areas have multiple substations with level-4 or level-5 non-alignment. However, stakeholders have asserted that both areas, particularly the Tehachapi area, are unique locations regarding parcelization that industry has overcome. CPUC staff view the recent large-scale development of solar in the area as confirmation that high-parcelization may not be a significant barrier to development particularly if there is higher-confidence commercial interest at the substations.

Only one substation, Colorado River in the SCE Eastern area, has a level-4 or -5 alignment flag for the Cropland Index criteria, indicating that the amount of solar mapped will likely impact a large portion of the cropland in the area inclusive of the high value cropland. Additional analysis by CEC staff noted that the main driver of the high-value status for the land in the area is attributes from the soil quality datasets within the CEC's Cropland Index model. Several substations in the PG&E Fresno area also have level-3 alignment flags for the Cropland Index criteria. This alignment level indicates the solar amounts mapped likely would need a large portion of the low-value cropland or the area around the substation has high levels of high-value cropland in general. Given that the solar mapped to this area also corresponds to a large portion of solar mapped to overdrafted groundwater basins offsets Working Group staff concerns about the amount of solar mapped.

Two substations in the SCE Northern study area, Vincent and Antelope, have a level-5 alignment flag for the Fire Threat Criteria. In both cases, the high flag arises from the substation's locations relatively near forested mountains and thus a large portion of the areas near the substations have a very high fire risk; however, the solar resource potential land near the substations is mostly in low fire threat regions.

For the various environmental implications criteria, Kramer, Tesla, and Redbluff substation again have the most solar with the highest non-alignment flags. All three along with Coolwater have level-3 alignment or higher flags for the ACE Connectivity criteria. Additionally, the solar mapped to Kramer has a level-5 non-alignment flag for the combined All-ACE Criteria, the dataset that combines high implication acres from all three ACE datasets used in mapping. Several substations in the PG&E Kern and Freno study areas have level-3 alignment for the All-ACE Criteria, particularly Arco and Los Banos, which have large amounts of solar, indicating potential impacts if additional solar is mapped to the substations.

Onshore Wind

Table 15 depicts a summary of the initial 2040 portfolio's mapped onshore wind resources alignment with the land-use implications and environmental impacts criteria. The table summarizes by CAISO study area the wind mapped (in MW) and their alignment flags for the various criteria.

The structure is the same as for the solar analysis summary, except that the parcelization and Cropland Index criteria are not applied for onshore wind. This analysis is for onshore wind in California or connecting to the existing CAISO transmission system. This includes Southern Nevada wind, for which the WECC dataset is used for the Core Land-use Scree, but excludes Wyoming, Idaho, and New Mexico wind. Although interconnecting directly to the CAISO system, Baja California wind is not analyzed as the Working Group was not able to incorporate comparable data for resource potential areas in Mexico.

In the preliminary mapping for the 24-25 TPP, the resource potential for onshore wind used a minimum 28% Capacity Factor (CF) threshold within the techno-economic exclusions. For mapping analysis since then, staff have used a minimum 20% CF to identify the base wind resource potential to which the land-use and environmental analysis is applied. Staff again have not changed any of the environmental, land-use, or protected layer exclusions criteria or application. Additionally, the analysis excludes wind mapped to repower projects as areas with existing wind resources are excluded from the wind resource potential totals.

As seen in Table 15, key higher non-alignment flags for land-use and environmental criteria for the initial onshore wind mapping occur in the following study areas: PG&E North of Greater Bay, PG&E Greater Bay, PG&E Kern, and SDG&E study areas. In the PG&E Fresno and SCE Eastern study areas, there are also some higher non-alignment flags for smaller amounts of wind. Generally, as has been the situation in mapping for past TPPs, the onshore wind has more non-alignment flags than solar; however, onshore wind is more locational constrained and there is significantly less commercial development interest than solar. Thus, the options for remapping the wind are more limited. CPUC staff note that the mapping analysis results in zero level-5 non-alignment flags in the Core Land-use Screen criteria and there are no alignment flags higher than level-3 for any of the individual environmental impacts criteria. Two substations (Eagle Rock and Table Mountain in the PG&E North of Greater Bay study area) and 240 MW of wind have level-5 flags for the most inclusive All-ACE criteria, which combines the three ACE datasets used in mapping.

Northern California (PG&E North of Greater Bay and Greater Bay study areas) has the most wind mapped and the most wind with higher non-alignment flags. The wind mapped to Birds Landing (251 MW), Eagle Rock (131 MW), the proposed new substation near Madeline in NVE (700 MW), Table Mountain (113 MW), and Tesla (300 MW) all have level-4 flags for the CEC Core land-use criteria. Wind at Eagle Rock, a proposed new substation on the Pit 1 – Cottonwood line (206 MW), and two proposed new substations in NVE portion of Northern California (1,000 MW) have level-5 flags for the fire threat criteria. Finally, several substations have level-3 alignment flags for the various environmental impacts criteria — Hilltop (NVE) (150 MW), the proposed new substation near Madeline (700 MW), and the proposed new substation on the Pit 1 – Cottonwood line for Intactness (206 MW), Eagle Rock (131 MW) all for ACE Irreplaceability, and Table Mountain (113 MW) for ACE Connectivity.

Outside of Northern California, Cabrillo (91 MW) in PG&E Kern, Windhub (174 MW), and a proposed new substation on the Suncrest-Ocotillo line (400 MW) in SDG&E have level-4 alignment flags for the CEC Core Land-use Screen criteria. The wind mapped to Los Banos (110 MW) in PG&E Fresno has a level-3 alignment flag for the ACE Connectivity criteria, while wind mapped to multiple substations – Antelope (200 MW), Boulevard East (63 MW), Devers (234 MW), and Templeton (113 MW) – have level-5 non-alignment flags for the Fire Threat Criteria.

Table 15: Summary (in MWs) of initial onshore in-CAISO wind mapping results alignment with the land-use implications and environmental impacts criteria for the 2040 portfolio. Criteria alignment is summarized by category and CAISO study area.

	Land-use Implications and Feasibility								Environmental (conservation and biological) Impact Factors							
Initial 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag			
Onshore Wind	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
PG&E North of Greater Bay	859	-	944	-	466	-	-	1,337	1,690	113	-	-	1,803	-	-	-
PG&E Greater Bay	109	-	551	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno	500	-	-	-	500	-	-	-	390	110	-	-	500	-	-	-
PG&E Kern	113	-	91	-	-	-	-	204	204	-	-	-	204	-	-	-
SCE Northern Area	500	-	174	-	474	-	-	200	674	-	-	-	674	-	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah	1,229	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	-	235	-	-	-	-	-	235	235	-	-	-	235	-	-	-
SDG&E	63	-	400	-	-	-	-	463	463	-	-	-	463	-	-	-
Total:	**3,735**	**235**	**2,160**	**-**	**2,462**	**-**	**-**	**2,439**	**4,678**	**223**	**-**	**-**	**4,901**	**-**	**-**	**-**

	Environmental (conservation and biological) Impact Factors															
Initial 2040 Portfolio Mapping	ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag				Intactness Criteria Alignment - Highest Flag				Wetlands Criteria Alignment - Highest Flag			
Onshore Wind	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
PG&E North of Greater Bay	1,672	131	-	-	1,559	-	-	244	747	1,056	-	-	1,803	-	-	-
PG&E Greater Bay	660	-	-	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno	500	-	-	-	390	110	-	-	500	-	-	-	500	-	-	-
PG&E Kern	204	-	-	-	113	91	-	-	204	-	-	-	204	-	-	-
SCE Northern Area	674	-	-	-	500	174	-	-	674	-	-	-	674	-	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern*	235	-	-	-	235	-	-	-	235	-	-	-	235	-	-	-
SDG&E*	463	-	-	-	463	-	-	-	463	-	-	-	463	-	-	-
Total:	**4,770**	**131**	**-**	**-**	**4,282**	**375**	**-**	**244**	**3,845**	**1,056**	**-**	**-**	**4,901**	**-**	**-**	**-**

*Area Includes OOS resources

Geothermal

Table 16 depicts a summary of the initial 2040 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 in Nevada or Utah. The Core Land-use screen criteria utilize the CEC's Protected Area Layer to assess higher and lower potential implication values. For geothermal mapping, the only level-5 flags are for the 148 MW of resources mapped to the Geysers area, and 41 MW mapped to Control in the North of Lugo area, both for the fire threat criteria.

Table 16: Summary (in MWs) of initial in-state geothermal mapping results alignment with the land-use implications and environmental impacts criteria for the 2040 portfolio. Criteria alignment summarized by category and RESOLVE resource area.

Initial 2040 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
Geysers	148	-	-	-	-	-	-	148	148	148	-	-
Mono - Long Valley	41	-	-	-	-	-	-	41	41	-	-	-
Salton Sea	525	-	-	-	525	-	-	-	525	-	-	-
East Brawley	125	-	-	-	125	-	-	-	125	-	-	-
Total (MW):	839	-	-	-	650	-	-	189	839	148	-	-

Pumped Storage Hydro

As mentioned in Section 5, the Working Group has added environmental implications analysis for potential pumped storage hydro locations new to this year's mapping effort. This analysis only applies to resources mapped to new potential pumped storage locations; expansions of existing PSH resources that do not change the size or locations of the reservoirs or build new infrastructure are excluded. Table 17 summarizes the initial environmental impact analysis conducted for potential pumped storage locations considered in the initial busbar mapping.

Initial mapping results in two potential new PSH locations with mapped resources: 409 MW mapped to the Sycamore Canyon 230 kV and analyzed with locational and water source data for the proposed San Vicente pumped storage plant and 310 MW mapped to Bellota 230 kV and analyzed with for the proposed Mokelumne pumped storage plant. The proposed Salt Springs pumped storage plant also aligns with the mapped to Bellota 230 kV and its analysis overlaps with eh Mokelumne project. Thus the 310 MW mapped there reflects multiple potential pumped storage projects. Overall, the Mokelumne area and Salt Springs area both have generally good alignment with level-2 flags in only two and one criteria respectively. Both projects propose using the same existing reservoir as the lower-reservoir and the water source, though the Mokelumne area has a better alignment flag for probable upper-reservoir as it proposes using an existing revoir. The PSH resources mapped to the San Vicente proposed project area has several level-3 alignment flags: terrestrial biodiversity, terrestrial connectivity, and aquatic rare species richness. The mapped resources have the best alignment for probable lower-reservoir and water source as the potential project proposes using an existing reservoir not locating on a major water system for both, but it has a level-3 alignment flag for the probable upper reservoir with the higher potential impact of needing a new off-stream reservoir.

Table 17: Summary of environmental implications analysis for potential pumped storage hydro locations considered in busbar mapping.

		Land-use & Env. Impacts Criteria Alignment						Staff Assessment of Criteria based on FERC filings					
LDES Res. mapped to new PSH	Potential Pumped Storage Site (FERC Application Name)	Terres-trial Biodiv-ersity	Terres-trial Connec-tivity	Terres-trial Irre-placea-bility	Intact-ness	Aquatic Rare Species Richness	Aquatic Irre-placea-bility	Probable Lower Reservoir		Probable Upper Reservoir		Probable Water Source	
-	Eagle_Mountain	1	1	1	3	1	1	Brownfield	2	Brownfield	2	Ground Water (Low Priority)	3
-	Swan Lake North	No Data, out-of-state						New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	LEAPS	1	1	2	1	1	1	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
409	San_Vicente	3	3	2	1	3	2	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
310	Mokulumne	1	1	1	2	1	2	Existing on-stream	2	Existing on-stream	2	Existing on-stream reservoir	2
-	Bison_Peak	1	3	1	3	1	1	New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	Tehachapi	3	3	3	2	1	1	New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	Nacimiento	1	2	1	2	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Twitchell	1	1	1	2	2	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Whale Rock	1	3	1	2	4	1	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
-	Vandenberg	1	2	1	2	1	1	Ocean	4	New off-stream	3	Ocean	5
-	Haiwee	2	1	1	3	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	MQR	3	3	3	1	5	5	New off-stream	3	New off-stream	3	Existing off-stream reservoir	1
-	Salt Springs	1	1	1	2	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Maxwell	1	2	1	1	1	1	Brownfield	2	New off-stream	3	Existing off-stream reservoir	1

6.2.B Initial Community Environmental Impacts Criteria Alignment

Table 18 shows the initial mapping results for the 2040 portfolio alignment with the prioritized mapping criteria for the community and societal environmental impacts summarized by CAISO study area. The table highlights the number of MWs of generation and storage in the initial 2040 portfolio mapped to areas within a PM2.5 or ozone air quality non-attainment zone, to a substation near fossil fuel plants, in an area that is identified as an Inflation Reduction Act (IRA) Energy Community, or in a disadvantaged community (DAC) per the SB 535 definition as identified by the CalEnviroScreen 4.0 dataset.

Table 18: Summary of initial mapping (2040 portfolio) alignment with the community environmental impacts criteria. Summarizes by CAISO study area mapped generation and storage amounts meeting prioritized criteria goals.

Initial 2040 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Fossil Fuel Plant (<5 mile)		In IRA Energy Community		In DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	359	186	1,050	200	2,541	380	113	-
PG&E Greater Bay	3,410	1,751	2,841	1,358	3,349	788	601	308
PG&E Fresno	11,124	4,732	3,903	1,507	47	161	11,086	4,662
PG&E Kern	5,888	1,701	153	43	4,146	1,133	5,571	1,648
SCE Northern Area	6,698	4,860	322	400	6,700	4,930	753	765
SCE Metro	2,177	2,662	36	2,480	2,177	2,662	35	2,435
SCE North of Lugo	2,492	756	662	231	2,535	781	1,115	381
East of Pisgah	500	150	3,168	529	12,708	3,125	-	-
SCE Eastern	4,911	1,981	772	1,801	7,786	4,879	163	530
SDG&E	4,225	2,599	843	1,332	1,981	1,584	843	828
Total	**41,784**	**21,377**	**13,749**	**9,879**	**43,969**	**20,422**	**20,281**	**11,556**

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, 60% the initial 2040 mapped portfolio occurs in air-quality non-attainment zones, primarily in the Los Angeles Basin and the San Joaquin Valley, while roughly 3.2 GW of renewables and 3.6 GW of storage are mapped to substations within a mile of an existing fossil fuel power plant. Roughly 62% of the resources are in an IRA energy community, and nearly 11.6 GW of storage resources, roughly 40% of the 2040 portfolio's storage, and 20 GW of generation, almost 30% of the 2040 portfolios generation, is mapped to a busbar in a disadvantaged community.

The mapping of biomass resources receives additional emphasis due to the air quality impacts of combustion. Table 19 below shows the proximity of mapped biomass resources in both the 2035 and 2040 portfolios to disadvantaged communities and air quality non-attainment zones. Initial mapping resulted in about 73 MW out of 171 MW allocated to substations in or near a

disadvantaged community. While 13.2 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 in disadvantaged communities have generic biomass resources mapped to them: Ganso, Goose Lake, Kirker, Lamont, Los Banos, Mercy Springs, Norco, Reedley, Rio Bravo, Roadway, and Wilson.

Table 19: Initial mapping of biomass resources' alignment with proximity to disadvantaged communities and air quality non-attainment zones.

Initial Biomass/gas Mapping	Disadvantaged Communities			Non-Attainment Zones			
	>5 mi from DAC	<5 mi from DAC	In DAC	In (PM 2.5)	Out (PM 2.5)	In (Ozone)	Out (Ozone)
In-Development (MW)	10.2	3.0	3.2	10.2	6.2	0.2	16.2
Generic (MW)	95.2	22.6	36.9	43.0	111.7	66.6	88.1
Total (MW)	**105.3**	**25.6**	**40.1**	**53.2**	**117.9**	**66.8**	**104.3**

6.2.C 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, federal permitting and leasing, and Working Group communications. Such information is key for identifying development resources and potential locations for long duration energy storage, out-of-state wind, and offshore wind. Key examples of resources development interest utilized in the initial mapping this cycle included:

- LDES projects awarded grants through the CEC's Long-Duration Energy Storage program
- State budget funding through the 2021 budget for design, permitting, and licensing of a pumped storage project in the San Diego area.
- Offshore wind leases awarded by the Bureau of Ocean Energy Management (BOEM)
- Permitting and licensing applications through the Federal Energy Regulatory Commission (FERC)

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 yet incorporated into the new IRP resource baseline used for the portfolio modeling (introduced in Section 4.3). 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 Master

Generating Master Generating Capability List, CAISO's Generator Interconnection Resource ID Report, and feedback from PTOs. Detailed information on the initial in-development resources, which is based on information available in September 2024, is found in the Initial Baseline Reconciliation and In-Development Resources workbook (See Appendix E). Table 20 summarizes the identified in-development resources for the initial mapping by CAISO study area and resource type. The table shows that the region with the greatest share of in-development resources is SCE Eastern study area, followed by SCE Northern and PG&E Fresno study areas. In the SCE Eastern area, the in-development resource mix is dominated by solar and battery storage (3,500 and 3,900 MW respectively). The SCE Northern area's in-development resources are primarily solar, battery storage, and LDES (1,800 MW, 3,000 MW, and 200 MW respectively). The PG&E Fresno area's in-development resources are solar and battery storage (1,900 MW and 2,100 MW).

Table 20: Summary, by CAISO study area, of the initial mapping in-development resources.

In-Development Resources not in IRP Baseline (i.e., resources recently online, contracted, under construction, or undergoing the interconnection process)										
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind - New Tx (MW)	Offshore Wind (MW)	Solar (MW)	Battery_4hr (MW)	Battery_8hr (MW)	LDES (MW)	Total In-Development (MW)
PG&E North of Greater Bay	25	3.2	-	-	-	43	121	-	5	**197**
PG&E Greater Bay	-	3.0	91	-	-	106	588	-	-	**788**
PG&E Fresno	-	2.0	61	-	-	1,936	2,110	35	-	**4,144**
PG&E Kern	-	-	-	-	-	882	401	-	-	**1,283**
SCE Northern Area	-	-	-	-	-	1,834	2,979	6	200	**5,019**
SCE Metro	366	5.6	-	-	-	33	1,429	10	-	**1,843**
SCE North of Lugo	10	-	-	-	-	532	379	6	-	**926**
East of Pisgah	-	-	-	51	-	775	1,210	-	-	**2,036**
SCE Eastern	-	2.6	57	1,685	-	3,474	3,818	100	-	**9,137**
SDG&E	-	-	-	-	-	1,074	1,550	-	-	**2,625**
Total by Type:	**401**	**16.4**	**208**	**1,736**	**-**	**10,688**	**14,585**	**157**	**205**	**27,996**

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) (applies to CAISO queue resources only), have executed an interconnection agreement (CAISO queue and WDT queues), and have completed Phase II of interconnection studies (CAISO queue only). These resource categories are not mutually exclusive or inclusive (i.e. not all projects TPD have signed an interconnection agreement). If a project has one of these attributes, then the resources are considered higher-confidence commercial interest.

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 10/7/24, for commercial interest is in the Initial Commercial Interest Analysis of CAISO Interconnection Queue workbook (Appendix G), while summaries of commercial interest from the CAISO queue and the other queues are included in the Initial Mapping Dashboard (Appendix B).

Table 21 below shows the initial mapping of commercial interest by resource type and confidence category. The table values are derived from the various interconnection queues with resource

amounts already online, in the modeling baseline, or identified as in-development resources, excluded. These adjustments limit the risks of double counting commercial interest when assessing the mapping of the generic resources in the portfolio.

Table 21: Summary of commercial development interest (MW) from the interconnection queues by resource type and confidence-level.

Initial Commercial Development Interest	Has TPD	Executed IA	Total Higher Confidence	Lower Confidence	Total Resources
Geothermal (MW)	28	9	37	1,806	1,843
Biomass (MW)	-	28	28	52	80
OnshoreWind (MW)	827	2,589	3,846	4,172	8,018
OOS Wind (MW)	-	-	-	11,478	11,478
Offshore Wind (MW)	3,250	1,029	6,053	5,660	11,713
Solar (MW)	3,234	14,668	40,641	96,423	137,064
Battery (MW)	37,228	20,917	81,904	181,400	263,304
LDES (MW)	1,265	1,332	2,749	3,101	5,850
Total (MW)	**45,832**	**40,573**	**135,258**	**304,092**	**439,350**

As seen in Table 21, higher-confidence commercial interest represents about 30% 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 2035 and 2040 portfolios, 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 22 and Table 23 breakdown the initial commercial interest calculated by CAISO study area for higher-confidence commercial interest (Table 22) and total commercial interest (Table 23).

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. 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 battery storage is greater than the amount of battery storage included in the portfolio. Generally, mapping results should not select locations without any commercial interest, for solar and storage in particular. The total amount of commercial interest in battery storage (263 GW) exceeds the 2040 portfolio amount (29 GW) nearly 10x, and staff will seek to relocate those resources if it does not significantly decrease alignment with the other criteria.

Table 22: Summary of higher-confidence commercial queue interest (MW) summarized by CAISO study area and resource type.

Higher Confidence Commercial Interest										
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind - New Tx (MW)	Offshore Wind (MW)	Distributed Solar (MW)	Solar (MW)	Batery (MW)	LDES (MW)	Total by Area (MW)
PG&E North of Greater Bay	37	10.0	206	-	162	58	1,010	5,169	-	**6,652**
PG&E Greater Bay	-	0.6	882	-	1,525	108	1,086	10,976	-	**14,577**
PG&E Fresno	-	11.6	4	-	-	88	6,389	8,249	-	**14,741**
PG&E Kern	-	5.5	-	-	4,366	131	4,508	6,472	520	**16,003**
SCE Northern Area	-	-	100	-	-	15	4,570	11,003	312	**16,000**
SCE Metro	-	-	-	-	-	-	10	5,764	-	**5,774**
SCE North of Lugo	-	-	362	-	-	37	1,446	2,601	-	**4,447**
East of Pisgah	-	-	310	-	-	-	6,865	7,043	-	**14,218**
SCE Eastern	-	-	60	-	-	18	9,984	15,069	1,917	**27,048**
SDG&E	-	-	1,923	-	-	22	4,773	9,557	-	**16,274**
Total by Type:	**37**	**27.6**	**3,846**	**-**	**6,053**	**477**	**40,641**	**81,904**	**2,749**	**135,735**

Table 23: Summary of total commercial queue interest (MW) summarized by CAISO study area and resource type.

Total Commercial Interest										
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind - New Tx (MW)	Offshore Wind (MW)	Distributed Solar (MW)	Solar (MW)	Batery (MW)	LDES (MW)	Total by Area (MW)
PG&E North of Greater Bay	37	34.9	337	-	2,462	156	7,220	15,672	482	**26,402**
PG&E Greater Bay	-	5.4	1,385	-	1,525	257	4,277	28,700	500	**36,650**
PG&E Fresno	-	11.6	204	-	-	148	32,996	46,583	119	**80,061**
PG&E Kern	-	20.3	-	-	7,726	286	15,832	21,495	520	**45,879**
SCE Northern Area	-	-	229	-	-	208	11,375	27,165	812	**39,790**
SCE Metro	80	-	-	-	-	-	10	19,684	-	**19,774**
SCE North of Lugo	5	2.7	462	-	-	229	9,561	18,477	500	**29,237**
East of Pisgah	968	-	1,418	11,478	-	-	21,980	27,143	500	**63,486**
SCE Eastern	671	5.3	761	-	-	68	20,739	33,381	1,917	**57,542**
SDG&E	83	-	3,223	-	-	4	13,073	25,002	500	**41,885**
Total by Type:	**1,843**	**80.1**	**8,018**	**11,478**	**11,713**	**1,356**	**137,064**	**263,304**	**5,850**	**440,707**

Table 24 and Table 25 show the initial mapping results for generic resources (resources beyond those mapped to align with identified in-development resources) for the 2035 and 2040 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 24 depicting the four study areas in the PG&E territory and Table 25 showing the six study areas in the Southern California, Nevada, and Arizona area.

Overall, the initial mapping aligns well with the higher-confidence commercial interest. For non-solar and battery storage in all areas, the amount mapped generally aligns or exceeds the higher-confidence commercial interest as there are more portfolio resources than total higher-confidence

resources for those technology types. The main exception is for central coast offshore wind in PG&E Kern and PG&E Greater Bay as the portfolio maintained the 4.5 GW of OSW in total and staff kept the North Coast mapping consist with prior mapping rather than relocated to the Central Coast to align with the higher-confidence commercial interest.

For utility-scale solar, there are three study areas with significant misalignments between the amount mapped and the higher-confidence commercial interest, even in the 2040 portfolio, when the amount of generic solar in the portfolio is comparable to the amount of higher-confidence commercial interest. Both SCE Eastern and SDG&E study areas have significantly more higher-confidence commercial interest, roughly double the amount mapped (6 GW in SCE Eastern and 2 GW in SDG&E). In contrast, PG&E Fresno has 2 GW more solar mapped than higher-confidence commercial interest. The regional misalignment is driven by three main factors. First, there is overall 6 GW more higher-confidence solar interest than generic solar in the 2040 portfolio. Second, several main substations with that higher-confidence commercial interest either have a significant amount of resources mapped to them already (e.g., Cielo Azul, Colorado River, Imperial Valley, Hoodoo Wash) or have environmental impact flags (e.g. Redbluff). Finally, several substations in the PG&E Fresno area had several favorable mapping flags including available transmission capacity (e.g. the new Manning substation) and positive land-use and environmental impact factors (e.g. lower environmental impact flag and located in overdrafted ground water basin).

For battery storage, every study area has more, and in several cases significantly more, higher-confidence commercial interest. As discussed above, for batteries, the queue has a higher-confidence commercial interest amount that is nearly 2.5x the amount of batteries in the portfolio.

Table 24: Comparison of initial mapping results (2035 and 2040 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 (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**	**PG&E Greater Bay**	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**
Geothermal (MW)	98	98	28	37	37	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	77	77	-	10	35	Biomass (MW)	10	10	-	1	5
OnshoreWind (MW)	1,803	1,803	200	206	1,352	OnshoreWind (MW)	923	923	161	882	1,385
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	1,707	-	-	-
Offshore Wind (MW)	1,607	1,607	-	162	2,462	Offshore Wind (MW)	-	-	750	1,525	1,525
Distrib. Solar (MW)	30	30	-	58	156	Distrib. Solar (MW)	33	33	-	108	257
Solar (MW)	305	1,260	25	1,010	7,220	Solar (MW)	-	650	-	1,086	4,277
Battery (MW)	180	465	270	5,169	15,672	Battery (MW)	310	1,262	6,048	10,976	28,700
LDES (MW)	-	-	-	-	482	LDES (MW)	310	310	-	-	500
Total (MW)	**4,099**	**5,339**	**522**	**6,652**	**27,417**	**Total (MW)**	**1,586**	**4,895**	**6,959**	**14,577**	**36,650**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E Fresno	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**	**PG&E Kern**	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	25	25	-	12	12	Biomass (MW)	33	33	-	6	20
OnshoreWind (MW)	500	500	-	4	204	OnshoreWind (MW)	113	113	-	-	-
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	2,924	2,924	2,500	4,366	7,726
Distrib. Solar (MW)	29	29	-	88	148	Distrib. Solar (MW)	32	32	-	131	286
Solar (MW)	1,912	8,572	146	6,389	32,996	Solar (MW)	1,646	4,956	246	4,508	15,832
Battery (MW)	727	2,447	5,508	8,249	46,583	Battery (MW)	460	1,300	2,254	6,472	21,495
LDES (MW)	140	140	-	-	119	LDES (MW)	-	-	465	520	520
Total (MW)	**3,332**	**11,712**	**5,654**	**14,741**	**80,061**	**Total (MW)**	**5,207**	**9,357**	**5,464**	**16,003**	**45,879**

Table 25: Comparison of initial mapping results (2035 and 2040 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 (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	2	2	-	-	-
OnshoreWind (MW)	674	674	100	100	229
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	15	208
Solar (MW)	1,510	4,190	710	4,570	11,375
Battery (MW)	420	1,545	6,287	11,003	27,165
LDES (MW)	200	200	300	312	812
Total (MW)	**2,806**	**6,611**	**7,397**	**16,000**	**39,790**

	Mapped Portfolio		Commercial Queue Interest		
SCE Metro	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	23	23	-	-	80
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	-	-	-	-	-
OOS Wind (MW)	1,750	1,750	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	-	-	-	10	10
Battery (MW)	623	1,223	3,861	5,764	19,684
LDES (MW)	-	-	-	-	-
Total (MW)	**2,396**	**2,996**	**3,861**	**5,774**	**19,774**

	Mapped Portfolio		Commercial Queue Interest		
SCE North of Lugo	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	-	-	-	-	5
Biomass (MW)	4	4	-	-	3
OnshoreWind (MW)	362	362	-	362	462
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	7	7	-	37	229
Solar (MW)	766	1,620	381	1,446	9,561
Battery (MW)	167	397	1,618	2,601	18,477
LDES (MW)	-	-	-	-	500
Total (MW)	**1,306**	**2,390**	**1,999**	**4,447**	**29,237**

	Mapped Portfolio		Commercial Queue Interest		
East of Pisgah	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	517	517	-	-	968
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	1,229	1,229	66	310	1,418
OOS Wind (MW)	4,100	4,100	-	-	11,478
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	1,636	6,036	741	6,865	21,980
Battery (MW)	470	1,915	4,224	7,043	27,143
LDES (MW)	-	-	-	-	500
Total (MW)	**7,952**	**13,797**	**5,031**	**14,218**	**63,486**

	Mapped Portfolio		Commercial Queue Interest		
SCE Eastern	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	500	500	-	-	671
Biomass (MW)	5	5	-	-	5
OnshoreWind (MW)	268	268	-	60	761
OOS Wind (MW)	1,414	1,414	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	18	68
Solar (MW)	800	4,080	500	9,984	20,739
Battery (MW)	171	1,086	4,736	15,069	33,381
LDES (MW)	-	-	500	1,917	1,917
Total (MW)	**3,157**	**7,352**	**5,736**	**27,048**	**57,542**

	Mapped Portfolio		Commercial Queue Interest		
SDG&E	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	100	100	-	-	83
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	1,816	1,816	300	1,923	3,223
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	14	14	-	22	4
Solar (MW)	427	2,697	485	4,773	13,073
Battery (MW)	272	1,337	2,386	9,557	25,002
LDES (MW)	409	409	-	-	500
Total (MW)	**3,038**	**6,373**	**3,171**	**16,274**	**41,885**

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 2040 portfolio. Table 26 shows the results for utility-scale solar and battery storage,

Table 27 shows the alignment results for onshore in-CAISO wind and geothermal resources, and Table 28 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 limited amount of commercial interest info in the queue summaries so are not included in these tables.

Table 26: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2040 portfolio mapping results of solar and battery storage resources.

2040 Preliminary Mapping Results	Solar					Battery Storage				
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	1	2	0	0	9	0	0	7	10	11
PG&E Greater Bay	0	1	0	3	11	0	0	26	6	23
PG&E Fresno	0	8	1	3	13	0	4	19	6	16
PG&E Kern	0	4	0	3	7	0	0	9	4	11
SCE Northern Area	1	2	0	2	2	0	1	10	1	5
SCE Metro	0	0	1	0	0	0	0	10	2	6
SCE North of Lugo	1	2	2	0	6	0	1	7	0	5
East of Pisgah	0	5	0	0	7	0	0	3	2	11
SCE Eastern	0	0	2	1	6	0	0	8	3	5
SDG&E	0	0	1	0	5	0	0	11	11	16
Total	3	24	7	12	66	0	6	110	45	109

Table 27: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2040 portfolio mapping results of geothermal resources and onshore "in state" wind.

2040 Preliminary Mapping Results	Geothermal					Onshore Wind				
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	3	0	0	0	0	3	3	0	0	0
PG&E Greater Bay	0	0	0	0	0	2	1	1	0	1
PG&E Fresno	0	0	0	0	0	2	1	0	0	0
PG&E Kern	0	0	0	0	0	1	0	0	0	0
SCE Northern Area	0	0	0	0	0	3	0	0	0	0
SCE Metro	0	1	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	0	0	1	0	0	0	0	0
East of Pisgah	1	1	0	0	1	0	2	0	0	1
SCE Eastern	0	1	0	0	0	1	0	0	0	2
SDG&E	1	0	0	0	0	0	0	0	1	1
Total	5	3	0	0	2	12	7	1	1	5

Table 28: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the final 2040 portfolio mapping results of biomass and distributed solar resources.

2040 Preliminary Mapping Results	Biomass					Distributed Solar				
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	9	3	0	0	0	1	0	9	0	16
PG&E Greater Bay	5	2	0	0	0	0	0	26	0	14
PG&E Fresno	5	0	2	0	0	0	0	12	0	6
PG&E Kern	5	2	0	0	0	0	0	19	0	11
SCE Northern Area	1	0	0	0	0	0	0	3	0	4
SCE Metro	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	1	1	0	0	0	0	0	5	0	3
East of Pisgah	0	0	0	0	0	0	0	0	0	0
SCE Eastern	0	1	0	0	0	0	0	2	0	3
SDG&E	0	0	0	0	0	2	0	3	0	0
Total	26	9	2	0	0	3	0	79	0	57

Given the large amount of commercial interest, the flags for solar and battery storage are predominately the result of having more commercial interest than resources map. Staff have focused this discussion on the flag where mapping exceeds commercial interest. As seen in Table 26, three substations have mapped solar amounts exceeding total commercial interest and 24 locations where mapped solar exceeds higher-confidence commercial interest. The three buses exceeding total commercial interest are Santa Clara 230 kV (which has no commercial interest (CI)), Davis 115 kV (100 MW mapped but only 85 MW of total CI), and Victor 115 kV (115 MW mapped and only 100 MW total CI). Of the 24 buses with more solar mapped than higher-confidence solar interest, a third (eight) are in the PG&E Fresno area reflecting the large amount of solar mapped to the study. Another five are in the East of Pisgah area, reflecting the availability of transmission and consistency with past solar mapping to the area. Finaly, four are in PG&E Kern reflecting locations with available transmission capability or good alignment with environmental and land-use criteria. Similarly, PG&E Fresno has four out of the six buses where batteries mapped exceed the higher-confidence commercial interest, reflecting the co-location of storage with the mapped solar.

For onshore wind, geothermal, and biomass, the discussion below focuses on the locations where staff have not mapped resources to or less resources to, despite having commercial interest. Geothermal had two flags for locations with commercial interest but no resources mapped, Control 115 kV (it has a small amount of CI in the WDT queue but no transmission capability available) and Eldorado 500 kV (it has most of the Northern Nevada geothermal aligned to it and over all Working Group staff shifted previously mapped Nevada geothermal to in-development Utah geothermal).

Onshore wind has a total of seven flags for more commercial interest than mapped. Both Telsa 500 kV and a new Suncrest - Ocotillo 500 kV line substation have more higher-confidence commercial interest than the amount mapped. In both cases, higher environmental impact flags and limited resource potential supported staff not mapping additional resources to these locations. Devers 230 kV, El Casco 230 kV, Metcalf 500 kV, and Trout Canyon 500 kV all have low confidence commercial interest but no wind mapped as the locations have limited resource potential.

Finally, two substations have higher-confidence commercial interest for biomass and no resources mapped (Borden 70 kV and McCall 115 kV). Staff did not map to these two locations as they have high non-alignment flags for the community impact factors criteria.

6.2.D 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 29: Comparison of initial mapped portfolio to the 24-25 TPP base case (adjusted to exclude resources now in baseline) by resource type.

Initial Mapping Compared to Previous Base Case	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
Geothermal (MW)	1,639	1,639	1,969	1,969
Biomass (MW)	171	171	166	166
OnshoreWind (MW)	7,895	7,895	6,123	7,023
OOS Wind (MW)	9,000	10,707	6,096	9,096
Offshore Wind (MW)	4,531	4,531	3,855	4,531
Solar (MW)	19,834	44,893	18,988	30,681
Battery-4hr (MW)	15,707	15,707	14,958	15,707
Battery-8hr (MW)	2,834	12,011	1,618	7,115
LDES (MW)	1,264	1,264	1,030	1,080
Zone Total (MW)	**62,875**	**98,818**	**54,802**	**77,368**

Table 29 compares the initial mapped portfolio with the previous 24-25 TPP base case portfolio. The 25-26 TPP portfolios utilize the same IRP modeling baseline as the 24-25 TPP portfolios so direct comparison can be made. Overall, the 25-26 TPP base case portfolio has more, or the same amount, of every resource except for geothermal. There is a 360 MW reduction, which does drive some non-alignment with the mapping. The portfolio development used the same 2023 Inputs and Assumptions as the 24-25 TPP with only a few minor updates (including a higher geothermal cost assumption) and the newer 2023 IEPR load projection. Overall, those updates and the one-year further out modeling are the key drivers of overall portfolio differences.

Figure 11 and Figure 12 show a summary of the initial mapping for 2035 and 2040 portfolios compared to the 24-25 TPP base case's 2034 and 2039 portfolios, respectively, by CAISO study area. Table 30 shows the same comparison in table form by CAISO study area. The only area where less resources have been mapped in the initial mapping for both 2035 and 2040 is SCE North of Lugo. In 2035, most regions have similar amounts of total resources mapped with more resources mapped to the North of Greater Bay area (driven predominately by more on-shore wind), the Fresno area (driven by more solar and storage), the SCE Metro area (driven by more OOS wind and Utah geothermal mapped as importing at Lugo), and the SCE Eastern area (driven by more solar, storage, and OOS wind). In 2040, for the initial mapping, the SDG&E, SCE Eastern, East of Pisgah, and SCE Northern areas have several GWs more resources driven by the larger amounts of solar and storage in the portfolio, while the PG&E Fresno area has a very large increase in resources mapped (over 6 GW, an approximately 70% increase) driven by significantly more solar and more battery storage mapped to buses in the study area.

Figure 11: Comparison of the initial mapped resource (2035 portfolio) to the 24-25 TPP portfolio (2034 model year) by CAISO study area. For each study area the left column represents the resources, by type, mapped to the study area for the 24-25 TPP base case and the right columns represents resources mapped to the study area for the initially mapping of the 25-26 TPP.

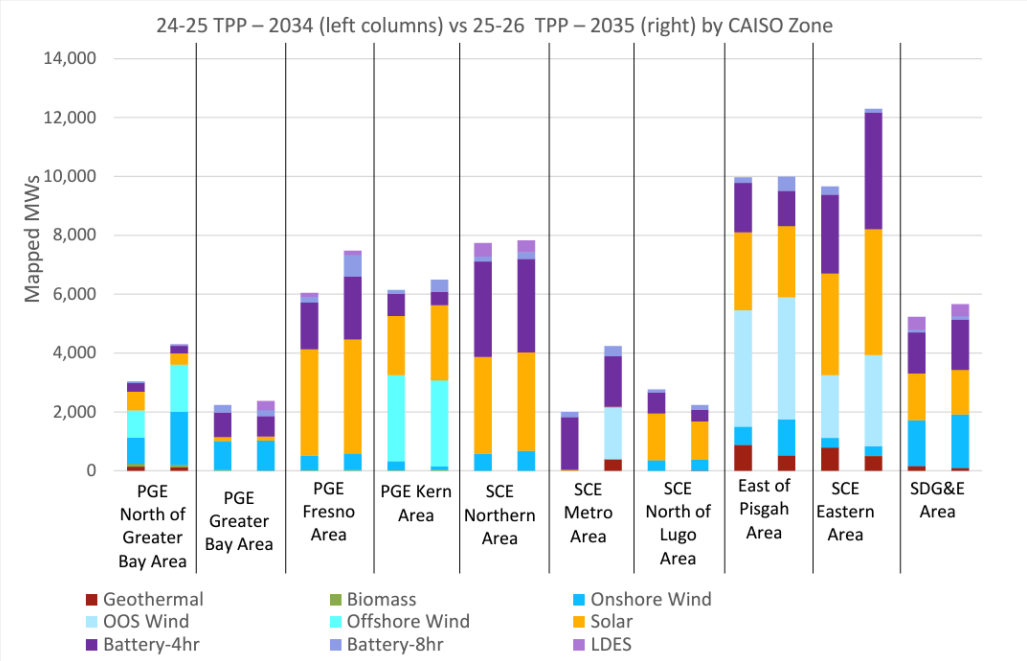


Figure 12: Comparison of the initial mapped resource (2040 portfolio) to the 24-25 TPP portfolio by CAISO study area.

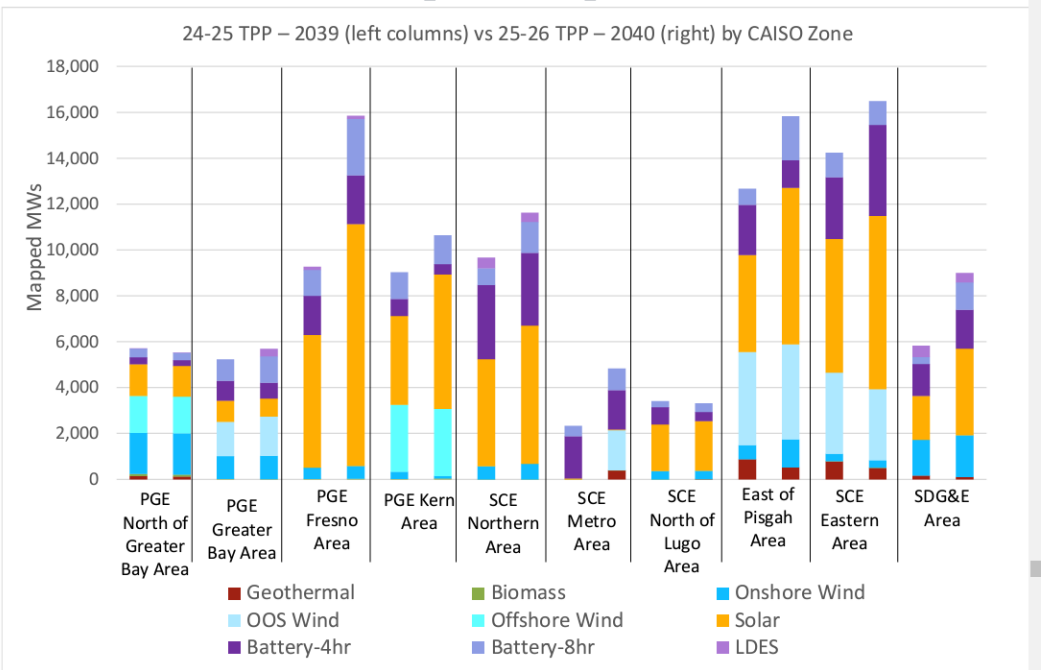


Table 30: Comparison of the initial mapping results (2035 and 2040 portfolios) to the 24-25 TPP portfolio (2034 and 2039) by CAISO study area and resource type.

Mapping Results Compared to 24-25 TPP Base Case by CAISO Study Area											
CAISO Study Area	Resource Type	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)	CAISO Study Area	Resource Type	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
PG&E North of Greater Bay	Geothermal (MW)	123.0	123.0	144.0	144.0	PG&E Fresno	Geothermal (MW)	-	-	-	-
	Biomass (MW)	80.0	80.0	94.5	94.5		Biomass (MW)	26.6	26.6	20.2	20.2
	OnshoreWind (MW)	1,802.7	1,802.7	887.0	1,787.4		OnshoreWind (MW)	560.5	560.5	490.0	490.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	1,607.0	1,607.0	931.0	1,607.0		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	377.0	1,332.0	630.2	1,390.2		Solar (MW)	3,877.1	10,537.1	3,619.5	5,794.7
	Battery-4hr (MW)	251.0	251.0	293.5	293.5		Battery-4hr (MW)	2,136.8	2,136.8	1,584.2	1,699.2
	Battery-8hr (MW)	50.0	335.0	50.0	390.0		Battery-8hr (MW)	735.0	2,455.0	200.0	1,131.5
	LDES (MW)	5.0	5.0	5.0	5.0		LDES (MW)	140.0	140.0	130.0	130.0
	Zone Total (MW)	**4,296**	**5,536**	**3,035**	**5,712**		**Zone Total (MW)**	**7,476**	**15,856**	**6,044**	**9,266**
PG&E Greater Bay	Geothermal (MW)	-	-	-	-	PG&E Kern	Geothermal (MW)	-	-	-	-
	Biomass (MW)	12.6	12.6	22.6	22.6		Biomass (MW)	32.5	32.5	18.0	18.0
	OnshoreWind (MW)	1,013.6	1,013.6	988.0	988.0		OnshoreWind (MW)	113.1	113.1	310.0	310.0
	OOS Wind (MW)	-	1,707.0	-	1,500.0		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	2,924.0	2,924.0	2,924.0	2,924.0
	Solar (MW)	138.9	788.9	140.3	915.3		Solar (MW)	2,559.3	5,869.3	2,005.2	3,870.2
	Battery-4hr (MW)	698.3	698.3	828.8	878.8		Battery-4hr (MW)	451.0	451.0	746.8	746.8
	Battery-8hr (MW)	200.0	1,152.2	250.0	920.0		Battery-8hr (MW)	410.0	1,250.0	142.0	1,157.0
	LDES (MW)	310.0	310.0	-	-		LDES (MW)	-	-	-	-
	Zone Total (MW)	**2,373**	**5,683**	**2,230**	**5,225**		**Zone Total (MW)**	**6,490**	**10,640**	**6,146**	**9,026**
SCE Northern Area	Geothermal (MW)	-	-	-	-	East of Pisgah	Geothermal (MW)	517.3	517.3	875.0	875.0
	Biomass (MW)	2.0	2.0	1.0	1.0		Biomass (MW)	-	-	-	-
	OnshoreWind (MW)	674.0	674.0	580.0	580.0		OnshoreWind (MW)	1,228.5	1,228.5	620.0	620.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	4,151.0	4,151.0	3,964.8	4,060.0
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	3,343.5	6,023.5	3,291.0	4,656.3		Solar (MW)	2,411.0	6,811.0	2,640.0	4,230.0
	Battery-4hr (MW)	3,179.0	3,179.0	3,239.9	3,239.9		Battery-4hr (MW)	1,210.0	1,210.0	1,684.0	2,188.1
	Battery-8hr (MW)	226.0	1,351.0	169.5	734.0		Battery-8hr (MW)	470.0	1,915.0	180.0	695.5
	LDES (MW)	400.0	400.0	458.0	458.0		LDES (MW)	-	-	-	-
	Zone Total (MW)	**7,825**	**11,630**	**7,739**	**9,669**		**Zone Total (MW)**	**9,988**	**15,833**	**9,964**	**12,669**
SCE Metro	Geothermal (MW)	389.0	389.0	-	-	SCE Eastern	Geothermal (MW)	500.0	500.0	790.0	790.0
	Biomass (MW)	5.6	5.6	5.6	5.6		Biomass (MW)	7.6	7.6	2.6	2.6
	OnshoreWind (MW)	-	-	-	-		OnshoreWind (MW)	324.5	324.5	324.0	324.0
	OOS Wind (MW)	1,750.0	1,750.0	-	-		OOS Wind (MW)	3,099.0	3,099.0	2,130.8	3,535.6
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	32.9	32.9	27.0	34.0		Solar (MW)	4,273.5	7,553.5	3,458.5	5,833.5
	Battery-4hr (MW)	1,711.5	1,711.5	1,795.0	1,845.0		Battery-4hr (MW)	3,969.0	3,969.0	2,680.0	2,680.0
	Battery-8hr (MW)	350.0	950.0	166.5	446.5		Battery-8hr (MW)	120.0	1,035.0	270.0	1,070.0
	LDES (MW)	-	-	-	-		LDES (MW)	-	-	-	-
	Zone Total (MW)	**4,239**	**4,839**	**1,994**	**2,331**		**Zone Total (MW)**	**12,294**	**16,489**	**9,656**	**14,236**
SCE North of Lugo	Geothermal (MW)	9.7	9.7	-	-	SDG&E	Geothermal (MW)	100.0	100.0	160.0	160.0
	Biomass (MW)	4.2	4.2	1.5	1.5		Biomass (MW)	-	-	-	-
	OnshoreWind (MW)	362.2	362.2	360.0	360.0		OnshoreWind (MW)	1,815.8	1,815.8	1,564.0	1,564.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	1,305.1	2,159.1	1,593.0	2,037.0		Solar (MW)	1,515.3	3,785.3	1,582.8	1,919.8
	Battery-4hr (MW)	403.0	403.0	716.0	746.0		Battery-4hr (MW)	1,697.5	1,697.5	1,389.7	1,389.7
	Battery-8hr (MW)	148.0	378.0	90.0	265.0		Battery-8hr (MW)	125.0	1,190.0	100.0	305.0
	LDES (MW)	-	-	-	-		LDES (MW)	409.2	409.2	437.0	487.0
	Zone Total (MW)	**2,232**	**3,316**	**2,761**	**3,410**		**Zone Total (MW)**	**5,663**	**8,998**	**5,234**	**5,826**

Table 31: Summary of the number of substations in each CAISO study area with non-alignment flags for the consistency with previous base case criteria for the initial mapping results (2040 model year) compared to the 24-25 TPP 2039 model year broken down by resource type. Circles indicate study areas where substations with flags occur (Yellow for slight decrease and Orange for Significant decrease).

2040 Preliminary 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*	2	0	0	0	0	0	0	0	0	0
	Significant**	1	0	0	0	0	0	0	2	1	1
Biomass	Slight	0	0	1	0	0	0	0	0	0	0
	Significant	13	8	2	1	0	0	1	0	0	0
Wind, Onshore	Slight	1	0	0	0	0	0	0	0	0	0
	Significant	2	1	0	1	0	0	0	1	0	2
OOS Wind	Slight	0	0	0	0	0	0	0	0	1	0
	Significant	0	0	0	0	0	0	0	0	0	0
Offshore Wind	Slight	0	0	0	0	0	0	0	0	0	0
	Significant	0	0	0	0	0	0	0	0	0	0
Distributed_ Solar	Slight	0	0	0	2	0	0	0	0	0	0
	Significant	7	8	9	4	0	2	2	0	0	0
Solar	Slight	0	0	1	0	0	0	0	0	2	0
	Significant	5	1	0	1	1	0	3	3	0	1
Total Battery	Slight	2	1	2	2	2	2	0	2	0	1
	Significant	5	7	0	3	0	3	3	2	1	4
LDES	Slight	0	0	0	0	1	0	0	0	0	1
	Significant	1	0	0	0	0	0	0	0	0	0

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

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

Table 31 shows 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 2040 portfolio. From the tables of non-alignment flags, battery storage, distributed solar, and biomass have the largest number of non-alignments. With respect to biomass and distributed solar, while the fractional changes are significant, the absolute magnitude of these two resources in the portfolio are small. Biomass has numerous non-alignment flags in the PG&E study areas as staff sought to better align with updated commercial interest and resource potential information. Similarly for distributed solar, updated commercial interest information causes small amounts of distributed solar to be relocated to buses with higher-confidence commercial interest.

Battery storage resource mapping also results in 28 flags for significant misalignment with several in almost every study area. The key driver in the battery mapping differences is the increased amount of 4-hr and some 8-hr battery storage identified as in-development as nearly all the 4-hr batteries in the portfolio were mapped to align with in-development resources. Staff did map some 8-hr battery to these locations as they are favorable locations and have higher-confidence commercial interest, but those buses still have flags due to the MW differential. Additionally, that effort resulted in a few locations with previously mapped 8-hr battery having less batteries as well. The one flag for LDES was the result of the 2024 White Paper including a more accurate bus location to which the in-development resource was mapped.

Initial utility-scale solar mapping resulted in 15 flags for significant non-alignment and those were concentrated in three study areas SCE North of Lugo, East of Pisgah, and PG&E North of Greater Bay. For North of Lugo, both Kramer buses (115 kV and 230 kV) as well as Coolwater 115 kV have less solar due to the higher environmental impact flags and the updated capability limitations of the Kramer area transmission constraints. In East of Pisgah, two of the flags are caused by staff mapping to the new 230 kV buses of Lathrop and Vista rather than the previously mapped to 138 kV. In both cases these new substations are approved policy upgrades in the study areas for the portfolio resources. The last flag at Eldorado is due to a reduction in solar commercial interest. For the five flags in the North of Greater Bay study area, the solar was not mapped to these buses to generally better align with higher-confidence commercial interest in other locations.

For geothermal, initial mapping changes compared to the previous base case that resulted in significant non-alignment were at the following substations: Beatty 138 kV (changed from 500 MW to zero, 400 MW were mapped to the new Beatty 230 kV substation in better alignment with the transmission system while the 100 MW reduction was due to less MW in the portfolio); Eldorado 500 kV (changed from 299 MW to zero; staff remapped this to in-development Utah geothermal importing at Lugo); Imperial Valley 230 kV and Mirage 230 kV (IID geothermal changed from 950 MW to 600 MW due to reduction in geothermal in portfolio and increase in Utah geothermal); and Geysers 12 (changed 63 MW to zero, as the 2024 White Paper includes additional buses that better represent interconnection locations).

For wind, the following seven buses have in both 2035 and 2040 significantly less total wind mapped than the prior portfolio: Caliente 230 kV (changed from 210 MW to 0 MW as there is no commercial interest, limited transmission availability, and higher environmental flags), East County 138 kV (mapped to Boulevard East, previously not included as a bus, to better align with commercial development interest), Glenn 230 kV(total changed from 333 MW to 202 MW as no

commercial interest and to limit potential transmission exceedances), Kelso 230 kV (changed from 196 MW to 84 MW to better align with commercial interest and limited resource potential), Lathrop 138 kV (mapped to new substation Lathrop 230 kV), and Round Mountain 230 kV (changed from 100 MW to 0 MW as bus has no commercial interest and high potential environmental impact flags). A few other buses had the amount of FCDS wind reduced but the total wind remained the same or increased).

6.3 Post-Ruling Portfolio Modeling and Busbar Mapping Adjustments

Portfolio changes and mapping adjustments included with the Proposed Decision mapped results:

The proposed base case was included in the September 2024 Ruling while initial mapping results were released with the October 2024 Ruling. Following those rulings, staff made no model assumptions changes and thus did not rerun the RESOLVE model to update the portfolio. As part of the busbar mapping effort, staff made one small adjustment to the composition of the portfolio. CPUC staff identified slightly more in-development 4-hr battery resources than the portfolio includes in total in both the 2035 and 2040 model years. Thus, CPUC staff converted 241 MW of 8-hr storage resources into 482 MW of 4-hr battery storage to align with the amount of in-development 4-hr battery storage.

For busbar mapping, several key issues drove remapping changes between initial mapping results and the results for the Proposed Decision:

- Improve reliability and GHG emissions modeling results in production cost modeling
    - Overall staff shifted 974 MW of solar and 100 MW of 8-hr storage in 2035 and 3,511 MW of solar and 650 MW of 8-hr storage in 2045 from areas south of Path 26 to locations north of the constraint.
- Align resources with additional in-development resources
    - Staff identified additional in-development resources totaling 300 MW of onshore wind, 563 MW of Solar, 1,604 MW of 4-hr battery storage, and 498 MW of 8-hr battery storage. While some locations already had mapped generic resources corresponding to the amounts of additional in-development resources, in other situations resources needed to be remapped to align with the additional in-development resources.
- Improve general busbar mapping criteria alignment for mapped resources and optimize use of existing transmission and likely triggered upgrades
    - In remapping resources to address the above two issues, staff still utilized the mapping criteria to prioritize which resources to relocate and to which locations the resources should be mapped.
    - Additionally, mapping adjustments were made to improve alignment with mapping criteria or better optimize transmission utilizations (e.g. staff remapped a significant

portion of the biomass to try to improve criteria alignment particularly with the community environmental impacts criteria).

The mapping adjustment drivers listed above are reflected in the base case mapping results included in the Dashboard for the Proposed Decision Mapping of the 25-26 TPP Base Case (Appendix C) and summarized by CAISO study area below.

6.3.A Net Mapping Adjustments for 2035 Base Case Portfolio

The tables below display the adjustments to the 2035 mapping results between the initial mapping and updated mapping for the Proposed Decision.

The net MW mapping adjustments for the 2035 base case portfolio are summarized by resource type and CAISO in Table 32. Table 33 shows the number of substations by CAISO study area at which resources were added or removed for the 2035 portfolio, and Table 34 shows a narrower focused number of substations where staff remapped 50 MW or more of a single resource, either added or removed. For both Table 33 and Table 34, the top table shows the number of substations with mapping increases and the bottom table shows the number with decreases.

Overall, in the remapping of resources in the 2035 portfolio there are a few key trends:

- Biomass is shifted from the Central Valley to Northern California to better align with community environmental impact criteria
- On-shore instate wind is shifted from EODS to FCDS in a few southern study areas to utilize existing transmission capability or capability freed up by solar and storage remapping.
- Shift in solar from the Riverside, Tehachapi, and Kramer regions to PG&E study areas to improve reliability and GHG modeled results in the portfolio's capacity expansion modeling. Reductions in the Riverside, Tehachapi, Kramer areas were centered on buses that higher non-compliance flags.
- Shift of solar from FCDS to EODS in SCE eastern area to align with in-development resources.
- Remapping to add 4-hr batteries buses to align with in-development resources.
- Remapping to reduce 8-hr batteries in several southern study areas to be swapped for the 4-hr batteries needed, to be remapped to SCE Northern area to align with in-development resources, and to be remapped to Northern California locations to improve reliability model results.

Table 32: Summary of the net MW adjustments between initial and updated mapping results for the 2035 base case portfolio by CAISO study area and resource type.

Summary of Mapping Changes between Initial and PD Mapping for the 2035 Portfolio													
2035 Portfolio: Net Change (MW) In Resources Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	29	-	-	-	-	1	-	-	(126)	45	-	(51)
PG&E Greater Bay	-	(1)	-	-	-	-	5	-	150	21	36	-	211
PG&E Fresno	-	(17)	-	-	-	-	-	125	400	171	(35)	-	644
PG&E Kern	-	(9)	-	-	-	-	-	100	193	42	-	-	326
SCE Northern Area	-	(2)	-	-	-	-	-	(259)	(275)	45	283	-	(208)
SCE Metro	-	-	-	-	-	-	-	-	-	179	(340)	-	(161)
SCE North of Lugo	-	-	80	(80)	-	-	-	(7)	(100)	104	(35)	-	(38)
East of Pisgah	-	-	194	(194)	-	-	-	-	(13)	-	(150)	-	(163)
SCE Eastern	-	0	-	-	-	-	-	(500)	100	16	(20)	-	(403)
SDG&E	-	-	200	(200)	-	-	-	(20)	100	30	(25)	-	85
All Areas	-	(0)	474	(474)	-	-	6	(561)	555	482	(241)	-	241

Table 33: Summary by CAISO study area of the number of substations with any mapping changes for the 2035 base case portfolio.

2035 Mapping: No. of Subs w/ Increase in Res. Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	4	-	-	-	-	1	-	-	1	1	-	7
PG&E Greater Bay	-	1	-	-	-	-	2	-	1	3	3	-	10
PG&E Fresno	-	-	-	-	-	-	-	2	3	3	1	-	9
PG&E Kern	-	1	-	-	-	-	-	1	3	1	-	-	6
SCE Northern Area	-	-	-	-	-	-	-	-	-	1	1	-	2
SCE Metro	-	-	-	-	-	-	-	-	-	3	-	-	3
SCE North of Lugo	-	-	1	-	-	-	-	-	-	1	-	-	2
East of Pisgah	-	-	1	-	-	-	-	-	-	-	-	-	1
SCE Eastern	-	1	-	-	-	-	-	-	1	1	-	-	3
SDG&E	-	-	1	-	-	-	-	-	1	5	1	-	8
All Areas	0	7	3	0	0	0	3	3	9	19	7	0	51

2035 Mapping: No. of Subs w/ Decrease in Res. Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	2	-	-	2	-	-	4
PG&E Greater Bay	-	2	-	-	-	-	-	-	-	2	-	-	4
PG&E Fresno	-	5	-	-	-	-	-	-	1	-	3	-	9
PG&E Kern	-	4	-	-	-	-	-	-	-	1	-	-	5
SCE Northern Area	-	1	-	-	-	-	-	2	2	1	3	-	9
SCE Metro	-	-	-	-	-	-	-	-	-	2	3	-	5
SCE North of Lugo	-	-	-	1	-	-	-	1	1	1	3	-	7
East of Pisgah	-	-	-	1	-	-	-	-	1	-	1	-	3
SCE Eastern	-	-	-	-	-	-	-	1	2	2	1	-	6
SDG&E	-	-	-	1	-	-	-	1	-	1	1	-	4
All Areas	0	12	0	3	0	0	2	5	7	12	15	0	56

Table 34: Summary by CAISO study area of the number of substations with mapping changes 50 MW or larger for the 2035 base case portfolio.

2035 Mapping: No. of Subs w/ >50 MW Increase (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	-	-	-	0
PG&E Greater Bay	-	-	-	-	-	-	-	-	1	1	-	-	2
PG&E Fresno	-	-	-	-	-	-	-	1	3	1	-	-	5
PG&E Kern	-	-	-	-	-	-	-	1	2	1	-	-	4
SCE Northern Area	-	-	-	-	-	-	-	-	-	1	1	-	2
SCE Metro	-	-	-	-	-	-	-	-	-	3	-	-	3
SCE North of Lugo	-	-	1	-	-	-	-	-	-	1	-	-	2
East of Pisgah	-	-	1	-	-	-	-	-	-	-	-	-	1
SCE Eastern	-	-	-	-	-	-	-	-	1	1	-	-	2
SDG&E	-	-	1	-	-	-	-	-	1	1	1	-	4
All Areas	0	0	3	0	0	0	0	2	8	10	2	0	25

2035 Mapping: No. of Subs w/ >50 MW Decrease in Res. (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	2	-	-	2
PG&E Greater Bay	-	-	-	-	-	-	-	-	-	1	-	-	1
PG&E Fresno	-	-	-	-	-	-	-	-	-	-	-	-	0
PG&E Kern	-	-	-	-	-	-	-	-	-	1	-	-	1
SCE Northern Area	-	-	-	-	-	-	-	2	2	1	1	-	6
SCE Metro	-	-	-	-	-	-	-	-	-	1	2	-	3
SCE North of Lugo	-	-	-	1	-	-	-	-	1	-	-	-	2
East of Pisgah	-	-	-	1	-	-	-	-	-	-	1	-	2
SCE Eastern	-	-	-	-	-	-	-	1	2	2	-	-	5
SDG&E	-	-	-	1	-	-	-	-	-	1	1	-	3
All Areas	0	0	0	3	0	0	0	3	5	9	5	0	25

6.3.B Net Mapping Adjustments for 2040 Base Case Portfolio

The adjustments to the 2040 mapping results between the initial mapping and updated mapping are consistent with the adjustments made in the 2035 mapped portfolio with additional adjustments driven by further relocation of solar and storage to north of Path 26. Additional adjustments were part of the general effort to limit and optimize transmission exceedances and improve criteria alignment.

The net MW mapping adjustments for the 2040 base case portfolio are summarized by resource type and CAISO in Table 35. Table 36 shows the number of substations by CAISO study area at which resources were added or removed for the 2040 portfolio, and Table 37 shows a narrower focused number of substations where staff remapped 50 MW or more of a single resource, either added or removed. For both Table 36 and Table 37, the top table shows the number of substations with mapping increases and the bottom table shows the number with decreases.

In addition, the trends in the 2035 portfolio remapping, the 2040 portfolio remapping had the following additional trends.

- Further remapping of solar and storage (3,511 MW solar and 650 MW 8-hr battery storage in total) from southern study areas to areas north of Path 26. The additional resources were generally relocated from buses in the East of Pisgah, SCE Eastern, and SDG&E study areas with lower-confidence development interest or higher land-use and environmental flags and to buses in the Fresno study area.

- Remapping of resources from a few substations in the PG&E Kern study area to limit transmission constraint exceedances to buses in locations with existing transmission capacity or exceedances already triggered.

- Similarly solar was remapped in from FCDS to EODS, in addition to some relocations to other buses, to reduce the exceedances in constraints with already approved upgrades in the SCE North of Lugo and East of Pisgah study areas.

Table 35: Summary of the net MW adjustments between initial and updated mapping results for the 2039 base case portfolio by CAISO study area and resource type.

Summary of Mapping Changes between Initial and PD Mapping for the 2040 Portfolio													
2040 Portfolio: Net Change (MW) In Resources Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	29	-	-	-	-	1	-	-	(126)	(30)	-	(126)
PG&E Greater Bay	-	(1)	-	-	-	-	5	252	400	21	356	-	1,033
PG&E Fresno	-	(17)	-	-	-	-	-	1,525	1,550	171	310	-	3,539
PG&E Kern	-	(9)	-	-	-	-	-	(320)	98	42	(40)	-	(229)
SCE Northern Area	-	(2)	-	-	-	-	-	(259)	(345)	45	233	-	(328)
SCE Metro	-	-	-	-	-	-	-	-	-	179	(340)	-	(161)
SCE North of Lugo	-	-	80	(80)	-	-	-	(247)	105	104	85	-	47
East of Pisgah	-	-	194	(194)	-	-	-	(1,070)	257	-	(280)	-	(1,093)
SCE Eastern	-	0	-	-	-	-	-	(850)	(450)	16	(255)	-	(1,538)
SDG&E	-	-	200	(200)	-	-	-	(502)	(150)	30	(280)	-	(902)
All Areas	-	(0)	474	(474)	-	-	6	(1,471)	1,465	482	(241)	-	241

Table 36: Summary by CAISO study area of the number of substations with any mapping changes for the 2040 base case portfolio.

2040 Mapping: No. of Subs w/ Increase in Res. Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	4	-	-	-	-	1	-	-	1	1	-	7
PG&E Greater Bay	-	1	-	-	-	-	2	2	2	3	7	-	17
PG&E Fresno	-	-	-	-	-	-	-	8	8	3	6	-	25
PG&E Kern	-	1	-	-	-	-	-	1	3	1	2	-	8
SCE Northern Area	-	-	-	-	-	-	-	-	-	1	1	-	2
SCE Metro	-	-	-	-	-	-	-	-	-	3	-	-	3
SCE North of Lugo	-	-	1	-	-	-	-	-	2	1	2	-	6
East of Pisgah	-	-	1	-	-	-	-	-	5	-	-	-	6
SCE Eastern	-	1	-	-	-	-	-	-	1	1	-	-	3
SDG&E	-	-	1	-	-	-	-	-	1	5	2	-	9
All Areas	0	7	3	0	0	0	3	11	22	19	21	0	86

2040 Mapping: No. of Subs w/ Decrease in Res. Mapped (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	2	-	-	2	1	-	5
PG&E Greater Bay	-	2	-	-	-	-	-	-	-	2	-	-	4
PG&E Fresno	-	5	-	-	-	-	-	-	1	-	3	-	9
PG&E Kern	-	4	-	-	-	-	-	3	2	1	2	-	12
SCE Northern Area	-	1	-	-	-	-	-	2	3	1	4	-	11
SCE Metro	-	-	-	-	-	-	-	-	-	2	3	-	5
SCE North of Lugo	-	-	-	1	-	-	-	3	1	1	2	-	8
East of Pisgah	-	-	-	1	-	-	-	8	2	-	3	-	14
SCE Eastern	-	-	-	-	-	-	-	4	4	2	4	-	14
SDG&E	-	-	-	1	-	-	-	5	2	1	5	-	14
All Areas	0	12	0	3	0	0	2	25	15	12	27	0	96

Table 37: Summary by CAISO study area of the number of substations with mapping changes 50 MW or larger for the 2040 base case portfolio.

2040 Mapping: No. of Subs w/ >50 MW Increase (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	-	-	-	0
PG&E Greater Bay	-	-	-	-	-	-	-	2	2	1	2	-	7
PG&E Fresno	-	-	-	-	-	-	-	7	8	1	3	-	19
PG&E Kern	-	-	-	-	-	-	-	-	3	1	-	-	4
SCE Northern Area	-	-	-	-	-	-	-	-	-	1	1	-	2
SCE Metro	-	-	-	-	-	-	-	-	-	3	-	-	3
SCE North of Lugo	-	-	1	-	-	-	-	-	2	1	2	-	6
East of Pisgah	-	-	1	-	-	-	-	-	5	-	-	-	6
SCE Eastern	-	-	-	-	-	-	-	-	1	1	-	-	2
SDG&E	-	-	1	-	-	-	-	-	1	1	2	-	5
All Areas	0	0	3	0	0	0	0	9	22	10	10	0	54

2040 Mapping: No. of Subs w/ >50 MW Decrease in Res. (PD - Initial)	Geothermal FCDS	Biomass FCDS	Wind FCDS	Wind EODS	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar FCDS	Solar FCDS	Solar EODS	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	2	1	-	3
PG&E Greater Bay	-	-	-	-	-	-	-	-	-	1	-	-	1
PG&E Fresno	-	-	-	-	-	-	-	-	-	-	-	-	0
PG&E Kern	-	-	-	-	-	-	-	3	1	1	1	-	6
SCE Northern Area	-	-	-	-	-	-	-	2	3	1	2	-	8
SCE Metro	-	-	-	-	-	-	-	-	-	1	2	-	3
SCE North of Lugo	-	-	-	1	-	-	-	2	1	-	-	-	4
East of Pisgah	-	-	-	1	-	-	-	8	1	-	2	-	12
SCE Eastern	-	-	-	-	-	-	-	4	4	2	3	-	13
SDG&E	-	-	-	1	-	-	-	3	2	1	4	-	11
All Areas	0	0	0	3	0	0	0	22	12	9	15	0	61

6.3.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 September 2024 and October 2024 Rulings and further Working Group analysis. Full substation level mapping adjustments and complete busbar mapping criteria analysis for both the 2035 and 2040 model years can be found in the Proposed Decision Dashboard (Appendix C). The updated mapping results alignment with the busbar mapping criteria are discussed in Section 6.4.

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

Table 38 summarizes the post initial 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 38: 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 Greater Bay: Resources Mapped (PD - 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
2035 Net MW Change	-	29	-	-	-	-	1	-	-	(126)	45	**(51)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	0	0	**0**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	2	0	**2**
2040 Net MW Change	-	29	-	-	-	-	1	-	-	(126)	(30)	**(126)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	0	0	**0**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	2	1	**3**

PG&E North of Greater Bay: Resources Mapped (PD - 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
2035 Net MW Change	-	(1)	-	-	-	-	5	-	150	21	36	**211**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	1	1	0	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	1	0	**1**
2040 Net MW Change	-	(1)	-	-	-	-	5	252	400	21	356	**1,033**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	2	2	1	2	**7**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	1	0	**1**

Key mapping adjustments for these two areas are:

- In 2035, relocating all the generic 4-hr batteries mapped in both study areas (Cortina 115 kV, Gold Hill 115 kV, Hollister 115kV, and Martin 115kV) in both 2035 and 2040 to align with identified in-development batteries in the study area including 90.7 MW to Kelso 230 kV and 39 MW to Ripon 115 kV and to other locations

- This reduction was partially offset by small additions in the amount of 8-hr batteries mapped to Cortina 115 kV (45 MW) and Hollister 115 kV (15 MW) in 2035. And in 2040, remapping additional 8-hr batteries to Cooley Landing 60 kV (15 MW), Martin 115 kV (40 MW), Pittsburg 115 kV (75 MW), and Pittsburg 230 kV (175 MW). These adjustments along with the reduction in 8-hr batteries mapped to Delevan 230 kV (-75 MW) were driven by alignment with higher-confidence deliverability particularly locations with TPD allocated to storage.

- In 2040, solar and storage resources were remapped from southern study areas to Bellota (400 MW solar) and a proposed new substation on the Rancho Seco - Bellota 230 kV line (252 MW solar and 40 MW 8-hr battery storage) as part of remapping resources to improve modeled reliability results.

- Finally, in 2035, staff made small reductions to biomass mapped to Kirker 115 kV (-1 MW) and Newark 115 kV (-1 MW) and additions to Calpella 115 kV (10 MW), Jessup 115 kV (8 MW), Salinas 115 kV (1.25 MW), and Wyandotte (10 MW) to support a reduction in biomass resources mapped to buses with high non-alignment to the community environmental impacts criteria, particularly proximity to disadvantaged communities.

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 (PD - 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
2035 Net MW Change	-	(17)	-	-	-	-	-	125	400	171	(35)	**644**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	1	3	1	0	**5**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	0	0	**0**
2040 Net MW Change	-	(17)	-	-	-	-	-	1,525	1,550	171	310	**3,539**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	7	8	1	3	**19**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	0	0	**0**

PG&E Kern: Resources Mapped (PD - 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
2035 Net MW Change	-	(9)	-	-	-	-	-	100	193	42	-	**326**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	1	2	1	0	**4**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	1	0	**1**
2040 Net MW Change	-	(9)	-	-	-	-	-	(320)	98	42	(40)	**(229)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	3	1	0	**4**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	3	1	1	1	**6**

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

- In 2035, remapped 4-hr battery storage from Arco 230 kV (-50 MW) and to Tranquility 230 kV (160 MW) and Wheler Ridge 70 kV (92 MW) to align with in-development resources.
- In 2035, removed 8-hr storage mapped to Lemore 70 kV (-15 MW) and Malaga (-30 MW) due to lower levels of commercial interest to convert to 4-hr storage for in-development mapping alignment.
- In 2035, relocated 25 MW of solar and 10 MW of 8-hr storage from Helm 70 kV to avoid a transmission exceedance in the Helm 230/70kV TB #1 constraint.
- In 2035, remapped 195 MW of solar and 20 MW of 8-hr storage to Borden 230 kV from Helm 70 kV and buses in the southern study areas to support improving modeled reliability.
- In 2035, remapped solar from southern study area buses to Arco 230 (25 MW), Gates 230 (250 MW), Lamont 115 kV (68 MW), Le Grand 115 kV (105 MW) and Wheeler Ridge 230 KV (200 MW) as part of the Path 26 remapping and in alignment with levels of commercial development interest, land-use criteria, and limiting additional transmission exceedances in the study areas.
- Reduced biomass mapped to the following substations to improve general community environmental criteria alignment: Caliente 230 kV and Los Banos 230 kV (these also had a high interconnection voltage for the small amount of biomass mapped) as well as Exchequer

115 kV, Ganso 115 kV, Norco 115 kV, Reedley 115 kV, Rio Bravo 115 kV, Sanger 115 kV, and Wilson 115 kV.

- In 2040, the solar and storage mapped to Caliente 230 kV (-300 MW solar, -50 MW 8-hr storage) and Shafter 115 kV (-200 MW solar, -30 MW 8-hr storage) was remapped to other locations as both buses only had lower-confidence commercial interest and was resulting in an exceedance to the Cal Flat-Gates 230 kV line constraint.

- In 2040, as part of the remapping above and shift in solar and storage resources from southern study areas to north of Path 26, additional solar and storage resources were remapped to the following substations: Excelsior 115 kV (200 MW solar), Kearney 230 kV (400 MW solar, 20 MW 8-hr battery), Lamont 115 kV (additional 10 MW solar, 15 MW 8-hr battery), Le Grand 115 kV (additional 50 MW solar), Manning 230 kV (500 MW solar, 100 MW 8-hr battery), Mc Mullin 230 kV (500 MW solar, 60 MW 8-hr battery), New Sub - Los Banos - Midway (Proposed) 500 kV (700 MW solar, 125 MW 8-hr battery), and Sanger 115 kV (200 MW solar, 30 MW 8-hr battery).

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

Table 39 summarizes the post ruling mapping adjustments, showing the net MW change in mapped amount for SCE Northern and SCE Metro 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 SCE Northern and SCE Metro study areas. The tables show net MW changes and the number of substations with 50 MW or larger mapping adjustments by resource type.

SCE Northern: Resources Mapped (PD - 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
2035 Net MW Change	-	(2)	-	-	-	-	-	(259)	(275)	45	283	**(208)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	1	1	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	2	2	1	1	**6**
2040 Net MW Change	-	(2)	-	-	-	-	-	(259)	(345)	45	233	**(328)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	1	1	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	2	3	1	2	**8**

SCE Metro: Resources Mapped (PD - 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
2035 Net MW Change	-	-	-	-	-	-	-	-	-	179	(340)	**(161)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	3	0	**3**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	1	2	**3**
2040 Net MW Change	-	-	-	-	-	-	-	-	-	179	(340)	**(161)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	0	3	0	**3**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	0	0	1	2	**3**

Key mapping adjustments for the SCE Northern and Metro areas are:

- In 2035, staff remapped batteries from Johana 230 kV (-40 MW 4-hr, -40 MW 8-hr), Mandalay 230 kV (-200 MW 4-hr), Mira Loma 230 kV (-58 MW 4-hr, -100 MW 8-hr), Langua Bell 230 kV (-200 MW 8-hr), Vestal 230 kV (-45 MW 8-hr), Vincent 230 kV(-100 8-

hr), and Windhub 230 kV (-20 MW 8-hr) and remapped batteries to Hinson 230 kV (70 MW 4-hr), Laguna Bell 230 kV (107 MW 4-hr), Rio Hondo 230 kV (100 MW 4-hr), Whirlwind 230 kV (245 MW 4-hr, 448 MW 8-hr) to align with updated in-development resources.

- In 2035, staff further remapped 350 MW of solar from Vincent 230 kV and 184 MW of solar from Windhub 230 kV to northern study areas since the mapped co-located storage at both buses was remapped per the above bullet.
- In 2040, the 150 MW of solar and 50 MW of 8-hr battery were remapped from the Santa Clara 230 kV bus to northern study areas as the bus had no solar commercial interest and only low-confidence battery commercial interest.

Greater Kramer – SCE North of Lugo Study Area

Table 40 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.

Key mapping adjustments for the SCE North of Lugo area are:

- In 2035, staff reduced battery storage at Calcite 230 kV (-24.5 MW 4-hr, -8 MW 8-hr), Kramer 230 kV (-25 MW-hr) and Roadway 115 (-2 MW 8-hr) to support the remapping of 128.7 MW of 4-hr battery to Kramer 230 kV to align with the updated in-development resources in other study areas.
- In 2035, staff converted 80 MW of onshore wind mapped to Coolwater 115 kV from EODS to FCDS.
- In 2035, staff remapped 107 MW of solar from Kramer 230 kV to buses north of Path 26, as solar mapped to the Kramer substation had high non-alignment with various land-use and environmental impact criteria.
- In 2040, staff remapped 112 MW of 8-hr battery in total to Calcite 230 kV and Pisgah 230 kV bus, reduced the solar mapped to Calcite by 85 MW and increasing the solar mapped to Pisgah by 50 MW, and shifted solar from FCDS to EODS at both substation to better align with the higher-confidence TPD allocated commercial interest at both buses and better utilize the potential upgrade to the area constraint.

Table 40: 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 (PD - 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
2035 Net MW Change	-	-	80	(80)	-	-	-	(7)	(100)	104	(35)	**(38)**
Subs w/ >50 MW Increse	0	0	1	0	0	0	0	0	0	1	0	**2**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	0	1	0	0	**2**
2040 Net MW Change	-	-	80	(80)	-	-	-	(247)	105	104	85	**47**
Subs w/ >50 MW Increse	0	0	1	0	0	0	0	0	2	1	2	**6**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	2	1	0	0	**4**

Southern Nevada – East of Pisgah Study Area

Table 41 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.

Table 41: 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 (PD - 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
2035 Net MW Change	-	-	194	(194)	-	-	-	-	(13)	-	(150)	**(163)**
Subs w/ >50 MW Increse	0	0	0	1	0	0	0	0	0	0	1	**2**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	0	0	0	0	**1**
2040 Net MW Change	-	-	194	(194)	-	-	-	(1,070)	257	-	(280)	**(1,093)**
Subs w/ >50 MW Increse	0	0	1	0	0	0	0	0	5	0	0	**6**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	8	1	0	2	**12**

Mapping adjustments between the initial and updated mapping results in the following key shifts:

- In 2035, staff remapped 150 MW of 8-hr battery and 13 MW of solar from Mohave 500 kV to provide additional battery storage to align with the updated in-development resources and to shift resources to buses north of Path 26.
- In 2035, staff also converted 194 MW of onshore wind from EODS to FCDS.
- In 2040, staff remapped solar and battery from the following substations: Mohave 500 kV (200 MW of FCDS solar), Beatty 230 kV (200 MW of FCDS solar and 30 MW of 8-hr battery), Carpenter Canyon 230 kV (100 MW of FCDS solar), and Sloan Canyon 230 kV (300 MW of solar, 100 MW FCDS and 200 MW EODS, and 100 MW of 8-hr battery) to address multiple issues. First, these buses generally had lower-confidence commercial interest beyond the amounts of resources that were still mapped, and these resources were remapped to areas with higher-confidence commercial interest (e.g. Pisgah and Calcite) or were needed as part of the resource shift to buses north of Path 26. Additionally, Sloan Canyon, in particular, had higher flags for the land-use criteria and additional uncertainty over the impacts of the new 2024 BLM Solar Programmatic Environmental Impact Statement. Finally, these remapping helped reduce the exceedance in the already approved upgrade for the Sloan Canyon - Eldorado 500 kV constraint.
- In 2040, staff shifted 470 MW of solar at Carpenter Canyon 230 kV, Desert View 230 kV, Innovation 230 kV, Trout Canyon 230 kV, and Valley 230 kV from FCDS to EODS to reduce the transmission exceedance in the Sloan Canyon - Eldorado 500 kV constraint.

Riverside and Arizona – SCE Eastern Study Area

Table 42 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 in the SDG&E study area.

Table 42: 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 (PD - 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
2035 Net MW Change	-	0	-	-	-	-	-	(500)	100	16	(20)	**(403)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	1	1	0	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	1	2	2	0	**5**
2040 Net MW Change	-	0	-	-	-	-	-	(850)	(450)	16	(255)	**(1,538)**
Subs w/ >50 MW Increse	0	0	0	0	0	0	0	0	1	1	0	**2**
Subs w/ >50 MW Decrease	0	0	0	0	0	0	0	4	4	2	3	**13**

Key mapping adjustments for the SCE Eastern study area are:

- In 2035, the mapping adjusts to account for the in-development resources update were at Cielo Azul 500 kV (changed 500 MW of solar from FCDS to EODS, and added 267 MW of 4-hr battery), remapped 100 MW solar and 100 MW of 4-hr battery from being imported at Mirage to being imported at Imperial Valley, and relocated 150.6 MW of 4-hr battery at Valley (SCE) 500 kV and 20 MW of 8-hr storage at Colorado River 230 kV to support in-development battery remapping efforts.
- In 2035, staff remapped 300 MW of solar from Colorado River 230 kV to north of Path 26 buses as Colorado River area had higher land-use criteria flags.
- In 2040, staff relocated 500 MW of solar and 60 MW of 8-hr storage from Red Bluff 500 kV and remapped it to buses north of Path 26, as Red Bluff had higher non-compliance flag in the land-use criteria.
- In 2040, staff made additional reductions in solar and storage mapped initially to buses to support the shift of resources North of Path 26, even though the buses generally had higher-confidence commercial interest. Those buses were Ceilo Azul 500 kV (-200 MW solar, -100 MW 8-hr battery), Colorado River 230 kV (-50 MW 8-hr battery), Delaney 500 kV (-200 MW solar, -25 MW 8-hr battery), and Dever 230 kV (-50 MW).

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

Table 43 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. Key mapping adjustments for the SDG&E study area are:

- In 2035, remapping included the following adjustments to better align with the additional in-development resources: reduction in battery storage at Talega 138 kV (-100 MW 4-hr) and Capistrano 138 kV (-75 MW 8-hr); and increase in battery mapped to Escondido 69 kV (13 MW 4-hr), Granite 69 kV (2.3 MW 4-hr), Los Coches 69 kV (1.5 MW 4-hr), Otay Mesa 230 kV (13 MW 4-hr), and Pendleton 69 kV (50 MW 8-hr).

- As noted in the SCE Eastern study area, staff remapped 100 MW of solar and 100 MW of 4-hr battery to be modeled as importing from IID at Imperial Valley 230 kV

- In 2040, staff remapped solar and storage from buses initially mapped from several buses in the SDG&E study area to buses north of Path 26 including Imperial Valley 230 kV (-250 MW solar), Hoodoo Wash 500 kV (-310 MW solar, -100 MW 8-hr battery), and New Sub - North Gila - IV (Proposed) 500 kV (-150 MW solar, -35 MW 8-hr battery).

- In 2040, staff remapped 8-hr battery from San Luis Rey 230 kV (-100 MW) and Silvergate 230 kV (-100 MW) as both had lower-confidence commercial interest for battery storage. Staff mapped 80 MW to Talega 138 kV as it has higher-confidence commercial interest with TPD and the rest to buses north of Path 26.

Table 43: 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 (PD - 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
2035 Net MW Change	-	-	200	(200)	-	-	-	(20)	100	30	(25)	**85**
Subs w/ >50 MW Increse	0	0	1	0	0	0	0	0	1	1	1	**4**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	0	0	1	1	**3**
2040 Net MW Change	-	-	200	(200)	-	-	-	(502)	(150)	30	(280)	**(902)**
Subs w/ >50 MW Increse	0	0	1	0	0	0	0	0	1	1	2	**5**
Subs w/ >50 MW Decrease	0	0	0	1	0	0	0	3	2	1	4	**11**

6.4 Mapping Criteria Alignment, Post-Remapping

The updated mapping results for the base case portfolio by RESOLVE resource area are shown below in Table 44 for 2035 and Table 45 for 2040. Table 46 below shows the updated mapping results summarized by CAISO study area for 2035 and 2040. This section summarizes the criteria alignment of the updated mapping results of the base case portfolio with subsections 6.4.A through 6.4.F summarizing the mapped portfolio's alignment with each of the busbar mapping criteria categories.

Table 44: Summary of the updated mapping results for the 2035 base case portfolio and changes from initial mapping by RESOLVE resource area.

RESOLVE Resource Name	In-Development Resources			2035 — Mapped Total (In-Dev & Generic)			2035 – Change in Mapping (PD - Initial)		
	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	16	-	**16**	171	-	**171**	-	-	**-**
Central_Nevada_Geothermal	-	-	**-**	400	-	**400**	-	-	**-**
Greater_Imperial_Geothermal	-	-	**-**	600	-	**600**	-	-	**-**
Inyokern_North_Kramer_Geothermal	10	-	**10**	10	-	**10**	-	-	**-**
Northern_California_Geothermal	25	-	**25**	123	-	**123**	-	-	**-**
Northern_Nevada_Geothermal	-	-	**-**	117	-	**117**	-	-	**-**
Pacific_Northwest_Geothermal	-	-	**-**	-	-	**-**	-	-	**-**
Utah_Geothermal	366	-	**366**	389	-	**389**	-	-	**-**
Distributed Solar		154	**154**	-	294	**294**	-	6	**6**
Arizona_Solar	53	2,864	**2,917**	420	2,864	**3,284**	(500)	500	**-**
Greater_Imperial_Solar	-	299	**299**	-	322	**322**	(20)	100	**80**
Greater_Kramer_Solar	275	240	**515**	650	524	**1,174**	(7)	(100)	**(107)**
Greater_LA_Solar	10	10	**20**	10	10	**20**	-	-	**-**
Northern_California_Solar	-	128	**128**	75	508	**583**	-	150	**150**
Riverside_Solar	475	1,374	**1,849**	475	1,374	**1,849**	-	(400)	**(400)**
Southern_NV_Eldorado_Solar	125	650	**775**	886	1,512	**2,398**	-	(13)	**(13)**
Southern_PGAE_Solar	991	1,794	**2,785**	2,301	4,825	**7,126**	225	593	**818**
Tehachapi_Solar	427	1,383	**1,810**	1,178	1,608	**2,786**	(259)	(275)	**(534)**
Baja_California_Wind	300	-	**300**	900	453	**1,353**	200	(200)	**-**
CentralValley_North_LosBanos_Wind	61	-	**61**	491	70	**561**	-	-	**-**
Greater_Imperial_Wind	-	-	**-**	360	103	**463**	-	-	**-**
Greater_Kramer_Wind	-	-	**-**	330	32	**362**	80	(80)	**-**
Kern_Greater_Carrizo_Wind	-	-	**-**	219	-	**219**	-	-	**-**
Northern_California_Wind	-	-	**-**	1,705	98	**1,803**	-	-	**-**
Riverside_Palm_Springs_Wind	57	-	**57**	288	37	**325**	-	-	**-**
Solano_Wind	91	-	**91**	721	187	**908**	-	-	**-**
Southern_NV_Eldorado_Wind	-	-	**-**	1,052	177	**1,229**	194	(194)	**-**
Tehachapi_Wind	-	-	**-**	674	-	**674**	-	-	**-**
Idaho_Wind	-	-	**-**	1,100	-	**1,100**	-	-	**-**
New_Mexico_Wind	1,685	-	**1,685**	4,849	-	**4,849**	-	-	**-**
Wyoming_Wind	-	-	**-**	3,000	-	**3,000**	-	-	**-**
SW_Ext_Tx_Wind	51	-	**51**	51	-	**51**	-	-	**-**
Diablo_Canyon_Offshore_Wind	-	-	**-**	-	-	**-**	-	-	**-**
Humboldt_Bay_Offshore_Wind	-	-	**-**	1,607	-	**1,607**	-	-	**-**
Morro_Bay_Offshore_Wind	-	-	**-**	2,924	-	**2,924**	-	-	**-**
Renewable Resource Total	**5,017**	**8,896**	**13,913**	**28,073**	**14,996**	**43,069**	**(87)**	**87**	**(0)**
Arizona_Li_Battery_4hr	2,192		**2,192**	2,192	-	**2,192**	267	-	**267**
Arizona_Li_Battery_8hr	-		**-**	-	-	**-**	-	-	**-**
Greater_Imperial_Li_Battery_4hr	675		**675**	675	-	**675**	100	-	**100**
Greater_Imperial_Li_Battery_8hr	-		**-**	-	-	**-**	-	-	**-**
Greater_Kramer_Li_Battery_4hr	507		**507**	507	-	**507**	104	-	**104**
Greater_Kramer_Li_Battery_8hr	6		**6**	113	-	**113**	(35)	-	**(35)**
Greater_LA_Li_Battery_4hr	2,511		**2,511**	2,511	-	**2,511**	(121)	-	**(121)**
Greater_LA_Li_Battery_8hr	10		**10**	60	-	**60**	(415)	-	**(415)**
San_Diego_Li_Battery_4hr	403		**403**	403	-	**403**	26	-	**26**
San_Diego_Li_Battery_8hr	50		**50**	50	-	**50**	50	-	**50**
Northern_California_Li_Battery_4hr	980		**980**	980	-	**980**	(93)	-	**(93)**
Northern_California_Li_Battery_8hr	-		**-**	321	-	**321**	71	-	**71**
Riverside_Li_Battery_4hr	2,266		**2,266**	2,266	-	**2,266**	(251)	-	**(251)**
Riverside_Li_Battery_8hr	100		**100**	100	-	**100**	(20)	-	**(20)**
Southern_NV_Li_Battery_4hr	1,210		**1,210**	1,210	-	**1,210**	-	-	**-**
Southern_NV_Li_Battery_8hr	-		**-**	320	-	**320**	(150)	-	**(150)**
Southern_PGAE_Li_Battery_4hr	2,671		**2,671**	2,671	-	**2,671**	205	-	**205**
Southern_PGAE_Li_Battery_8hr	35		**35**	1,120	-	**1,120**	(25)	-	**(25)**
Tehachapi_Li_Battery_4hr	2,774		**2,774**	2,774	-	**2,774**	245	-	**245**
Tehachapi_Li_Battery_8hr	454		**454**	509	-	**509**	283	-	**283**
Li_Battery Total	**16,844**		**16,844**	**18,782**		**18,782**	**241**	**-**	**241**
Northern_California_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Southern_PGAE_Pumped_Storage			**-**	450	-	**450**	-	-	**-**
Riverside_East_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Riverside_West_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
San_Diego_Pumped_Storage			**-**	409	-	**409**	(0)	-	**(0)**
Tehachapi_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Tehachapi_Adiabatic_CAES	200		**200**	400	-	**400**	-	-	**-**
Northern_California_Flow_Battery	5		**5**	5	-	**5**	-	-	**-**
Other Storage Total	**205**		**205**	**1,264**		**1,264**	**(0)**	**-**	**(0)**
Storage Total	**17,049**		**17,049**	**20,046**		**20,046**	**241**	**-**	**241**
Total Storage+Resources	**22,066**	**8,896**	**30,961**	**48,119**	**14,996**	**63,115**	**154**	**87**	**241**

Table 45: Summary of the updated mapping results for the 2040 base case portfolio and changes from initial mapping by RESOLVE resource area.

RESOLVE Resource Name	In-Development Resources			2040 — Mapped Total (In-Dev & Generic)			2040 – Change in Mapping (PD - Inial)		
	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
InState Biomass	16	-	**16**	171	-	**171**	-	-	**-**
Central_Nevada_Geothermal	-	-	**-**	400	-	**400**	-	-	**-**
Greater_Imperial_Geothermal	-	-	**-**	600	-	**600**	-	-	**-**
Inyokern_North_Kramer_Geothermal	10	-	**10**	10	-	**10**	-	-	**-**
Northern_California_Geothermal	25	-	**25**	123	-	**123**	-	-	**-**
Northern_Nevada_Geothermal	-	-	**-**	117	-	**117**	-	-	**-**
Pacific_Northwest_Geothermal	-	-	**-**	-	-	**-**	-	-	**-**
Utah_Geothermal	366	-	**366**	389	-	**389**	-	-	**-**
Distributed Solar		154	**154**	-	294	**294**	-	6	**6**
Arizona_Solar	53	2,864	**2,917**	1,188	4,184	**5,372**	(832)	100	**(732)**
Greater_Imperial_Solar	-	299	**299**	250	1,022	**1,272**	(270)	(50)	**(320)**
Greater_Kramer_Solar	275	240	**515**	750	1,243	**1,993**	(247)	105	**(142)**
Greater_LA_Solar	10	10	**20**	10	10	**20**	-	(150)	**(150)**
Northern_California_Solar	-	128	**128**	682	2,008	**2,690**	252	400	**652**
Riverside_Solar	475	1,374	**1,849**	725	2,004	**2,729**	(250)	(650)	**(900)**
Southern_NV_Eldorado_Solar	125	650	**775**	1,666	4,332	**5,998**	(1,070)	257	**(813)**
Southern_PGAE_Solar	991	1,794	**2,785**	7,281	11,850	**19,131**	1,205	1,648	**2,853**
Tehachapi_Solar	427	1,383	**1,810**	1,678	3,718	**5,396**	(259)	(195)	**(454)**
Baja_California_Wind	300	-	**300**	900	453	**1,353**	200	(200)	**-**
CentralValley_North_LosBanos_Wind	61	-	**61**	491	70	**561**	-	-	**-**
Greater_Imperial_Wind	-	-	**-**	360	103	**463**	-	-	**-**
Greater_Kramer_Wind	-	-	**-**	330	32	**362**	80	(80)	**-**
Kern_Greater_Carrizo_Wind	-	-	**-**	219	-	**219**	-	-	**-**
Northern_California_Wind	-	-	**-**	1,705	98	**1,803**	-	-	**-**
Riverside_Palm_Springs_Wind	57	-	**57**	288	37	**325**	-	-	**-**
Solano_Wind	91	-	**91**	721	187	**908**	-	-	**-**
Southern_NV_Eldorado_Wind	-	-	**-**	1,052	177	**1,229**	194	(194)	**-**
Tehachapi_Wind	-	-	**-**	674	-	**674**	-	-	**-**
Idaho_Wind	-	-	**-**	1,100	-	**1,100**	-	-	**-**
New_Mexico_Wind	1,685	-	**1,685**	4,849	-	**4,849**	-	-	**-**
Wyoming_Wind	-	-	**-**	4,707	-	**4,707**	-	-	**-**
SW_Ext_Tx_Wind	51	-	**51**	51	-	**51**	-	-	**-**
Diablo_Canyon_Offshore_Wind	-	-	**-**	-	-	**-**	-	-	**-**
Humboldt_Bay_Offshore_Wind	-	-	**-**	1,607	-	**1,607**	-	-	**-**
Morro_Bay_Offshore_Wind	-	-	**-**	2,924	-	**2,924**	-	-	**-**
Renewable Resource Total	**5,017**	**8,896**	**13,913**	**38,015**	**31,820**	**69,835**	**(997)**	**997**	**(0)**
Arizona_Li_Battery_4hr	2,192		**2,192**	2,192	-	**2,192**	267	-	**267**
Arizona_Li_Battery_8hr	-		**-**	490	-	**490**	(225)	-	**(225)**
Greater_Imperial_Li_Battery_4hr	675		**675**	675	-	**675**	100	-	**100**
Greater_Imperial_Li_Battery_8hr	-		**-**	315	-	**315**	(35)	-	**(35)**
Greater_Kramer_Li_Battery_4hr	507		**507**	507	-	**507**	104	-	**104**
Greater_Kramer_Li_Battery_8hr	6		**6**	463	-	**463**	85	-	**85**
Greater_LA_Li_Battery_4hr	2,511		**2,511**	2,511	-	**2,511**	(121)	-	**(121)**
Greater_LA_Li_Battery_8hr	10		**10**	965	-	**965**	(385)	-	**(385)**
San_Diego_Li_Battery_4hr	403		**403**	403	-	**403**	26	-	**26**
San_Diego_Li_Battery_8hr	50		**50**	250	-	**250**	(150)	-	**(150)**
Northern_California_Li_Battery_4hr	980		**980**	980	-	**980**	(93)	-	**(93)**
Northern_California_Li_Battery_8hr	-		**-**	1,403	-	**1,403**	316	-	**316**
Riverside_Li_Battery_4hr	2,266		**2,266**	2,266	-	**2,266**	(251)	-	**(251)**
Riverside_Li_Battery_8hr	100		**100**	430	-	**430**	(130)	-	**(130)**
Southern_NV_Li_Battery_4hr	1,210		**1,210**	1,210	-	**1,210**	-	-	**-**
Southern_NV_Li_Battery_8hr	-		**-**	1,635	-	**1,635**	(280)	-	**(280)**
Southern_PGAE_Li_Battery_4hr	2,671		**2,671**	2,671	-	**2,671**	205	-	**205**
Southern_PGAE_Li_Battery_8hr	35		**35**	4,385	-	**4,385**	280	-	**280**
Tehachapi_Li_Battery_4hr	2,774		**2,774**	2,774	-	**2,774**	245	-	**245**
Tehachapi_Li_Battery_8hr	454		**454**	1,434	-	**1,434**	283	-	**283**
Li_Battery Total	**16,844**		**16,844**	**27,959**		**27,959**	**241**	**-**	**241**
Northern_California_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Southern_PGAE_Pumped_Storage			**-**	450	-	**450**	-	-	**-**
Riverside_East_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Riverside_West_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
San_Diego_Pumped_Storage			**-**	409	-	**409**	(0)	-	**(0)**
Tehachapi_Pumped_Storage			**-**	-	-	**-**	-	-	**-**
Tehachapi_Adiabatic_CAES	200		**200**	400	-	**400**	-	-	**-**
Northern_California_Flow_Battery	5		**5**	5	-	**5**	-	-	**-**
Other Storage Total	**205**		**205**	**1,264**		**1,264**	**(0)**	**-**	**(0)**
Storage Total	**17,049**		**17,049**	**29,223**		**29,223**	**241**	**-**	**241**
Total Storage+Resources	**22,066**	**8,896**	**30,961**	**67,238**	**31,820**	**99,058**	**(756)**	**997**	**241**

Table 46: Updated mapping results of the base case portfolio summarized by CAISO study area and resource type for both 2035 (Top) and 2040 (Bottom) model years.

2035 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Total 2035 Resources
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	Total (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	123	108.8	1,803	-	1,607	46	333	220	5	**4,244**
PG&E Greater Bay	-	11.9	1,014	-	-	44	250	955	310	**2,584**
PG&E Fresno	-	9.5	561	-	-	79	4,324	3,008	140	**8,120**
PG&E Kern	-	23.3	113	-	2,924	50	2,802	903	-	**6,816**
SCE Northern Area	-	-	674	-	-	24	2,786	3,733	400	**7,617**
SCE Metro	389	5.6	-	1,750	-	13	20	1,901	-	**4,078**
SCE North of Lugo	10	4.2	362	-	-	24	1,174	620	-	**2,194**
East of Pisgah	517	-	1,229	4,151	-	-	2,398	1,530	-	**9,825**
SCE Eastern	500	7.9	325	3,099	-	-	3,874	4,085	-	**11,890**
SDG&E	100	-	1,816	-	-	15	1,581	1,827	409	**5,748**
Total 2035 Resources:	**1,639**	**171.0**	**7,895**	**9,000**	**4,531**	**294**	**19,539**	**18,782**	**1,264**	**63,115**

2040 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Total 2040 Resources
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	Total (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	123.0	108.8	1,803	-	1,607	46	1,288	430	5	**5,409**
PG&E Greater Bay	-	11.9	1,014	1,707	-	44	1,402	2,227	310	**6,715**
PG&E Fresno	-	9.5	561	-	-	79	13,534	5,073	140	**19,395**
PG&E Kern	-	23.3	113	-	2,924	50	5,597	1,703	-	**10,411**
SCE Northern Area	-	-	674	-	-	24	5,396	4,808	400	**11,302**
SCE Metro	389.0	5.6	-	1,750	-	13	20	2,501	-	**4,678**
SCE North of Lugo	9.7	4.2	362	-	-	24	1,993	970	-	**3,363**
East of Pisgah	517.3	-	1,229	4,151	-	-	5,998	2,845	-	**14,740**
SCE Eastern	500.0	7.9	325	3,099	-	-	6,254	4,765	-	**14,950**
SDG&E	100.0	-	1,816	-	-	15	3,119	2,637	409	**8,096**
Total 2040 Resources:	**1,639.0**	**171.0**	**7,895**	**10,707**	**4,531**	**294**	**44,598**	**27,959**	**1,264**	**99,059**

6.4.A Updated System Level Transmission Criteria Alignment

This section summarizes the updated mapping results' utilization of system level transmission and discusses the exceedances in CAISO 2024 White Paper constraints identified through the transmission calculations and their potential upgrade needs. This analysis incorporates the minor update to the transmission constraints discussed in Section 5. Full details of the system level transmission criteria alignment and the transmission constraint utilization calculations for the updated mapping of the base case portfolio can be found in the Proposed Decision Mapping Dashboard (Appendix C).

Table 47 below shows the 2035 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 updated mapping of the 2040 portfolio. Overall, remapping slightly increased the mapped resources within constraints with actual exceedances in 2035 (increase of 3 GW behind actual exceedances) and in 2040 (increase of nearly 5 GW behind actual exceedances). The number of constraint exceedances increased in both 2035 and 2040 modeling years.

Table 47: Updated mapping (2035 Portfolio) alignment with transmission constraint exceedance criteria summarized by resource type before any upgrades.

Updated Mapping 2035 Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	547	-	1268.3
Biomass (MW)	40	2	129.83
OnshoreWind (MW)	4,218	186	3,568
OOS Wind (MW)	1,750	-	7,250
Offshore Wind (MW)	2,924	-	1607
Solar (MW)	16,901	604	2,055
Battery (MW)	12,992	400	6,834
LDES (MW)	809	-	455
Total by Status (MW)	**40,181**	**1,191**	**23,167**

Table 48: Updated mapping (2040 Portfolio) alignment with transmission constraint exceedance criteria summarized by resource type before any upgrades.

Updated Mappping 2040 Transmission Criteria Alignment	No Constraint Exceedances	Only Default Constraint Exceedances	Actual Constraint Exceedances
Geothermal (MW)	547	-	1268.3
Biomass (MW)	11	2	158
OnshoreWind (MW)	3,302	186	4,484
OOS Wind (MW)	1,750	-	8,957
Offshore Wind (MW)	-	-	4531
Solar (MW)	24,185	2,304	18,130
Battery (MW)	17,536	1,125	10,743
LDES (MW)	809	-	455
Total by Status (MW)	**48,140**	**3,616**	**48,726**

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 2024 White Paper. The updated mapping of the base case portfolio results in 11 exceedances (on-peak, off-peak, or both) in actual constraints and one exceedance in a default constraint for the 2035 model year, per Working Group staff calculations, and 20 actual and two default exceedances in the 2040 model year. Compared to initial mapping results, one additional constraint exceedance in both 2035 and 2040 in the PG&E North of Greater Bay study area is due to the inclusion of the Humboldt 500 kV bus in the Collinsville-Tesla 500 kV Line constraint. Beyond that adjustment, no additional exceedances were caused in 2035. In 2040, one additional actual constraint exceedance is triggered in the PG&E North of Greater Bay, Greater Bay, and Fresno study areas each, while a

default constraint exceedance in the SCE Eastern area and an actual constraint exceedance in PG&E Kern are alleviated with the remapping.

Table 49: Number of transmission constraint exceedances by CAISO study area in the updated mapping results for the 2035 and 2040 portfolios.

Updated Tx Constraint Exceedances	2035		2040	
	Actual	Default	Actual	Default
PG&E North of Greater Bay	3	0	3	0
PG&E Greater Bay	2	0	4	0
PG&E Fresno	2	0	8	0
PG&E Kern	0	0	0	0
SCE North	0	0	0	0
SCE Metro	0	0	0	0
SCE North of Lugo (NOL)	1	1	2	1
East of Pisgah (EOP)	1	0	1	1
SCE East	1	0	1	0
SDG&E	1	0	1	0
Total	**11**	**1**	**20**	**2**

A calculated exceedance does not determine if the identified upgrade in the 2024 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 the full TPP analysis can accurately assess what upgrades may be needed if at all.

Additionally, 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 updated 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 2035 and 2040 model years are behind exceeded constraints, as seen in Table 50. This includes 1,150 MW of onshore wind mapped to Nevada Energy (NVE) area substations in Lassen and Modoc counties and modeled as interconnecting through Malin in both 2035 and 2040, as well as 1,707 MW of Wyoming wind on new transmission mapped to Tesla in 2040. In total, the remapping efforts resulted in five 2024 White Paper constraint exceedances between the two study areas in 2035, an increase of one from initial mapping results, and seven in 2040, an increase of two. The additional constraint exceeded in both 2035 and 2040 is the Collinsville – Tesla 500 kV line constraint. Its addition is the result of the inclusion of the Humboldt 500 kV substation, and the offshore mapped to it, in this constraint.

.

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

PG&E North of Greater Bay and Greater Bay Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2035	2040	2035	2040	2035	2040
Geothermal (MW)	-	-	-	-	163	163
Biomass (MW)	4	3	-	-	122	123
OnshoreWind (MW)	685	279	6	6	2,126	2,532
OOS Wind (MW)	-	-	-	-	-	1,707
Offshore Wind (MW)	-	-	-	-	1,607	1,607
Solar (MW)	608	2,107	-	-	81	689
Battery (MW)	629	1,839	-	-	1,374	1,647
LDES (MW)	-	-	-	-	315	315
Total by Status (MW)	**1,927**	**4,228**	**6**	**6**	**5,788**	**8,783**

For the North of Greater Bay study area, the Collinsville-Tesla 500 kV Line, the Carberry-Round Mountain 230kV Line, and the Bellota-Weber 230 kV line constraints have on-peak actual exceedances in both the 2035 and 2040 model years.

The Carberry-Round Mountain 230kV Line constraint exceedance is unchanged from Section 6.2 and an upgrade is likely needed. CAISO staff through the Working Group noted that, although the projects in the interconnection queue behind this constraint had been awarded TPD, more recent studies have updated and reduced the available capability on the constraint and thus the upgrade is likely needed to accommodate the amount mapped. The 2024 White Paper identified upgrade, which costs an estimated $180 million, is identified as only providing 26 MW of additional capability, which is not enough to accommodate the exceedance mapped. The full TPP analysis will be necessary to confirm if the White Paper upgrade is the optimal solution or if a potentially different solution is applicable.

In 2035, the exceedance in the Bellota-Weber 230 kV line constraint is smaller compared to the initial mapping, only 293 MW of exceedance. CAISO staff gave feedback through the Working Group that this level exceedance and study amounts may or may not trigger the identified White Paper upgrade; however, as always, the full TPP analysis will be necessary to confirm if any upgrades would be needed and the scope of such upgrades. In 2040, the updated mapping exceedance is now slightly larger compared to initial mapping, 1,140 MW, and likely to trigger an upgrade. As with the Carberry-Round Mountain 230kV Line constraint, the identified White Pape upgrade's capability, costing an estimated $400 million, is insufficient to accommodate the full exceedance.

The third exceedance occurs in the Collinsville-Tesla 500 kV Line constraint and has a 600 MW exceedance in 2035 that grows to 1,550 MW in 2040. The key driver behind this exceedance is the inclusion of offshore wind mapped to Humboldt. The White Paper identified upgrade provides an estimated 8,645 MW of additional capability and costs an estimated $2,852 million.

As discussed in Section 6.2, the 2035 and 2040 mapping includes 1,150 MW 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 again

modeled as interconnecting to the CAISO system in the Malin-Round Mountain area and would likely need upgrades to the existing NVE and Bonneville Power Administration (BPA) systems or a major new CAISO transmission line to the wind resources.

For the Greater Bay study area, the two constraints exceeded in both 2035 and 2040 are the same as for the initial mapping results: the Windmaster-Delta pumps 230 kV Line and the Birds Landing-Contra Costa 230kV Line constraints. The remapping results in similar exceedance levels in 2035, which as discussed in Section 6.2 are unlikely to require transmission upgrades. For the updated 2040 mapping results, there are again increases in the exceedances in both constraints. While the 2040 mapped exceedance for the Birds Landing-Contra Costa 230kV Line is only 500 MW, the White Paper identified upgrade, costing $700 million and providing 1,766 MW of additional capability, is still likely not triggered. For the Windmaster-Delta pumps 230 kV Line, the exceedance in 2040 (roughly 1,190 MW) may trigger the identified White Paper upgrade which costs an estimated $417 million and provides over 6,000 MW additional capability. In 2040, the updated mapping also caused a small on-peak exceedance in the Tesla-Tracy-Pump 230 kV line #2 constraint, which has the same identified White Paper upgrade as the Windmaster-Delta pumps 230 kV Line.

The final exceedance in 2040 occurs in the Tesla-Bellota 230 kV line constraint with an on-peak exceedance of 1,391 MW, a few hundred MWs higher than in the initial mapping. The identified 2024 White Paper upgrade provides only 300 MW of additional capability for an estimated cost of $1,700 million. Additionally, as noted in Section 6.2., the Wyoming wind mapped to the Tesla area is a key driver of this exceedance and thus the identified White Paper upgrade may not be the appropriate transmission solution.

Finally, staff kept the 1,707 MW of Wyoming wind on new transmission as interconnection at Tesla 500 kV in 2040. This aligns with a solution identified at a high level in both of CAISO's 20-Year Transmission Outlooks. The most recent 20-year Transmission Outlook (2023-2024) had a rough cost estimate for a new HVDC line of $4 -5.2 billion.

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

As shown in Table 51, most resources mapped in 2035 to the Fresno and Kern study areas do not result in a constraint exceedance; however, by the 2040 mapping, almost all the mapped resources are within at least one exceedance.

Morro Bay offshore wind is mapped to the Diablo Canyon 500 kV substation in the PG&E Kern area and is behind no constraint exceedances in 2035, but one exceedance in 2040. Additionally, as mentioned in Section 6.2, staff note that interconnecting to Diablo Canyon may be technically limited and have significant cost; and thus, a previously identified alternative location, a proposed new Morro Bay 500 kV substation, may be better suited and potentially more cost-effective.

Overall, remapping has eliminated the one exceedance in PG&E Kern in 2040 caused by the initial mapping, but it has resulted in one additional exceedance in PG&E Fresno. Resources were remapped from buses in the PG&E Kern area to better align with other criteria and to limit the exceedance on the Cal Flat-Gates 230 kV line, which had an identified White Paper upgrade with an estimated cost of $1,008 million.

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

PG&E Fresno & Kern Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2035	2040	2035	2040	2035	2040
Geothermal (MW)	-	-	-	-	-	-
Biomass (MW)	27	-	-	-	8	35
OnshoreWind (MW)	360	-	-	-	390	750
OOS Wind (MW)	-	-	-	-	-	-
Offshore Wind (MW)	2,924	-	-	-	-	2,924
Solar (MW)	6,404	3,090	-	1,700	669	14,288
Battery (MW)	2,403	907	-	725	913	4,549
LDES (MW)	-	-	-	-	140	140
Total by Status (MW)	**12,118**	**3,997**	**-**	**2,425**	**2,120**	**22,686**

In 2035, the two exceedances in the Fresno area remain: the Chowchilla-Le grand 115kV Line constraint with an exceedance of 427 MW and the Borden-Storey#1 230 kV Line constraint with an exceedance of 935 MW, both slight reductions compared with initial mapping. Both exceedances likely require upgrades as the Chowchilla-Le grand 115kV Line has no available capability and the Borden-Storey #1 230 kV Line's exceedance is almost 1 GW.

Five of the additional exceedances in 2040 for the Fresno study are the same as in the initial mapping, though exceedance amounts have generally increased.

- Tranquility-Helm 230 kV Line: On-peak actual exceedance has increased 517 MW and the updated mapping also triggers and off-peak exceedance of 497 MW.
- Schindler 115/70kV TB #1: On-peak actual exceedance has increased to ~223 MW and 65 MW in HSN and the off-peak exceedance is up to 191 MW
- Mustang-Henrietta 230 kV line: On-peak actual exceedance is roughly the same as for the initial mapping and an off-peak default exceedance has nearly doubled to 2,089 MW.
- Gates 500/230kV TB #11: On-peak exceedance has increased to 400 MW and it now has an off-peak exceedance of 1,079 MW
- Gates 500/230kV TB #12: The off-peak actual exceedance has increased to 1,708 MW. The identified White Paper upgrade is the same for Gates 500/230kV #11 and #12 constraints. It costs an estimated $35 million and provides over 14 GW of additional capability to Gates 500/230kV #12 constraint and 10 GW of capability to Gates 500/230kV #11 constraint.

The new actual constraint exceedances in the updated 2040 mapping in the Fresno study area occurs in the off-peak of the Oro Loma-El Nido 115kV Line constraint, with a 240 MW off-peak exceedance. The identified White Paper upgrade costs an estimated $330 million and provides a calculated 3,192 MW of additional capability in the on-peak but only an additional estimated 65 MW in the off-peak, not enough to alleviate the exceedance as calculated.

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. The only resources in these two areas behind an exceed constraint are batteries mapped to substations in the Moorpark Local Capacity Sub-Area, and they are included in the Lugo - Victorville area constraint, which is exceeded and discussed as part of the East of Pisgah study area.

As discussed in Section 6.2, preliminary 24-25 TPP policy results indicate the potential need for a transmission upgrade for the Midway-Whirlwind 500 kV line constraint, with a range of potential upgrade solutions that are ongoing further assessment as part of the 24-25 TPP. The updated mapping maintains the 1,750 MW of New Mexico wind on new transmission as interconnecting to the Lugo 500 kV substation. These resources were mapped based on the high-level transmission solutions identified in the CAISO's 20-year Transmission Outlook (2023-2024),[22] which identified a new HVDC line to Lugo with a rough cost of estimate of $3.5-4.9 billion. CPUC staff note that this solution is not driven by any specific transmission project being planned and is not a mandate to assume this specific intertie if alternative, more effective solutions are available.

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

SCE Northern & Metro Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	**2035**	**2040**	**2035**	**2040**	**2035**	**2040**
Geothermal (MW)	422	422	-	-	-	-
Biomass (MW)	139	-	-	-	-	-
OnshoreWind (MW)	6,927	674	-	-	-	-
OOS Wind (MW)	9,000	1,750	-	-	-	-
Offshore Wind (MW)	1,607	-	-	-	-	-
Solar (MW)	12,549	5,639	-	-	-	-
Battery (MW)	17,194	7,099	-	-	640	640
LDES (MW)	1,264	400	-	-	-	-
Total by Status (MW)	**49,101**	**15,983**	**-**	**-**	**640**	**640**

Greater Kramer & Southern Nevada— SCE North of Lugo and East of Pisgah Study Area

Table 53 shows most of the resources mapped to these two study areas in both 2035 and 2040 are still within at least one exceeded constraint.

[22] https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024.

Table 53: Summary of updated mapped resources alignment with available transmission criteria in the SCE North of Lugo and East of Pisgah study areas.

SCE NOL & East of Pisgah Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2035	2040	2035	2040	2035	2040
Geothermal (MW)	-	3	-	-	575	575
Biomass (MW)	3	209	2	2	-	-
OnshoreWind (MW)	359	-	180	180	1,052	1,202
OOS Wind (MW)	-	-	-	-	4,151	4,151
Offshore Wind (MW)	-	5,810	-	-	-	-
Solar (MW)	2,471	2,198	314	314	886	1,966
Battery (MW)	533	-	400	400	1,195	1,195
LDES (MW)	-	-	-	-	-	-
Total by Status (MW)	**3,365**	**8,219**	**895**	**895**	**7,859**	**9,089**

The three exceedances in the North of Lugo area are the same as in the initial mapping. A small ~13 MW on-peak exceedance in the Control to Inyokern area constraint is unchanged from the initial mapping in both 2035 and 2040. The constraint has an identified 2024 White Paper upgrade that provides approximately 186 MW of additional constraint capacity and costs an estimated $329 million. CAISO staff in the Working Group estimate that the upgrade would likely be needed to accommodate even the small amount of exceedance observed due to the 13 MW of Nevada geothermal seeking MIC on the Silver Peak intertie. The small default on-peak exceedance on the South of Kramer area constraint has increased to 96 MW with the updated mapping. This exceedance is of the already approved upgrade from the 22-23 TPP (Conversation of the Kramer - Victor 115 kV lines to 220 kV). CPUC staff note the amount of resources mapped behind this constraint is lower than the amounts included in the 23-24 TPP and 24-25 TPP. In feedback to the Working Group, CAISO staff noted that this exceedance may trigger a smaller additional reconductoring of the Kramer – Victor 220 kV line with an estimated $50 million cost. Finally, the 2040 only on-peak exceedance of the Calcite to Lugo Area Constraint has decreased to only 237 MW due to the remapping, but the exceedance may still likely trigger the identified White Paper upgrade.

In the East of Pisgah study area, the remapping did not eliminate either constraint exceedance, but it does reduce the magnitude of both exceedances. The 2040 default constraint exceedance in the Sloan Canyon - Eldorado 500 kV constraint is reduced to only 216 MW with the remapping. The Lugo-Victorville Area constraint exceedance is reduced to 143 MW in 2035 and 2,393 MW in 2040. While an upgrade is likely needed to alleviate the exceedance in the 2040 timeframe, the exceedance is relatively small in 2035 and the overall amount of resources mapped is slightly less than in the 24-25 TPP portfolio. In the preliminary policy results for the 24-25 TPP, the CAISO noted that the proposed Trout Canyon – Lugo 500kV line identified in the 2024 White Paper with an estimated cost of $2,165 million may be needed.

The updated mapping did not adjust the 3,000 MW of Wyoming wind and 1,060 MW of Idaho wind mapped as interconnecting to the study area in 2035 and 2040. As noted in the initial mapping discussion in 6.2, 6.21,500 MW of Wyoming wind cannot utilize the full TransWest line, as line is only 3,000 MW HVDC to its Utah intertie with the Intermountain Power Plant (IPP) transmission

system. From there, TransWest has planned only 1,500 MW of capacity on an AC line to the CAISO system at Eldorado-Harry Allen. CPUC staff note that additional new transmission would likely be necessary to connect the remaining 1,500 MW of Wyoming wind to the CAISO system. CPUC staff note that ne potential option is a second new transmission line from Utah to Nevada, if the full 3,000 MW of the first segment of TransWest is available. The now dated cost for that AC line segment of TransWest from Utah to Harry Allen was estimated at $660 million in the 2021-2022 TPP utilizing 2020 cost assumptions. More recently, CAISO's 20-year Transmission Outlook (2023-2024) identified, at a high-level a new HVDC from Wyoming to the Eldorado or Lugo areas, with an estimated cost of $4-5.2 billion. CPUC staff note that further study is necessary to better assess the optimal and cost-effective solutions.

Riverside, Arizona, San Diego, & Greater Imperial — SCE Eastern and SDG&E Study Areas

As seen in Table 54, the majority of resources mapped to the SCE Eastern and the SDG&E are not mapped to constraints with exceedances. Most of the resources behind an exceeded constraint are solar, battery, and New Mexico wind resources mapped to Arizona buses, which are within the Lugo-Victorville Area constraint discussed in the previous section.

Table 54: Summary of mapped resources alignment with available transmission criteria in the SCE Eastern and SDG&E study areas.

SCE Eastern &SDG&E Study Areas	No Constraint Exceedances		Default Constraint Exceedances		Actual Constraint Exceedances	
Transmission Criteria Alignment	2035	2040	2035	2040	2035	2040
Geothermal (MW)	125	5	-	-	530	530
Biomass (MW)	5	2,140	-	-	-	-
OnshoreWind (MW)	2,140	-	-	-	-	-
OOS Wind (MW)	-	-	-	-	3,099	3,099
Offshore Wind (MW)	-	7,539	-	-	-	-
Solar (MW)	4,389	5,493	290	290	420	1,188
Battery (MW)	4,003	409	-	-	2,712	2,712
LDES (MW)	409	-	-	-	-	-
Total by Status (MW)	**11,072**	**15,587**	**290**	**290**	**6,760**	**7,528**

The updated mapping eliminated the small default exceedance in the Serrano-Alberhill-Valley Constraint observed in the 2040 initial mapping for the SCE Eastern area. The other initial mapping exceedance in the Eagle Mountain Constraint remains unchanged. The identified White Paper upgrade is a new Devers – Julian Hinds 220 kV line, estimated at $1.2 billion, with a duration of 10 years, enabling an incremental 600 MW. Most of the resources behind this constraint are geothermal and some solar/storage mapped as importing into the CAISO at Mirage from IID. In the Work Group, CAISO staff noted that the studies that identified this constraint and upgrade were centered on overloads on the system towards in different areas. Thus, the large amount of resources mapped as being imported at Mirage from IID would likely not require the identified White Paper upgrade but a different upgrade along the IID-SCE intertie system, as recently identified in Path 42 studies in the Preliminary policy results for the 24-25 TPP. The identified upgrade or a similar one may still be

needed to accommodate resources mapped to or imported at Blythe. For the SDG&E study area, the single constraint exceeded in both 2035 and 2040, the Chicarita 138 kV constraint, remains the same as for the initial mapping.

The update mapping did not change the 600 MW of geothermal mapped to the Imperial Irrigation District (IID) transmission system. 500 MW is assumed to be imported into the CAISO at the IID-SCE intertie along the Mirage-Devers system and the other 100 MW is assumed to be imported into the CAISO at the IID-SDGE intertie at Imperial Valley substation. As discussed above, the geothermal interconnecting at the IID-SCE intertie will likely need an upgrade on the IID system as well to accommodate the amount of geothermal mapped.

The updated mapping also maintains 3,099 MW of New Mexico wind on new transmission mapped to the Palo Verde substation in the SCE Eastern area. The mapping assumes the resource will utilize the already approved subscriber PTO SunZia transmission line. The HVDC SunZia line from central New Mexico to Pinal Central in central Arizona has a capacity of 3,000 MW; however, from Pinal Central to Palo Verde, SunZia only has 2,131 MW of secured transmission rights. Thus, additional new transmission may be needed between Palo Verde and Pinal Central to enable the additional 950 MW of New Mexico wind to be delivered to Palo Verde.

In addition to the new HVDC to the Lugo area to interconnect additional New Mexico wind, the 20-year Transmission Outlook (2023-2024) also identified new HVDC lines from New Mexico to Palo Verde to Imperial Valley as a high-level alternative option with a rough cost of $4.9 – 6 billion. CPUC note that there is a proposed AC transmission line that would run parallel to the SunZia line, RioSol, as another potential transmission route for additional New Mexico Wind.

6.4.B Updated Substation Interconnection Viability Criteria Alignment

The busbar mapping Working Group has only captured some portions of the criteria analysis in the dashboard analysis. The individual substation accessibility analysis is not included given the incompleteness of the specific substation information, concerns over confidentiality for some of the info, and questions on how best to systematically assess it. Working group staff did seek to factor the info available including fault duty limit, space limitations, and position availability, into the mapping effort, but the data and alignment results themselves are not included. The analysis and dashboard results focus on the approximate distances to interconnection based on land-use and environmental impact criteria analysis radii used and the interconnection bus voltage.

The updated mapping criteria alignment for solar, in-CAISO wind, and in-CAISO geothermal resources for the distance from interconnection analysis is shown in Table 55**Error! Reference source not found.** below. The table summarizes the criteria alignment by CAISO study area for the generic utility-scale solar, wind, and geothermal resources mapped in the 2040 model year, respectively. The MW number of generic resources mapped in each area 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.

As seen in Table 55, over 55% of the generic solar is mapped to substations where the resource potential likely to be utilized is within 10 miles of the interconnection point. Further, though a

significant portion of the mapped solar is modeled as needing up to 15 miles from interconnection point, this solar is mostly associated with larger amounts of solar connecting to higher voltage substations. Analysis of existing solar development and stakeholder feedback have shown that larger projects are generally still economically viable at such distances and thus this mapping still has a level-2 alignment flag. Only two buses have level-3 flags for having smaller amounts of solar at the up to 15-mile radius: Midway 115 kV, and Windhub 230 kV. Both locations have significant solar development and commercial interest, and staff view both alignment flags as acceptable.

For onshore wind, the updated mapping resulted in only two level-3 alignment flags, Hilltop 345 kV (in NVE) and East County 115 kV, and no onshore wind has a higher non-alignment flag. For geothermal, the mapping of 400 MW of geothermal to the Beatty 230 kV substation has a level-4 flag as the known geothermal areas in Southern and Central Nevada are a significant distance from the Beatty substation. Given the large MW mapped, the limited availability of geothermal, and historical cases of long gen-ties being constructed for geothermal, staff find this alignment flag acceptable.

Table 55: Updated mapping results alignment with the distance to interconnection criteria for the generic solar (top), onshore in-CAISO wind (center) and in-CAISO geothermal (bottom) in the 2040 portfolio. Table summarizes by CAISO study 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 (2040)	**5 mi**	**10 mi**	**15 mi**	**20 mi**	**1**	**2**	**3**	**4**
PG&E North of Greater B	-	1,260	-	-	735	525	-	-
PG&E Greater Bay	-	1,302	-	-	800	502	-	-
PG&E Fresno	-	5,467	6,145	-	3,895	7,717	-	-
PG&E Kern	-	1,900	2,834	-	1,100	3,249	385	-
SCE Northern Area	-	1,550	2,036	-	500	2,756	330	-
SCE Metro	-	-	-	-	-	-	-	-
SCE North of Lugo	-	978	500	-	604	874	-	-
East of Pisgah	600	2,987	1,636	-	3,387	1,836	-	-
SCE Eastern	-	1,730	650	-	1,500	880	-	-
SDG&E	955	23	950	-	955	973	-	-
Total Generic	**1,555**	**17,196**	**14,751**	**-**	**13,476**	**19,311**	**715**	**-**

Interconnection Distance Criteria	Maximum Distance from Substation				Criteria Alignment Flag			
In-CAISO Wind Generic MWs Mapped (2040)	**10 mi**	**15 mi**	**20 mi**	**30 mi**	**1**	**2**	**3**	**4**
PG&E North of Greater B	316	337	1,150	-	316	1,337	150	-
PG&E Greater Bay	195	728	-	-	195	728	-	-
PG&E Fresno	190	110	200	-	190	310	-	-
PG&E Kern	113	-	-	-	113	-	-	-
SCE Northern Area	674	-	-	-	674	-	-	-
SCE Metro	-	-	-	-	-	-	-	-
SCE North of Lugo	-	150	212	-	-	362	-	-
East of Pisgah	-	300	929	-	-	1,229	-	-
SCE Eastern	-	-	268	-	-	268	-	-
SDG&E	63	-	1,453	-	63	1,400	53	-
Total Generic	**1,551**	**1,625**	**4,211**	**-**	**1,551**	**5,633**	**203**	**-**

Interconnection Distance Criteria	Maximum Distance from Substation				Criteria Alignment Flag			
Geothermal Generic MWs Mapped (2040)	**10 mi**	**15 mi**	**20 mi**	**>30 mi**	**1**	**2**	**3**	**4**
PG&E North of Greater B	-	98	-	-	-	98	-	-
East of Pisgah	-	-	-	400	-	-	-	400
SCE Eastern	500	-	-	-	500	-	-	-
SDG&E	100	-	-	-	100	-	-	-
Total Generic	**600**	**98**	**-**	**400**	**600**	**98**	**-**	**400**

Table 56 shows updated mapping results' alignment with the interconnection to buses of appropriate voltage criteria for solar and battery storage (top) and onshore in-CAISO wind (bottom). This analysis is designed to provide general high-level guidance on the potential difficulty and cost of interconnecting to buses. It is not designed to be the firm assessment of where resources are mapped, as each substation will have its own specific technical capabilities and limitations even across the same voltages. The criteria are generally seeking to limit mapping small MW amounts to high voltage buses with their higher costs per interconnection and significant MW amounts to lower voltage buses, which are unlikely to be able to accommodate such resource amounts without significant upgrades, particularly for solar and battery storage as those resources are the most location fungible.

For utility-scale solar and battery storage, most of the mapping results align well with the voltage criteria. Only three buses have a level-5 nonalignment: Coolwater 115 kV (SCE NOL), Crescent 70 kV (PG&E Fresno), and Midway 115 kV (PG&E Kern). For the three substations, the amount of solar and storage or the total amount of resources mapped to the bus are significantly higher than the criteria's guided amounts. In all three cases, the amount of solar and storage mapped is guided by the in-development and higher-confidence commercial interest, which alleviates some potential concerns for these non-alignment flags. The Coolwater 115 kV flag is also driven by wind resources being mapped to the bus, which brings the total amount of potential interconnections higher. CPUC staff view, given the limited geographic locations for wind and the wind commercial interest at Coolwater, the potential need for interconnections upgrades is warranted.

The level-4 nonalignment flags are split into three categories. First, the 1,350 MW in the SCE Eastern area is from solar and storage mapped to the Cielo Azul 500 kV bus and stems from almost 5 GW of solar and storage, a combination of in-development and generic resources, being mapped to it. CPUC staff note that the amount mapped is still less than the amount of higher-confidence commercial interest. Given Cielo Azul's status as a new substation developed to interconnect large amounts of renewable resources, staff view this non-alignment flag as acceptable. Second, several 115 kV and 60-70 kV buses have flags for having an amount of in-development battery storage and co-located solar and storage resources that exceed the criteria levels for those voltages. CPUC staff view these flags as acceptable given these resources are in-development. Lastly, and occurring predominately in the 2040 mapping results, are the flags at buses (Excelsior 115 kV, Lamont 115 kV, Le Grand 115 kV, and Sanger 115 kV) where solar and storage have intentionally been mapped at higher levels designed to give a better understanding of the additional transmission and interconnection needs in these areas in that longer-term 15-year time horizon.

For onshore wind mapping there are no level-4 nonalignment flags and only two buses with level-5 nonalignment flags. The 5 MW with a level-5 flag in the PG&E Greater Bay study area is mapped to Altamont-Midway (Sandhill) 230 kV bus. CPUC staff view this nonalignment is acceptable given the mapped amount aligns with the total amount in commercial interest and likely represents portions of repowering existing resources. The other level-5 flag is for the wind mapped to Coolwater 115 kV (SCE North of Lugo), which as discussed above is an acceptable nonalignment for staff.

Table 56: Updated mapping results alignment with the interconnection to appropriate voltage criteria for solar and storage (top) and onshore wind (bottom).

Interconnection Voltage Criteria	Interconnection Bus Voltage				Criteria Alignment Flag				
Solar & Battery Generic MWs Mapped (2040)	<100 kV	100-200 kV	230 kV /345 kV	500 kV	1	2	3	4	5
PG&E North of Greater Bay	25	350	1,190	-	1,190	-	160	215	-
PG&E Greater Bay	15	312	1,483	1,000	2,218	427	15	150	-
PG&E Fresno	62	1,110	7,825	5,345	8,585	2,595	2,232	895	35
PG&E Kern	-	700	3,369	1,875	3,080	2,164	-	255	445
SCE Northern Area	-	-	3,710	1,006	2,461	1,155	1,100	-	-
SCE Metro	-	-	600	-	400	200	-	-	-
SCE North of Lugo	-	395	1,540	-	1,540	-	135	55	205
East of Pisgah	-	40	5,556	1,262	5,462	-	1,396	-	-
SCE Eastern	-	-	1,110	1,950	910	800	-	1,350	-
SDG&E	23	205	750	1,810	2,010	630	125	23	-
Total Generic	**124**	**3,112**	**27,133**	**14,248**	**27,856**	**7,971**	**5,163**	**2,943**	**685**

Interconnection Voltage Criteria	Interconnection Bus Voltage				Criteria Alignment Flag				
In-CAISO Wind Generic MWs Mapped (2040)	<100 kV	100-200 kV	230 kV /345 kV	500 kV	1	2	3	4	5
PG&E North of Greater Bay	-	131	1,672	-	1,409	263	131	-	-
PG&E Greater Bay	6	-	617	300	251	661	6	-	5
PG&E Fresno	-	-	500	-	200	300	-	-	-
PG&E Kern	-	-	113	-	-	113	-	-	-
SCE Northern Area	-	-	674	-	200	-	474	-	-
SCE Metro	-	-	-	-	-	-	-	-	-
SCE North of Lugo	-	212	150	-	-	150	-	-	212
East of Pisgah	-	-	610	619	1,229	-	-	-	-
SCE Eastern	-	-	268	-	268	-	-	-	-
SDG&E	-	63	53	1,400	1,453	63	-	-	-
Total Generic	**6**	**407**	**4,655**	**2,319**	**5,008**	**1,550**	**611**	**-**	**217**

6.4.C Updated Land-use Feasibility and Environmental Implications Criteria Alignment

Overall, the remapping effort and changes discussed in Section 6.3 did not impact the analysis for onshore wind or geothermal but made significant changes to the solar mapping locations. Additionally, while no adjustments were made to the mapped locations of the LDES, staff added the additional Protect Area layer analysis for the potential pumped storage hydro (PSH) locations.

Reiterating from Section 6.2.A, this analysis is not siting individual projects and the analysis is not seeking to simulate nor replace environmental review processes and permitting. This analysis is looking at the general potential implications and impacts of resources being developed on land in the area and competing priorities for land in the area. This holds true even for the PSH assessment where we do include analysis of some project specific details to estimate general potential impacts.

Utility-Scale Solar

The general alignment with the land-use implications and feasibility of the updating solar mapping results are shown in Table 57, along with the net changes in the criteria alignment between initial and updated mapping. Table 58 similarly shows the updated mapping alignment and changes in alignment from initial mapping for the environmental impacts criteria. In both tables, out-of-state solar mapping to Southern Nevada and Arizona substations does not have analysis for the land-use and environmental impacts criteria beyond the Core Land-use screen category, which is analysis using the WECC dataset, so the net increase in total solar summed in the tables reflects the shift from those out-of-state locations to in-state locations.

In remapping the significant amount of solar from Southern areas to locations north of Path 26 to improve reliability modeling results, staff prioritized reducing criteria misalignment at substations in the southern study areas. Working Group staff remapped solar particularly from the Kramer, Red Bluff, Colorado River, and Sloan Canyon substations, key non-alignment flags identified in the initial mapping and improved their alignment. The remaining solar at Kramer with higher criteria flags is in-development and was not remapped. Overall, the remapping improved the alignment in the study areas that had level-3 or higher non-alignment flags in both the ACE Connectivity and the All ACE criteria compared to the initial mapping. For the Core Land-use screen, the level-5 non-alignment flags were eliminated and the level-4 flags were significantly reduced. The remapped portfolio also improves alignment with the four land-use criteria as well. In particular, staff focused the solar remapping effort on mapping to buses in overdrafted groundwater basin in the Central Valley; thus the amount of solar mapped to such a substation has increased by 4.8 GW.

The remaining high non-alignment flags for parcelization and high fire threat, predominantly in the SCE Northern and SCE North of Lugo study areas, are acceptable to the Working Group given the discussion on those flags in Section 6.2.A.

Table 57: Summary (in MWs) of updated solar mapping results alignment with the land-use implications and feasibility criteria for the 2040 portfolio, as well as the changes in criteria alignment between updated and initial mapping. Criteria alignment is summarized by category and CAISO study area.

Land-use Implications and Feasibility																		
PD 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Parcelization Criteria Alignment - Highest Flag				Cropland Index Criteria Alignment - Highest Flag				Overdrafted Groundwater Basin		Fire Threat Criteria Alignment - Highest Flag			
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**In**	**Out**	**1 or 2**	**3**	**4**	**5**
PG&E North of Greater Bay	1,285	-	-	-	1,260	25	-	-	1,185	100	-	-	-	1,285	1,285	-	-	-
PG&E Greater Bay	1,002	-	400	-	1,402	-	-	-	1,002	400	-	-	652	750	1,252	150	-	-
PG&E Fresno	13,427	-	-	-	11,427	2,000	-	-	7,057	6,370	-	-	13,427	-	13,427	-	-	-
PG&E Kern	5,688	-	-	-	5,688	-	-	-	3,853	1,835	-	-	5,597	91	5,597	-	-	91
SCE Northern Area	5,117	105	-	-	855	200	1,738	2,429	5,222	-	-	-	950	4,272	3,866	350	-	1,006
SCE Metro	-	-	10	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-
SCE North of Lugo	1,696	-	222	-	500	200	222	996	1,918	-	-	-	32	1,886	1,918	-	-	-
East of Pisgah	5,998	300	-	-	-	-	-	-	-	-	-	-	-	6,298	-	-	-	-
SCE Eastern	5,365	889	-	-	2,499	-	-	230	1,279	1,450	-	-	-	6,254	2,729	-	-	-
SDG&E	3,119	-	-	-	1,272	-	-	-	1,272	-	-	-	-	3,119	1,142	90	-	40
Total:	**42,696**	**1,294**	**632**	**-**	**24,903**	**2,425**	**1,960**	**3,664**	**22,797**	**10,155**	**-**	**-**	**20,658**	**23,963**	**31,224**	**590**	**-**	**1,137**

Change in Alignment (PD - Initial																		
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**In**	**Out**	**1 or 2**	**3**	**4**	**5**
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PG&E Greater Bay	652	-	-	-	652	-	-	-	652	-	-	-	652	-	652	-	-	-
PG&E Fresno	3,775	-	-	-	1,775	2,000	-	-	3,025	750	-	-	3,775	-	3,775	-	-	-
PG&E Kern	78	-	-	-	78	-	-	-	178	(100)	-	-	378	(300)	78	-	-	-
SCE Northern Area	(604)	-	-	-	(150)	-	(270)	(184)	(604)	-	-	-	-	(604)	(184)	-	-	(420)
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	(35)	-	222	(329)	50	-	222	(414)	(142)	-	-	-	-	(142)	(142)	-	-	-
East of Pisgah*	(513)	-	-	-	-	-	-	-	-	-	-	-	-	(513)	-	-	-	-
SCE Eastern*	(800)	889	(1,389)	-	(750)	-	(100)	(50)	(650)	1,450	-	(1,700)	-	(1,300)	(900)	-	-	-
SDG&E*	(652)	-	-	-	(320)	-	-	-	380	(700)	-	-	-	(652)	(300)	-	-	(20)
Total:	**1,901**	**889**	**(1,167)**	**(329)**	**1,335**	**2,000**	**(148)**	**(648)**	**2,839**	**1,400**	**-**	**(1,700)**	**4,805**	**(3,511)**	**2,979**	**-**	**-**	**(440)**

*Area Includes OOS resources

Table 58: Summary (in MWs) of updated solar mapping results alignment with the environmental impacts criteria for the 2040 portfolio, as well as the changes in criteria alignment between updated and initial mapping. Criteria alignment is summarized by category and CAISO study area.

Environmental (conservation and biological) Impact Factors																				
PD 2040 Portfolio Mapping	ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag				ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag				Intactness & Wetlands Criteria Alignment - Highest Flag			
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
PG&E North of Greater Bay	1,272	13	-	-	1,285	-	-	-	1,285	-	-	-	1,117	168	-	-	1,285	-	-	-
PG&E Greater Bay	1,002	400	-	-	1,402	-	-	-	1,302	100	-	-	650	752	-	-	1,402	-	-	-
PG&E Fresno	13,427	-	-	-	13,427	-	-	-	13,427	-	-	-	12,027	1,400	-	-	13,427	-	-	-
PG&E Kern	5,688	-	-	-	5,688	-	-	-	5,685	3	-	-	4,595	1,090	3	-	5,688	-	-	-
SCE Northern Area	5,222	-	-	-	5,222	-	-	-	5,222	-	-	-	4,872	350	-	-	5,222	-	-	-
SCE Metro	10	-	-	-	10	-	-	-	-	-	-	10	-	-	-	10	10	-	-	-
SCE North of Lugo	1,496	200	222	-	1,918	-	-	-	1,918	-	-	-	1,496	200	-	222	1,918	-	-	-
East of Pisgah	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	2,729	-	-	-	2,729	-	-	-	2,729	-	-	-	2,729	-	-	-	2,729	-	-	-
SDG&E	1,272	-	-	-	1,272	-	-	-	1,272	-	-	-	1,272	-	-	-	1,272	-	-	-
Total:	**32,117**	**613**	**222**	**-**	**32,952**	**-**	**-**	**-**	**32,839**	**103**	**-**	**10**	**28,757**	**3,960**	**3**	**232**	**32,952**	**-**	**-**	**-**

Change in Alignment (PD - Initial																				
Solar	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**	**1 or 2**	**3**	**4**	**5**
PG&E North of Greater Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PG&E Greater Bay	652	-	-	-	652	-	-	-	652	-	-	-	400	252	-	-	652	-	-	-
PG&E Fresno	3,775	-	-	-	3,775	-	-	-	3,775	-	-	-	3,775	-	-	-	3,775	-	-	-
PG&E Kern	78	-	-	-	78	-	-	-	78	-	-	-	78	-	-	-	78	-	-	-
SCE Northern Area	(604)	-	-	-	(604)	-	-	-	(604)	-	-	-	(604)	-	-	-	(604)	-	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	(35)	-	(107)	-	(142)	-	-	-	(142)	-	-	-	(35)	-	-	(107)	(142)	-	-	-
East of Pisgah*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern*	489	(1,389)	-	-	(900)	-	-	-	(900)	-	-	-	489	(1,389)	-	-	(900)	-	-	-
SDG&E*	(320)	-	-	-	(320)	-	-	-	(320)	-	-	-	(320)	-	-	-	(320)	-	-	-
Total:	**4,035**	**(1,389)**	**(107)**	**-**	**2,539**	**-**	**-**	**-**	**2,539**	**-**	**-**	**-**	**3,783**	**(1,137)**	**-**	**(107)**	**2,539**	**-**	**-**	**-**

*Area Includes OOS resources

Onshore Wind

In the remapping effort, staff did not remap any onshore wind to alternative locations. Thus, Table 65, which shows the mapping alignment for the wind resources with the land-use and environmental impacts criteria, is unchanged from what was discussed in Section 6.2.B. As noted in Section 6.2.B, several locations with wind mapped do have some higher non-alignment flags; however, Working Group staff were not able to identify reasonable alternative locations that significantly improved alignment without significantly reducing alignment with multiple other criteria.

The portfolio includes a significant amount of onshore wind, which limits the ability of staff to shift to alternative locations. The amount of onshore wind and the locations are mostly consistent with the locations and amounts mapped in the 24-25 TPP, for which the Working Group conducted extensive mapping analysis using the mapping criteria and dataset (the 24-25 TPP methodology introduced the new land-use and environmental criteria and datasets) to improve the mapped wind resources alignment with the busbar mapping criteria. Thus, Working Group staff sought consistency with the 24-25 TPP mapping where possible. Staff did not map wind resources to the Caliente and Round Mountain substations, two substation which were mapped to in the 24-25 TPP, as both had higher land-use and environmental implications but no commercial interest.

Table 59:Summary (in MWs) of onshore in-CAISO wind mapping results alignment with the land-use implications and environmental impacts criteria for the 2040 portfolio. Criteria alignment is summarized by category and CAISO study area.

	Land-use Implications and Feasibility								Environmental (conservation and biological) Impact Factors							
Initial 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag			
Onshore Wind	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
PG&E North of Greater Bay	859	-	944	-	466	-	-	1,337	1,690	113	-	-	1,803	-	-	-
PG&E Greater Bay	109	-	551	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno	500	-	-	-	500	-	-	-	390	110	-	-	500	-	-	-
PG&E Kern	113	-	91	-	-	-	-	204	204	-	-	-	204	-	-	-
SCE Northern Area	500	-	174	-	474	-	-	200	674	-	-	-	674	-	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah	1,229	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	-	235	-	-	-	-	-	235	235	-	-	-	235	-	-	-
SDG&E	63	-	400	-	-	-	-	463	463	-	-	-	463	-	-	-
Total:	**3,735**	**235**	**2,160**	**-**	**2,462**	**-**	**-**	**2,439**	**4,678**	**223**	**-**	**-**	**4,901**	**-**	**-**	**-**

	Environmental (conservation and biological) Impact Factors															
Initial 2040 Portfolio Mapping	ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag				Intactness Criteria Alignment - Highest Flag				Wetlands Criteria Alignment - Highest Flag			
Onshore Wind	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
PG&E North of Greater Bay	1,672	131	-	-	1,559	-	-	244	747	1,056	-	-	1,803	-	-	-
PG&E Greater Bay	660	-	-	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno	500	-	-	-	390	110	-	-	500	-	-	-	500	-	-	-
PG&E Kern	204	-	-	-	113	91	-	-	204	-	-	-	204	-	-	-
SCE Northern Area	674	-	-	-	500	174	-	-	674	-	-	-	674	-	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern*	235	-	-	-	235	-	-	-	235	-	-	-	235	-	-	-
SDG&E*	463	-	-	-	463	-	-	-	463	-	-	-	463	-	-	-
Total:	**4,770**	**131**	**-**	**-**	**4,282**	**375**	**-**	**244**	**3,845**	**1,056**	**-**	**-**	**4,901**	**-**	**-**	**-**

*Area Includes OOS resources

Geothermal

Table 60 depicts a summary of the 2040 portfolio's mapped geothermal resources alignment with the Core land-use screen, which for geothermal utilizes the Protected Area layer, and the two land-use implications and environmental impacts criteria that have flags higher than level-1 alignment. Again, the analysis is for geothermal resources mapped to known geothermal areas in California only. No remapping of in-state geothermal was done so these results remain unchanged from the initial mapping.

Table 60: Summary (in MWs) of updated in-state geothermal mapping results alignment with the land-use implications and environmental impacts criteria for the 2040 portfolio. Criteria alignment summarized by category and Known Geothermal Resource Area.

PD 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Envrionmental Criteria Alignment - Highest Flag			
Geothermal	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
Geysers	148	-	-	-	-	-	-	148	-	148	-	-
Mono - Long Valley	41	-	-	-	-	-	-	41	41	-	-	-
Salton Sea	525	-	-	-	525	-	-	-	525	-	-	-
East Brawley	125	-	-	-	125	-	-	-	125	-	-	-
Total (MW):	**839**	**-**	**-**	**-**	**650**	**-**	**-**	**189**	**691**	**148**	**-**	**-**

Pumped Storage Hydro

Overall, staff made no mapping adjustments to the mapped LDES in the portfolio, so the locations, amounts and analysis discussed in Section 6.2.A are unchanged. Following stakeholder feedback to the October 2024 Ruling, Working Group staff have added the additional analysis of assessing the protected area layer within the 5-mile radius for PSH potential locations as noted in Section 5. Table 61 below shows the environmental impacts criteria for potential PSH locations with the addition of the protected area layer analysis. For both the 409 MW mapped to Sycamore Canyon 230 kV with its analysis using the San Vincente potential location and the 310 MW mapped to Bellota 230 KV and its analysis using the Mokelumne potential location or the Salt Springs potential location, the Protected Area layer analysis results in a level-1 alignment flag. The San Vincente potential location has the higher amount of land within the level-1 with almost 40% of the 5-mi radius area in the Protected Are layer, while the Salt Springs location has 25% and the Mokelumne location has 17%.

Table 61: Updated summary of environmental implications analysis for potential pumped storage hydro locations considered in busbar mapping.

		Land-use & Env. Impacts Criteria Alignment							Staff Assessment of Criteria based on FERC filings					
LDES Res. mapped to new PSH	Potential Pumped Storage Site (FERC Application Name)	Protected Area Layer	Terres-trial Biodiv-ersity	Terres-trial Connec-tivity	Terres-trial Irre-placea-bility	Intact-ness	Aquatic Rare Species Richness	Aquatic Irre-placea-bility	Probable Lower Reservoir		Probable Upper Reservoir		Probable Water Source	
-	Eagle_Mountain	2	1	1	1	3	1	1	Brownfield	2	Brownfield	2	Ground Water (Low Priority)	3
-	Swan Lake North	No Data, out-of-state							New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	LEAPS	1	1	1	2	1	1	1	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
409	San_Vicente	1	3	3	2	1	3	2	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
310	Mokulumne	1	1	1	1	2	1	2	Existing on-stream	2	Existing on-stream	2	Existing on-stream reservoir	2
-	Bison_Peak	1	1	3	1	3	1	1	New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	Tehachapi	1	3	3	3	2	1	1	New off-stream	3	New off-stream	3	Ground Water (Low Priority)	3
-	Nacimiento	1	1	2	1	2	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
	Twitchell	1	1	1	1	2	2	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Whale Rock	1	1	3	1	2	4	1	Existing off-stream	1	New off-stream	3	Existing off-stream reservoir	1
-	Vandenberg	1	1	2	1	2	1	1	Ocean	4	New off-stream	3	Ocean	5
-	Haiwee	5	2	1	1	3	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	MQR	1	3	3	3	1	5	5	New off-stream	3	New off-stream	3	Existing off-stream reservoir	1
-	Salt Springs	1	1	1	1	2	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Isabella	1	2	1	3	2	1	1	Existing on-stream	2	New off-stream	3	Existing on-stream reservoir	2
-	Maxwell	1	1	2	1	1	1	1	Brownfield	2	New off-stream	3	Existing off-stream reservoir	1

6.4.D Updated Community and Societal Environmental Impacts Criteria Alignment

The alignment of the updated mapped resources with the community and societal environmental impacts criteria is shown for the 2035 and 2040 model years in Table 62 and Table 63. In the 2035 mapping, approximately 22% of generation MWs and 42% of storage MWs are mapped to a substation in a disadvantaged community. In the 2040 mapping, those percentages grow to 33% and 43%, respectively, and 33% of storage is mapped to substations within 5-miles of a fossil fuel plant. In both model years, roughly 60% of mapped generation and 75% of mapped storage is in an Inflation Reduction Act Energy Community area, while the updated mapping result in 62% of generation and 79% of storage being in an air quality non-attainment area in 2040.

Table 63 shows the change between the initial and updated mapping for the 2040 portfolio in the amount of generation and storage aligning with the criteria. As discussed in Section 6.3, remapping was predominately directed by an increase in in-development resources and the need to remap resources to north of Path 26 to improve reliability modeling results. In remapping the storage in particular, staff sought to align the updating mapping locations to improve proximity to disadvantaged communities in PG&E territory, so there is a moderate increase in storage alignment with the disadvantaged community criteria. Additionally, remapping to Northern California and the Central Valley increased the amount of resources mapped to air quality non-attainment zones. The remapping reduced the amount of resources in IRA Energy Community areas and near Fossil Fuel plants as resources were mapped from southern California desert areas and the LA Metro area.

Table 62: Summary of updated mapping results (2035 portfolio) alignment with the community environmental impacts criteria. The table summarizes the mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area.

2035 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Fossil Fuel Plant (<5 mile)		In IRA Energy Community		In DAC		In or near (<5 mi) DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	267	101	525	50	1,683	95	113	-	198	38
PG&E Greater Bay	1,206	1,255	684	611	1,195	530	503	240	1,102	743
PG&E Fresno	4,972	3,148	1,027	772	45	161	4,937	3,093	4,970	3,148
PG&E Kern	2,862	903	106	3	2,422	665	2,846	900	2,862	903
SCE Northern Area	3,484	4,063	120	150	3,484	4,133	403	470	2,391	1,555
SCE Metro	2,177	1,901	36	1,619	2,177	1,901	35	1,774	2,177	1,901
SCE North of Lugo	1,531	595	662	229	1,574	620	665	229	680	229
East of Pisgah	-	-	3,168	279	8,295	1,530	-	-	-	200
SCE Eastern	3,931	1,525	492	1,570	4,706	4,085	163	530	168	1,315
SDG&E	2,585	1,687	293	860	1,961	1,010	293	678	293	724
Total	**23,015**	**15,178**	**7,112**	**6,142**	**27,541**	**14,729**	**9,959**	**7,914**	**14,841**	**10,755**

Table 63: Summary of updated mapping results (2040 portfolio) alignment with the community environmental impacts criteria. The table summarizes the mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area.

2040 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Fossil Fuel Plant (<5 mile)		In IRA Energy Community		In DAC		In or near (<5 mi) DAC	
Total MWs by Criteria	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	367	136	1,060	125	2,538	270	113	-	198	38
PG&E Greater Bay	4,065	2,127	2,841	1,653	3,352	1,185	603	573	3,309	1,825
PG&E Fresno	14,182	5,213	4,577	1,597	45	161	13,947	5,128	14,180	5,213
PG&E Kern	5,657	1,703	226	58	4,217	1,180	5,641	1,700	5,657	1,703
SCE Northern Area	6,094	5,138	320	200	6,094	5,208	753	520	3,571	1,805
SCE Metro	2,177	2,501	36	2,219	2,177	2,501	35	2,274	2,177	2,501
SCE North of Lugo	2,350	945	662	229	2,393	970	1,165	434	1,295	454
East of Pisgah	500	150	3,168	529	11,895	2,845	-	-	-	200
SCE Eastern	4,561	1,705	722	1,650	6,686	4,665	163	530	168	1,315
SDG&E	3,883	2,447	693	1,285	1,961	1,365	693	828	1,243	1,039
Total	**43,836**	**22,065**	**14,304**	**9,544**	**41,357**	**20,349**	**23,114**	**11,986**	**31,798**	**16,092**

Table 64: Change in mapped generation and storage amounts meeting prioritized criteria goals by CAISO study area between the initial and updated mapping results for the 2040 portfolio.

2040 Portfolio Mapping Difference: PD – Initial	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Fossil Fuel Plant (<5 mile)		In IRA Energy Community		In DAC		In or near (<5 mi) DAC	
MWs Difference	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**	**Generation**	**Storage**
PG&E North of Greater Bay	8	(50)	10	(75)	(2)	(110)	-	-	11	-
PG&E Greater Bay	655	377	-	296	3	397	2	265	2	435
PG&E Fresno	3,058	481	674	90	(2)	-	2,861	466	3,058	481
PG&E Kern	(231)	2	73	15	70	47	70	52	(231)	2
SCE Northern Area	(604)	278	(2)	(200)	(606)	278	-	(245)	(336)	(315)
SCE Metro	-	(161)	-	(261)	-	(161)	-	(161)	-	(161)
SCE North of Lugo	(142)	189	-	(2)	(142)	189	50	53	50	53
East of Pisgah	-	-	-	-	(813)	(280)	-	-	-	-
SCE Eastern	(350)	(276)	(50)	(151)	(1,100)	(214)	-	-	0	(151)
SDG&E	(342)	(152)	(150)	(47)	(20)	(219)	(150)	-	(300)	(33)
Total	**2,052**	**688**	**555**	**(335)**	**(2,612)**	**(73)**	**2,833**	**430**	**2,254**	**311**

The analysis for the updated biomass mapping is shown in Table 65. Overall, staff remapped over 60% of the generic biomass resources initially mapped to substations in disadvantaged communities to alternative substations. In total, 75% of the mapped generic biomass is now mapped to substations greater than 5 miles from a disadvantaged community.

Table 65: Mapping of biomass resources' alignment with proximity to disadvantaged communities and non-attainment zones criteria and change between initial and updated mapping results.

PD Biomass/gas Mapping	Disadvantaged Communities			Non-Attainment Zones			
	>5 mi from DAC	<5 mi from DAC	In DAC	In (PM 2.5)	Out (PM 2.5)	In (Ozone)	Out (Ozone)
In-Development (MW)	3.2	3.0	10.2	10.2	6.2	0.2	16.2
Generic (MW)	113.3	27.4	14.0	20.1	134.6	49.2	105.5
Total (MW)	**116.5**	**30.4**	**24.2**	**30.2**	**140.8**	**49.4**	**121.6**
Change from Initial	*18.1*	*4.8*	*(22.9)*	*(23.0)*	*23.0*	*(17.4)*	*17.4*

6.4.E Updated Commercial Development Interest Criteria Alignment

As noted in Section 5, as part of the post-ruling mapping adjustments, the Working Group incorporated more recent CAISO interconnection queue and in-development data. CPUC staff utilized a more up-to-date CAISO interconnection queue (accessed 11/25/24). The update queue had some minor project changes and updates to projects deliverability allocations and Phase II completion status. The updated CAISO queue analysis for commercial interest can be found in Appendix H (Updated Commercial Interest Analysis of CAISO Interconnection Queue). CPUC staff also worked to incorporate more resources from the WDAT queues. The updated queue info did not significantly change the commercial interest alignments as the updated queue only had minor changes in total resource amounts. The updated queue did increase the number of projects flagged as having completed Phase II; however, this did not significantly increase the total amount of higher-confidence commercial interest as many of these projects were already included through the TPD allocation information that CAISO staff provided the Working Group.

Table 66: Summary, by CAISO study area, of the updated in-development resources. Top shows in-development additions; bottom shows the total amounts of in-development resources.

Changes to In-Development Resources between Ruling and PD									
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Battery_4 hr (MW)	Battery_8 hr (MW)	LDES (MW)
PG&E North of Greater Bay	-	-	-	-	-	6	4	-	-
PG&E Greater Bay	-	-	-	-	-	5	131	-	-
PG&E Fresno	-	-	-	-	-	35	198	-	-
PG&E Kern	-	-	-	-	-	-	92	-	-
SCE Northern Area	-	-	-	-	-	-	245	448	-
SCE Metro	-	-	-	-	-	-	462	-	-
SCE North of Lugo	-	-	-	-	-	-	129	-	-
East of Pisgah	-	-	-	-	-	-	-	-	-
SCE Eastern	-	-	-	-	-	400	167	-	-
SDG&E	-	-	300	-	-	117	177	50	-
Total by Type:	**-**	**-**	**300**	**-**	**-**	**563**	**1,604**	**498**	**-**

Updated In-Development Resources Summary									
CAISO Study Area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind - New Tx	Offshore Wind (MW)	Solar (MW)	Battery_4 hr (MW)	Battery_8 hr (MW)	LDES (MW)
PG&E North of Greater Bay	25	3.2	-	-	-	49	125	-	5
PG&E Greater Bay	-	3.0	91	-	-	110	719	-	-
PG&E Fresno	-	2.0	61	-	-	1,971	2,308	35	-
PG&E Kern	-	-	-	-	-	882	493	-	-
SCE Northern Area	-	-	-	-	-	1,834	3,224	454	200
SCE Metro	366	5.6	-	-	-	33	1,891	10	-
SCE North of Lugo	10	-	-	-	-	532	507	6	-
East of Pisgah	-	-	-	51	-	775	1,210	-	-
SCE Eastern	-	2.6	57	1,685	-	3,874	3,985	100	-
SDG&E	-	-	300	-	-	1,192	1,727	50	-
Total by Type:	**401**	**16.4**	**508**	**1,736**	**-**	**11,251**	**16,189**	**655**	**205**

CPUC staff also updated the in-development resources to include newer information incorporated from the updated Generator Interconnection Resource ID Report (accessed 11/24/24), additional CPUC jurisdictional Load Serving Entities (LSEs) contract information, and feedback from PTOs and stakeholders. Table 66 shows a summary of the additional in-development resources incorporated into the updated mapping, while Appendix F (Updated Baseline Reconciliation and In-Development Resources) shows the details of the in-development resources. Overall, almost 3,000 MW of additional in-development resources were identified, with over two-thirds of it 4-hr or 8-hr battery storage. Additionally, these in-development resources were removed from the totals for commercial interest criteria analysis for the generic resource mapping.

Table 67 and Table 68 summarize the updated mapping results for both model years compared to identified commercial development interest by CAISO study area. Table 67 shows the mapped generic resources in the four PG&E study areas compared to the amount of commercial interest by confidence category. Table 68 shows the same comparison for the six study areas in the southern part of CAISO. Overall, in 2040, as was the case in the initial mapping, there is generally more higher-confidence storage, particularly storage with TPD, in all study areas, given the amount of storage in the interconnection queue. With respect to solar, the amounts mapped to southern study areas are generally less than the amount of higher-confidence commercial interest, except for the North of Lugo area, while the amount of solar mapped to the four PG&E study areas is equal to or exceeds the amount of higher-confidence solar. The remapping increased this misalignment as more solar was remapped to the PG&E study areas to improve reliability modeling and environmental and land-use criteria alignment. With respect to the non-solar or battery resources, mapped results are generally more than the amount of higher-confidence and typically even total commercial interest in most of the study areas.

Table 67: Comparison of updated mapping results (2035 and 204039 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 (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**	**PG&E Greater Bay**	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**
Geothermal (MW)	98	98	28	37	37	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	106	106	-	10	35	Biomass (MW)	9	9	-	1	5
OnshoreWind (MW)	1,803	1,803	200	206	1,352	OnshoreWind (MW)	923	923	161	882	1,385
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	1,707	-	-	-
Offshore Wind (MW)	1,607	1,607	-	162	2,462	Offshore Wind (MW)	-	-	750	1,525	1,525
Distrib. Solar (MW)	25	25	-	58	156	Distrib. Solar (MW)	33	33	-	108	257
Solar (MW)	305	1,260	25	1,010	7,220	Solar (MW)	150	1,302	-	1,086	4,277
Battery (MW)	95	305	270	4,988	15,531	Battery (MW)	236	1,508	5,977	11,019	28,763
LDES (MW)	-	-	-	-	482	LDES (MW)	310	310	-	-	500
Total (MW)	**4,038**	**5,203**	**522**	**6,471**	**27,276**	**Total (MW)**	**1,661**	**5,792**	**6,888**	**14,620**	**36,713**

	Mapped Portfolio		Commercial Queue Interest				Mapped Portfolio		Commercial Queue Interest		
PG&E Fresno	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**	**PG&E Kern**	**Generic (2035)**	**Generic (2040)**	**TPD**	**Higher Confidence**	**All Queue Interest**
Geothermal (MW)	-	-	-	-	-	Geothermal (MW)	-	-	-	-	-
Biomass (MW)	8	8	-	12	12	Biomass (MW)	23	23	-	6	20
OnshoreWind (MW)	500	500	-	4	204	OnshoreWind (MW)	113	113	-	-	-
OOS Wind (MW)	-	-	-	-	-	OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-	Offshore Wind (MW)	2,924	2,924	2,500	4,366	7,726
Distrib. Solar (MW)	29	29	-	88	148	Distrib. Solar (MW)	32	32	-	131	286
Solar (MW)	2,402	11,612	146	6,354	32,961	Solar (MW)	1,939	4,734	246	4,305	15,731
Battery (MW)	665	2,730	5,451	8,210	46,647	Battery (MW)	410	1,210	2,196	6,380	21,632
LDES (MW)	140	140	-	-	119	LDES (MW)	-	-	465	520	520
Total (MW)	**3,743**	**15,018**	**5,597**	**14,667**	**80,090**	**Total (MW)**	**5,441**	**9,036**	**5,406**	**15,708**	**45,916**

Table 68: Comparison of updated mapping results (2035 and 2040 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		
SCE Northern Area	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	674	674	100	100	229
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	15	208
Solar (MW)	976	3,586	710	4,552	11,357
Battery (MW)	55	1,130	5,724	10,594	28,207
LDES (MW)	200	200	300	312	812
Total (MW)	**1,905**	**5,590**	**6,835**	**15,573**	**40,814**

	Mapped Portfolio		Commercial Queue Interest		
SCE Metro	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	23	23	-	-	80
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	-	-	-	-	-
OOS Wind (MW)	1,750	1,750	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	-	-	-	10	10
Battery (MW)	-	600	3,621	5,779	21,810
LDES (MW)	-	-	-	-	-
Total (MW)	**1,773**	**2,373**	**3,621**	**5,789**	**21,900**

	Mapped Portfolio		Commercial Queue Interest		
SCE North of Lugo	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	-	-	-	-	5
Biomass (MW)	4	4	-	-	3
OnshoreWind (MW)	362	362	-	362	462
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	7	7	-	37	229
Solar (MW)	659	1,478	374	1,386	9,501
Battery (MW)	107	457	1,624	2,604	19,181
LDES (MW)	-	-	-	-	500
Total (MW)	**1,140**	**2,309**	**1,997**	**4,389**	**29,880**

	Mapped Portfolio		Commercial Queue Interest		
East of Pisgah	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	517	517	-	-	968
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	1,229	1,229	66	310	1,418
OOS Wind (MW)	4,100	4,100	-	-	11,478
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	-	-
Solar (MW)	1,623	5,223	741	6,865	21,980
Battery (MW)	320	1,635	4,224	7,043	27,143
LDES (MW)	-	-	-	-	500
Total (MW)	**7,789**	**12,704**	**5,031**	**14,218**	**63,486**

	Mapped Portfolio		Commercial Queue Interest		
SCE Eastern	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	500	500	-	-	671
Biomass (MW)	5	5	-	-	5
OnshoreWind (MW)	268	268	-	60	761
OOS Wind (MW)	1,414	1,414	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	-	-	-	18	68
Solar (MW)	-	2,380	-	9,484	20,239
Battery (MW)	-	680	4,619	15,158	36,199
LDES (MW)	-	-	500	1,917	1,917
Total (MW)	**2,187**	**5,247**	**5,119**	**26,638**	**59,860**

	Mapped Portfolio		Commercial Queue Interest		
SDG&E	Generic (2035)	Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	100	100	-	-	83
Biomass (MW)	-	-	-	-	-
OnshoreWind (MW)	1,516	1,516	-	1,517	2,923
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Distrib. Solar (MW)	14	14	-	4	22
Solar (MW)	390	1,928	485	3,129	13,056
Battery (MW)	50	860	2,339	4,750	25,130
LDES (MW)	409	409	-	-	500
Total (MW)	**2,479**	**4,827**	**2,824**	**9,400**	**41,713**

Generally, the mapping adjustments did not significantly shift the alignment with commercial interest. Table 69 shows the number of substations with changes to the commercial alignment flag. The biggest driver of changes were the updates to the commercial interest. They caused most of the increase in flags for more higher-confidence commercial interest than mapped and more total interest than mapped as the updates shifted battery storage project to higher-confidence and smaller battery projects were added from the WDAT queues. The remapping caused two key shifts in alignment flags in Table 69. First, the decrease in flags for biomass mapped to areas with no commercial interest and increase in flags for locations with more higher-confidence commercial interest (CI) biomass than map occurred as staff remapped biomass resource to improve the community environmental impacts criteria alignment. Second, the increase in flags for mapped solar resources exceeding higher-confidence amounts occurred as staff remapped solar to PG&E study areas to improve reliability modeling and reduce land-use and environmental impact flags.

Table 69: Change in number of substations with non-alignment flags between initial and updated mapping results by resource type.

Change in Number of Substations with Commmercial Interest Flags					
2040 PD - 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	-8	1	2	0	1
Onshore Wind	0	0	0	-1	0
Distributed Solar	-3	2	-1	0	2
Solar	1	6	1	2	-5
Battery Storage	0	2	24	-7	35
Total	**-10**	**11**	**26**	**-6**	**33**

Table 70, Table 71, and Table 72 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 70 has the analysis for the final utility-scale solar and battery storage; Table 71 has it for onshore, in-CAISO wind and geothermal; and Table 72 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. As seen in Table 72, the updated biomass mapping results in five substations, mostly in the PG&E Fresno study area, that have more commercial interest than mapped. Staff limited mapping to these locations to avoid high non-alignment flags at those locations for the community environmental impacts criteria, particularly proximity to disadvantaged communities.

For solar and battery storage, remapping increased the locations where the resources mapped exceeded the total amount of commercial interest, particularly in PG&E Kern and Fresno study areas, as seen in Table 70. As noted earlier, the driver of this increase in non-alignment were other factors: seeking to improve reliability modeling results and improving environmental and land-use criteria both by moving solar and storage from southern study areas to the northern study areas. There are also a significant number of substations for batteries where the higher-confidence commercial interest exceeds the amount mapped and a large number of buses for solar and batteries where total commercial interest exceeds the amount mapped. For battery storage, the key factor driving the number of flags for more commercial interest is that there are more than 36,000 MW of battery storage with TPD and nearly 80,000 MW of higher-confidence battery storage, which is more than double the amount of battery storage included in the 2040 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 higher-confidence storage with TPD co-located with solar. The creation of the Avi Kwa Ame National Monument last year significantly reduced the available solar resource potential around Mohave substation, so staff have mapped less resources overall to the substation, despite the higher-confidence commercial interest.

For onshore wind, the mapping was unchanged, and the results still have 12 substations where the amount mapped exceeds total commercial interest including several substations with no commercial interest. Compared to solar and storage there is significantly less wind in the identified queues. The mapping results in one (Tesla 500 kV) substation with a non-alignment flag for more higher-confidence commercial interest than mapped and five 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 if more wind is mapped. The five substations with the 1+ flags for wind, Devers 500 kV, El Casco, Metcalf, Trout Canyon, and Mohave, all have identified commercial interest from the Cluster 15 application list and generally higher potential environmental impacts.

Table 70: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the updated 2040 portfolio mapping results of solar and battery storage resources.

2040 Upddated Mapping Results	Solar					Battery Storage				
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	1	2	0	0	9	0	0	10	10	14
PG&E Greater Bay	0	2	0	2	10	0	0	32	6	25
PG&E Fresno	1	14	0	4	8	0	7	21	5	17
PG&E Kern	1	4	0	3	8	0	0	12	6	19
SCE Northern Area	0	2	1	1	2	0	0	12	1	7
SCE Metro	0	0	1	0	0	0	0	14	2	7
SCE North of Lugo	1	2	2	0	6	0	1	9	0	5
East of Pisgah	0	3	0	0	8	0	0	4	2	10
SCE Eastern	0	0	3	2	6	0	0	9	3	8
SDG&E	0	1	1	2	4	0	0	11	3	32
Total	4	30	8	14	61	0	8	134	38	144

Table 71: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the updated 2040 portfolio mapping results of onshore wind and geothermal resources.

2040 Upddated Mapping Results	Geothermal					Onshore Wind				
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	3	0	0	0	0	3	3	0	0	0
PG&E Greater Bay	0	0	0	0	0	2	1	1	0	1
PG&E Fresno	0	0	0	0	0	2	1	0	0	0
PG&E Kern	0	0	0	0	0	1	0	0	0	0
SCE Northern Area	0	0	0	0	0	3	0	0	0	0
SCE Metro	0	1	0	0	0	0	0	0	0	0
SCE North of Lugo	0	0	0	0	1	0	0	0	0	0
East of Pisgah	1	1	0	0	1	0	2	0	0	1
SCE Eastern	0	1	0	0	0	1	0	0	0	2
SDG&E	1	0	0	0	0	0	0	0	0	1
Total	5	3	0	0	2	12	7	1	0	5

Table 72: Summary of substations with non-alignment flags for the commercial interest criteria by CAISO study area for the updated 2040 portfolio mapping results of biomass and distributed solar resources.

2040 Upddated Mapping Results	Biomass					Distributed Solar				
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	11	3	0	0	0	0	0	10	0	16
PG&E Greater Bay	3	2	0	0	1	0	0	26	0	14
PG&E Fresno	2	0	4	0	0	0	0	12	0	6
PG&E Kern	1	3	0	0	0	0	0	19	0	11
SCE Northern Area	0	0	0	0	0	0	0	3	0	4
SCE Metro	0	0	0	0	0	0	0	0	0	0
SCE North of Lugo	1	1	0	0	0	0	0	5	0	3
East of Pisgah	0	0	0	0	0	0	0	0	0	0
SCE Eastern	0	1	0	0	0	0	0	2	0	3
SDG&E	0	0	0	0	0	0	2	1	0	2
Total	18	10	4	0	1	0	2	78	0	59

6.4.F Updated Prior TPP Base Case Criteria Alignment

The updated mapping results for both 2035 and 2040 are compared to the previous base case portfolios for the 24-25 TPP and 23-24 TPP and summarized by resource type in Table 73. The 25-26 TPP and the 24-25 TPP portfolios utilize the same IRP 2023 Inputs and Assumptions baseline so they can be directly compared with each other. The 23-24 TPP used an older baseline, so its resource amounts have been updated by removing resources now in the IRP baseline. The total portfolio amounts of resources did not change significantly during the remapping process (only a 240 MW increase in total battery nameplate MWs as 8-hr as converted to 4-hr to align with in-development resources). As noted in Section 6.2.D, the 25-26 TPP has the same or more of almost every resource type compared to the 24-25 TPP in both the 10-year and 15-year timeframes. The exception is geothermal, with the current portfolio having 330 MW less in both model years. In comparing the 2035 model year to the 23-24 TPP base case, the current portfolio has significantly more out-of-state and in-state onshore wind, while the 23-24 TPP portfolio had significantly more solar and a small amount more storage.

Table 73: Comparison of updated mapping portfolio to the 24-25 TPP base case (2034 and 2039 model years) and the 23-24 TPP base case (adjusted to exclude resources now in baseline) by resource type.

Final Mapping Compared to Previous Base Cases	Total Resources (2035)	Total Resources (2040)	24-25 TPP (2034)	24-25 TPP (2039)	23-24 TPP* (2035)
Geothermal (MW)	1,639.0	1,639.0	1,969.0	1,969.0	1,740.0
Biomass (MW)	171.0	171.0	171.0	171.0	127.4
OnshoreWind (MW)	7,894.8	7,894.8	6,123.0	7,023.4	2,261.4
OOS Wind (MW)	9,000.0	10,707.0	6,095.6	9,095.6	4,828.0
Offshore Wind (MW)	4,531.0	4,531.0	3,855.0	4,531.0	4,707.0
Solar (MW)	19,833.0	44,892.0	18,988.5	30,682.1	32,930.1
Battery (MW)	18,781.9	27,959.1	16,575.9	22,821.0	19,917.7
LDES (MW)	1,264.2	1,264.2	1,030.0	1,080.0	2,000.0
Total (MW)	**63,115**	**99,058**	**54,808**	**77,373**	**68,512**

*Subtracting resources now in updated IRP baseline

Figure 13 and Figure 14 compare the updated mapping results for 2035 and 2040 model years to the 24-25 TPP base case portfolio's 2034 and 2039 model years respectively, summarizing the number of resources mapped to each CAISO study area. Table 74 shows the comparison between the updated mapping results and two 24-25 TPP base case model years by CAISO study area in table form.

Following the mapping adjustments noted in Section 6.3.C, three areas (SCE Northern, SCE North of Lugo, and East of Pisgah) shown in Figure 13 have slightly fewer resources in 2035. For SCE Northern, less solar is mapped as a few hundred MW of solar have been remapped to PG&E study areas to improve reliability and GHG emissions modelling results. In the East of Pisgah area, solar was similarly remapped to northern study areas, while there is less 4-hr battery mapped to better align with in-development resources in other study areas. For the SCE North of Lugo area, less solar was mapped due to higher environmental impact concerns.

In 2040, most study areas have slightly more resources mapped overall compared to the 24-25 TPP's 2039 model year. The only area with fewer resources in 2040 is the PG&E North of Greater Bay study area, which has a few hundred MWs less batteries mapped as they were remapped to other study areas to better align with in-development resources. The PG&E Fresno area has significant more resources than in the 2039 portfolio, more than twice as much solar and over 2 GW more storage. In total, the 25-26 TPP has 14 GW more solar in 2040 than the 24-25 TPP has in the 2039 model year. Several other study areas including PG&E Kern, East of Pisgah, and SDG&E study areas have several GWs more solar mapped to them, but the PG&E Fresno area was the primary recipient of the additional solar resources, particularly with the remapping of solar from southern study areas to Northern study areas post ruling.

Generally, the PG&E Fresno area has a significant amount of solar development interest, particularly compared to other study areas north of Path 26, when the Working Group was assessing where to map the additional solar relocated from south of Path 26. Additionally, the buses in the study area had favorable land-use and environmental criteria alignment particularly compared to a few key substations in southern California (Red Bluff, Colorado River, Kramer) where less solar has been mapped this cycle. Finally, the PG&E Fresno area had some available transmission capability created by previously approved upgrades (e.g. at the new Manning substation) and additional upgrades are likely to be triggered driven by mapping of other longer lead-time resources (wind and non-battery LDES) so additional solar and storage were mapped to further utilize these upgrades.

Figure 13: Comparison of the updated 2035 mapped portfolio to the 24-25 TPP portfolio (2034 model year) by CAISO study area. For each study area the left column represents the resources, by type, mapped to the study area for the previous 24-25 TPP portfolio and the right columns represent the updated mapping for the current portfolio.

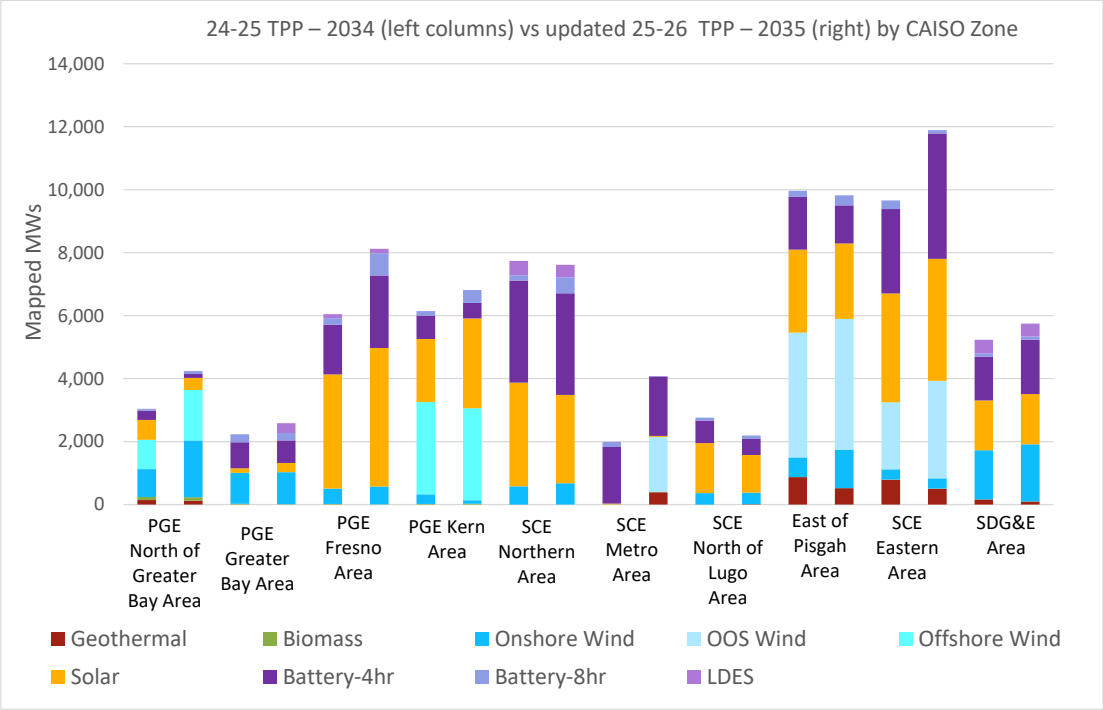


Figure 14: Comparison of the updated 2040 mapped resource (right) to the 2039 model year for the previous 24-25 TPP portfolio (left) by CAISO study area.

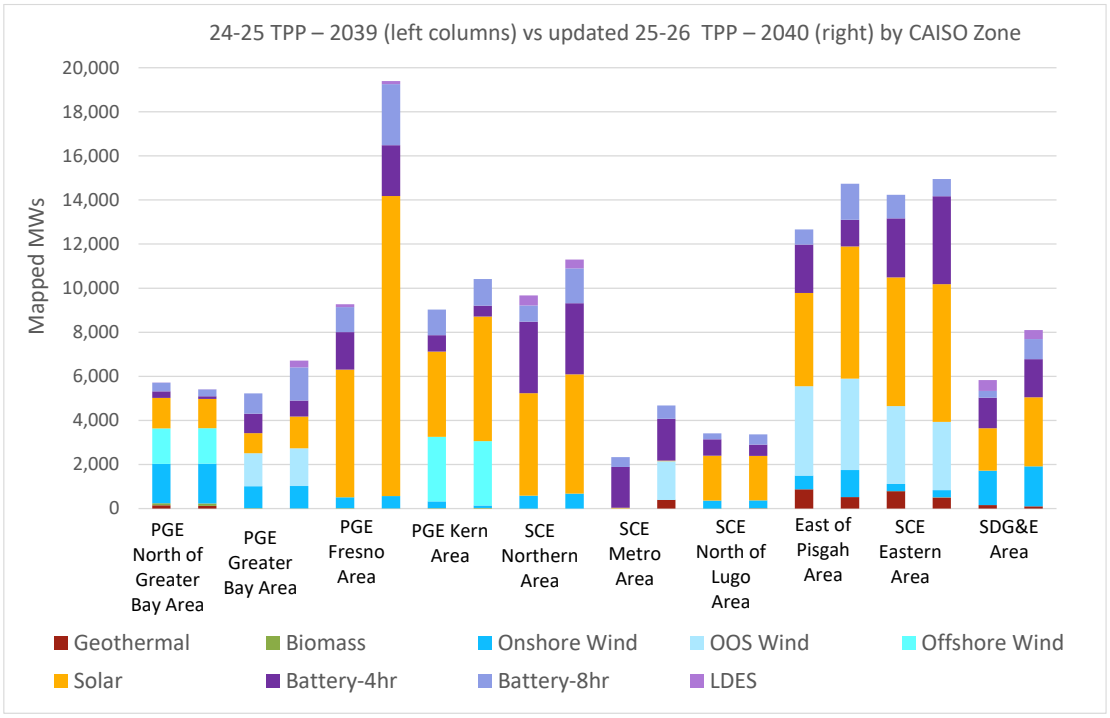


Table 74: Comparison of updated mapping results for the 2035 and 2040 model years to the 24-25 TPP 2034 and 2039 portfolios by CAISO study area and resource type.

CAISO Study Area	Resource Type	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)	CAISO Study Area	Resource Type	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
PG&E North of Greater Bay	Geothermal (MW)	123.0	123.0	144.0	144.0	PG&E Fresno	Geothermal (MW)	-	-	-	-
	Biomass (MW)	108.8	108.8	94.5	94.5		Biomass (MW)	9.5	9.5	20.2	20.2
	OnshoreWind (MW)	1,802.7	1,802.7	887.0	1,787.4		OnshoreWind (MW)	560.5	560.5	490.0	490.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	1,607.0	1,607.0	931.0	1,607.0		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	378.0	1,333.0	630.2	1,390.2		Solar (MW)	4,402.1	13,612.1	3,619.5	5,794.7
	Battery-4hr (MW)	125.0	125.0	293.5	293.5		Battery-4hr (MW)	2,307.8	2,307.8	1,584.2	1,699.2
	Battery-8hr (MW)	95.0	305.0	50.0	390.0		Battery-8hr (MW)	700.0	2,765.0	200.0	1,131.5
	LDES (MW)	5.0	5.0	5.0	5.0		LDES (MW)	140.0	140.0	130.0	130.0
	Zone Total (MW)	**4,244**	**5,409**	**3,035**	**5,712**		**Zone Total (MW)**	**8,120**	**19,395**	**6,044**	**9,266**
PG&E Greater Bay	Geothermal (MW)	-	-	-	-	PG&E Kern	Geothermal (MW)	-	-	-	-
	Biomass (MW)	11.9	11.9	22.6	22.6		Biomass (MW)	23.3	23.3	18.0	18.0
	OnshoreWind (MW)	1,013.6	1,013.6	988.0	988.0		OnshoreWind (MW)	113.1	113.1	310.0	310.0
	OOS Wind (MW)	-	1,707.0	-	1,500.0		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	2,924.0	2,924.0	2,924.0	2,924.0
	Solar (MW)	293.8	1,445.8	140.3	915.3		Solar (MW)	2,852.3	5,647.3	2,005.2	3,870.2
	Battery-4hr (MW)	718.8	718.8	828.8	878.8		Battery-4hr (MW)	493.0	493.0	746.8	746.8
	Battery-8hr (MW)	236.1	1,508.3	250.0	920.0		Battery-8hr (MW)	410.0	1,210.0	142.0	1,157.0
	LDES (MW)	310.0	310.0	-	-		LDES (MW)	-	-	-	-
	Zone Total (MW)	**2,584**	**6,715**	**2,230**	**5,225**		**Zone Total (MW)**	**6,816**	**10,411**	**6,146**	**9,026**
SCE Northern Area	Geothermal (MW)	-	-	-	-	East of Pisgah	Geothermal (MW)	517.3	517.3	875.0	875.0
	Biomass (MW)	-	-	1.0	1.0		Biomass (MW)	-	-	-	-
	OnshoreWind (MW)	674.0	674.0	580.0	580.0		OnshoreWind (MW)	1,228.5	1,228.5	620.0	620.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	4,151.0	4,151.0	3,964.8	4,060.0
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	2,809.5	5,419.5	3,291.0	4,656.3		Solar (MW)	2,398.0	5,998.0	2,640.0	4,230.0
	Battery-4hr (MW)	3,224.0	3,224.0	3,239.9	3,239.9		Battery-4hr (MW)	1,210.0	1,210.0	1,684.0	2,188.1
	Battery-8hr (MW)	509.0	1,584.0	169.5	734.0		Battery-8hr (MW)	320.0	1,635.0	180.0	695.5
	LDES (MW)	400.0	400.0	458.0	458.0		LDES (MW)	-	-	-	-
	Zone Total (MW)	**7,617**	**11,302**	**7,739**	**9,669**		**Zone Total (MW)**	**9,825**	**14,740**	**9,964**	**12,669**
SCE Metro	Geothermal (MW)	389.0	389.0	-	-	SCE Eastern	Geothermal (MW)	500.0	500.0	790.0	790.0
	Biomass (MW)	5.6	5.6	5.6	5.6		Biomass (MW)	7.9	7.9	2.6	2.6
	OnshoreWind (MW)	-	-	-	-		OnshoreWind (MW)	324.5	324.5	324.0	324.0
	OOS Wind (MW)	1,750.0	1,750.0	-	-		OOS Wind (MW)	3,099.0	3,099.0	2,130.8	3,535.6
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	32.9	32.9	27.0	34.0		Solar (MW)	3,873.5	6,253.5	3,458.5	5,833.5
	Battery-4hr (MW)	1,890.5	1,890.5	1,795.0	1,845.0		Battery-4hr (MW)	3,985.4	3,985.4	2,680.0	2,680.0
	Battery-8hr (MW)	10.0	610.0	166.5	446.5		Battery-8hr (MW)	100.0	780.0	270.0	1,070.0
	LDES (MW)	-	-	-	-		LDES (MW)	-	-	-	-
	Zone Total (MW)	**4,078**	**4,678**	**1,994**	**2,331**		**Zone Total (MW)**	**11,890**	**14,950**	**9,656**	**14,236**
SCE North of Lugo	Geothermal (MW)	9.7	9.7	-	-	SDG&E	Geothermal (MW)	100.0	100.0	160.0	160.0
	Biomass (MW)	4.2	4.2	1.5	1.5		Biomass (MW)	-	-	-	-
	OnshoreWind (MW)	362.2	362.2	360.0	360.0		OnshoreWind (MW)	1,815.8	1,815.8	1,564.0	1,564.0
	OOS Wind (MW)	-	-	-	-		OOS Wind (MW)	-	-	-	-
	Offshore Wind (MW)	-	-	-	-		Offshore Wind (MW)	-	-	-	-
	Solar (MW)	1,198.1	2,017.1	1,593.0	2,037.0		Solar (MW)	1,595.3	3,133.3	1,582.8	1,919.8
	Battery-4hr (MW)	507.2	507.2	716.0	746.0		Battery-4hr (MW)	1,727.2	1,727.2	1,389.7	1,389.7
	Battery-8hr (MW)	113.0	463.0	90.0	265.0		Battery-8hr (MW)	100.0	910.0	100.0	305.0
	LDES (MW)	-	-	-	-		LDES (MW)	409.2	409.2	437.0	487.0
	Zone Total (MW)	**2,194**	**3,363**	**2,761**	**3,410**		**Zone Total (MW)**	**5,748**	**8,096**	**5,234**	**5,826**

Table 75: Number of substations in each CAISO study area with non-alignment flags for the consistency with previous base case criteria for the updated mapping results (2040 model year) compared to the 24-25 TPP 2039 model year broken down by resource type. Circles indicate study areas where substations with flags occur (Yellow for slight decrease and Orange for Significant decrease).

2040 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*	2	0	0	0	0	0	0	0	0	0
	Significant**	1	0	0	0	0	0	0	2	1	1
Biomass	Slight	0	0	0	0	0	0	0	0	0	0
	Significant	13	8	5	3	1	0	1	0	0	0
Wind, Onshore	Slight	1	0	0	0	0	0	0	0	0	0
	Significant	2	1	0	1	0	0	0	1	0	2
OOS Wind	Slight	0	0	0	0	0	0	0	0	1	0
	Significant	0	0	0	0	0	0	0	0	0	0
Offshore Wind	Slight	0	0	0	0	0	0	0	0	0	0
	Significant	0	0	0	0	0	0	0	0	0	0
Distributed_ Solar	Slight	0	1	0	2	0	0	0	0	0	0
	Significant	7	7	9	4	0	2	2	0	0	0
Solar	Slight	0	0	1	0	1	0	0	0	2	0
	Significant	5	1	0	3	1	0	3	3	1	1
Total Battery	Slight	2	2	2	1	3	1	1	1	1	0
	Significant	6	6	0	3	2	5	2	4	1	7
LDES	Slight	0	0	0	0	1	0	0	0	0	1
	Significant	1	0	0	0	0	0	0	0	0	0

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

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

Table 76: Net change in number of substations with a non-alignment flag between the initial and updated mapping results for the 2040portfolio by resource type.

Change in substations with alignment flags between Initial and Updated Mapping (2040)		
Resource Type	Level of Decrease at Sub	Total Number of Flags Change
Geothermal	Slight*	0
	Significant**	0
Biomass	Slight	-1
	Significant	6
Wind, Onshore	Slight	0
	Significant	0
OOS Wind	Slight	0
	Significant	0
Offshore Wind	Slight	0
	Significant	0
Distributed_Solar	Slight	1
	Significant	-1
Solar	Slight	1
	Significant	3
Li_Battery	Slight	0
	Significant	8
LDES	Slight	0
	Significant	0

*100 MW or 10% less (level-3 flag)
**500 MW or 33% less (level-4 or -5 flag)

Table 75 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 updated mapping results for the 2040 model year. The change in number of substations with non-alignment flags between the initial and these updated mappings results is summarized by resource type in Table 76.

Overall, solar and battery storage mapping results in the most non-alignment flags. As in the initial mapping, the battery flags are primarily driven by the large amount of in-development battery resources and mapping to those locations limited the Working Group's ability to map to other buses that were previously mapped to. As part of the remapping update, the number of alignment flags increased reflects the remapping that was needed to align with the additional in-development battery resources identified. For solar, the alignment flags are driven by a need to align with in-development resources as well, a reduction in solar mapped to certain buses with higher environmental impact flags, and the remapping effort to shift solar from the Southern study areas to north of Path 26.

Wind and geothermal misalignment remain unchanged from the initial analysis as no remapping to different substations was conducted. Biomass and distributed solar, again, have numerous non-alignment flags in the PG&E study areas due to the percentage change factors as the mapped amount differences are relatively small, 1-5 MWs, but result in a significant percentage change. The increase in non-alignment flags for the biomass mapping resulted from the effort to remap biomass to locations with lower community impact criteria flags.

Another factor that impacted alignment flags across all resource types was the use of the 2024 White Paper information which included significantly more substations in its analysis. As a result, the

Working Group was able to better align with the actual interconnection location, particularly for in-development resources.

7. Results

Sections 7.2-7.6 summarize the updated 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 2035 and 2040 and key transmission implications of the mapping. Table 77 shows the total mapped resources by CAISO study area for the 2035 portfolio and Table 78 shows the results for the 2040 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 Updated Dashboard for the Proposed Decision Mapping of the 25-26 TPP Base Case (Appendix C) contains the full details of the mapping results and the busbar mapping criteria analysis, including mapping summaries by RESOLVE resource area. The Final Dashboard for the 25-26 TPP Base Case (Appendix D) has the same mapping results, with only minor updates to fix small errors in the tables and text.

Table 77: Updated mapping results of the base case portfolio (2035 model year) summarized by CAISO study area and resource type.

2035 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Total 2035 Resources
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	Total (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	123	108.8	1,803	-	1,607	46	333	220	5	**4,244**
PG&E Greater Bay	-	11.9	1,014	-	-	44	250	955	310	**2,584**
PG&E Fresno	-	9.5	561	-	-	79	4,324	3,008	140	**8,120**
PG&E Kern	-	23.3	113	-	2,924	50	2,802	903	-	**6,816**
SCE Northern Area	-	-	674	-	-	24	2,786	3,733	400	**7,617**
SCE Metro	389	5.6	-	1,750	-	13	20	1,901	-	**4,078**
SCE North of Lugo	10	4.2	362	-	-	24	1,174	620	-	**2,194**
East of Pisgah	517	-	1,229	4,151	-	-	2,398	1,530	-	**9,825**
SCE Eastern	500	7.9	325	3,099	-	-	3,874	4,085	-	**11,890**
SDG&E	100	-	1,816	-	-	15	1,581	1,827	409	**5,748**
Total 2035 Resources:	**1,639**	**171.0**	**7,895**	**9,000**	**4,531**	**294**	**19,539**	**18,782**	**1,264**	**63,115**

Table 78: Updated mapping results of the base case portfolio (2040 model year) summarized by CAISO study area and resource type.

2040 — Mapped Total Resources (In-Dev & Generic)	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery	LDES	Total 2040 Resources
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	Total (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	123.0	108.8	1,803	-	1,607	46	1,288	430	5	**5,409**
PG&E Greater Bay	-	11.9	1,014	1,707	-	44	1,402	2,227	310	**6,715**
PG&E Fresno	-	9.5	561	-	-	79	13,534	5,073	140	**19,395**
PG&E Kern	-	23.3	113	-	2,924	50	5,597	1,703	-	**10,411**
SCE Northern Area	-	-	674	-	-	24	5,396	4,808	400	**11,302**
SCE Metro	389.0	5.6	-	1,750	-	13	20	2,501	-	**4,678**
SCE North of Lugo	9.7	4.2	362	-	-	24	1,993	970	-	**3,363**
East of Pisgah	517.3	-	1,229	4,151	-	-	5,998	2,845	-	**14,740**
SCE Eastern	500.0	7.9	325	3,099	-	-	6,254	4,765	-	**14,950**
SDG&E	100.0	-	1,816	-	-	15	3,119	2,637	409	**8,096**
Total 2040 Resources:	**1,639.0**	**171.0**	**7,895**	**10,707**	**4,531**	**294**	**44,598**	**27,959**	**1,264**	**99,059**

As discussed in Section 6.4.A, the 2035 and 2040 mapped portfolio results in a number of 2024 White Paper constraint exceedances that will likely require upgrades, several of which are large upgrades providing gigawatts of additional transmission capability and costing billions of dollars. Additionally, the mapped portfolio includes resources like out-of-state wind and geothermal that will require major new transmission lines across multiple states and balancing areas. The in-CAISO exceedances and likely transmission upgrades are concentrated in the four PG&E study areas. The southern study areas can accommodate most of the in-CAISO resources mapped, even in the 2040 timeframe, because of the 21-22 TPP and 22-23 TPP approved transmission upgrades in these study areas.

The mapped 25-26 TPP base case portfolio results in a comparable number of transmission constraint exceedance in the CAISO system and potential transmission upgrades as the busbar mapping effort identified for the portfolio transmitted to the CAISO for the 24-25 TPP base case, which is still under study and full transmission needs have not been identified. Though direct comparison cannot be readily made as the mapping effort for the 24-25 TPP utilized the CAISO's 2023 White Paper and this mapping for the 25-26 TPP uses the new 2024 White Paper, the busbar mapping results for the 24-25 TPP base case identified 20 exceeded constraints in 2034 and 30 exceeded constraint in 2039 based on the 2023 White Paper while this mapping identified 12 constraint exceedances in 2035 and 22 constraint exceedances in 2040 based on the 2024 White Paper. Several constraints and potential upgrades are consistent between the two portfolios and thus may have transmission solutions identified in the 24-25 TPP. In the 2040 mapping, 14 of the exceedances are on constraints that are the same or similar to 2023 White Paper constraints exceeded in the 2039 portfolio for the 24-25 TPP base case, reflecting consistency between the portfolios. Many of the constraints in southern study areas identified in the 24-25 TPP have updated capabilities in the 2024 White Paper that no longer result in exceedances, while several new constraints not included in the 24-25 TPP analysis are exceeded in the 25-26 TPP mapping.

Additionally, the 25-26 TPP has a comparable amount of out-of-CAISO and out-of-state resources needing new transmission. A key update in these potential transmission needs in this year's busbar mapping is additional transmission solutions and cost information provided by the new CAISO's 20-year Transmission Outlook (2023-2024). The potential solutions to these transmission needs are not well known, particularly in comparison to earlier mapping efforts for out-of-state resources that could be compared to planned transmission projects that had been in-development for several years, thus for portions of the out-of-state or out-of-CAISO resources mapped this year, CPUC staff are recommending additional studies by CAISO and CPUC staff before any transmission would be approved.

7.1 Transmission Exceedances in Busbar Mapping and RESOLVE Modeling

The RESOLVE modeling for the portfolio development incorporates CAISO White Paper transmission constraint and upgrade information and its optimization of the resource build around includes identifying which upgrades should be triggered. RESOLVE also has cost assumptions for the new transmission needed for the various out-of-CAISO resources. As a capacity expansion model, RESOLVE has several limitations when it comes to the resource and transmission assessment including an ability to build partial transmission upgrades. Additionally, RESOLVE cannot fully incorporate all the additional data, criteria analysis, and nuances utilized in busbar mapping. Thus, historically, there has been often significant difference in the transmission upgrade

RESOLVE identifies as likely being needed and the ones identified through busbar mapping, with busbar mapping in the past several TPP cycles identifying significantly more transmission exceedances and potential upgrades needed than RESOLVE. CPUC staff have continued to implement improvements to RESOVLE to better capture the mapping implications. For this most recent cycle CPUC staff sought to limit RESOLVE's ability to model large amounts of resources interconnecting to areas with a limited number of substation and lower voltage systems. For the 26-27 TPP, CPUC staff are looking to implement further improvements including capturing the Path 26 constraints between Northern and Southern California.

For the 25-26 TPP base case portfolio, RESOLVE utilized the 2023 White Paper constraint information as the 2024 White Paper, which is utilized for 25-26 TPP busbar mapping, was not yet available. Thus, the comparison discussed below is not a direct comparison in which constraints were exceeded and upgrades triggered. Furthermore, RESOLVE is utilizing the out-of-state transmission cost assumptions developed for the 2023 IRP Inputs and Assumptions, which does not include information from the recent CAISO 20-year Transmission Outlook (2023-2024) on the more costly high-level transmission solutions for interconnecting out-of-state resources; this is an additional factor in CPUC staff recommendation for additional analysis on such transmission upgrades.

As noted above, in 2035 the updated mapping resulted in 11 exceedances of actual constraints (there is one additional default exceedance of an already approved upgraded) with seven in the PG&E study areas and four in the southern study areas. The RESOLVE results had three exceedances and partially triggered upgrades, all in the southern study areas, in 2035. In 2040, the updated mapping resulted in 20 exceedance of actual constraints (two additional default exceedances of already approved upgrades) with 15 in the PG&E study areas and five in the southern study areas. The initial RESOLVE results had eight exceedances with all but one in the southern study areas. CPUC staff note three main reasons for the divergences:

- Talking into account all the mapping criteria results in significant shifts in where resources are located. The incorporation of commercial interest, more refined land-use and environmental analysis, and additional interconnection factors result in the resources being mapped to more areas than what RESOLVE selects.
- RESOLVE currently does not capture Path 26 constraints. As discussed in Section 6.3, significant remapping was done to improve reliability across the zones modelled in the production cost model.
- Updated White Paper. Use of the 2024 White Paper in the busbar mapping effort results in more constraints in some locations but more available capability in other areas compared to the 2023 White Paper info used in RESOLVE.

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

Mapped Resources Summary

Table 79 and Table 80 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 2035 and 2040 portfolios by resource type and modeled deliverability status. In addition to resources mapped to substations in Northern California and the Bay area, the mapped resources in these two areas include Humboldt offshore wind in both 2035

and 2040, Wyoming Wind interconnecting to the Tesla area in 2040, and onshore wind mapped in 2035 and 2040 to the Nevada Energy (NVE) balancing area of northeastern California, which would likely require upgrades to out-of-CAISO transmission or new transmission to interconnect to the CAISO system.

Table 79: Updated mapping results (2035 & 2040) for the PG&E North of Greater Bay study area by resource type.

PG&E North of Greater Bay	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	25	-	98	-	**123**	98	-	**123**
Biomass	3	-	106	-	**109**	106	-	**109**
OnshoreWind	-	-	1,705	98	**1,803**	1,705	98	**1,803**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	1,607	-	**1,607**	1,607	-	**1,607**
Distributed Solar	-	21	-	25	**46**	-	25	**46**
Solar	-	28	75	230	**333**	430	830	**1,288**
Battery_4hr	125	-	-	-	**125**	-	-	**125**
Battery_8hr	-	-	95	-	**95**	305	-	**305**
LDES	5	-	-	-	**5**	-	-	**5**
Total by Status	**158**	**49**	**3,685**	**353**	**4,244**	**4,250**	**953**	**5,409**

Table 80: Updated mapping results (2035 & 2040) for the PG&E Greater Bay study area by resource type.

PG&E Greater Bay	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	3	-	9	-	**12**	9	-	**12**
OnshoreWind	91	-	736	187	**1,014**	736	187	**1,014**
OOS Wind	-	-	-	-	**-**	1,707	-	**1,707**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	10	-	33	**44**		33	**44**
Solar	-	100	-	150	**250**	252	1,050	**1,402**
Battery_4hr	719	-	-	-	**719**	-	-	**719**
Battery_8hr	-	-	236	-	**236**	1,508	-	**1,508**
LDES	-	-	310	-	**310**	310	-	**310**
Total by Status	**813**	**110**	**1,291**	**370**	**2,584**	**4,522**	**1,270**	**6,715**

Transmission Implications

Table 81 highlights the CAISO's 2024 White Paper transmission constraints with exceedances for the mapped 2035 and 2040 portfolios in the PG&E Greater Bay and North of Greater Bay study areas based on the busbar mapping transmission calculations. The table shows the resources mapped within each constraint, the calculated exceedance level, the identified 2024 White Paper upgrade, and CPUC staff estimated likelihood of the upgrade being triggered.

In the 2035 portfolio, resource mapping results in five transmission constraint exceedances as seen in Table 81. The two in the PG&E Greater Bay study area are unlikely to be triggered as noted in Section 6.4.A, but full TPP analysis will be needed to confirm. Of the three exceedances in the North of Greater Bay study area, two are likely to trigger upgrades, while the third constraint exceedance (Bellota-Weber 230 kV line) may not require an upgrade.

The identified White Paper upgrade for the Carberry-Round Mountain 230-kV constraint cost an estimated $180 million but only provides an estimated 26 MW of additional capacity. The full TPP analysis will be necessary to confirm if the White Paper upgrade is the optimal solution or if a potentially different solution is applicable. The other upgrade is the White Paper upgrade for the Collinsville-Tesla 500 kV Line constraint (~8.6 GW capacity increase and $2,852 million estimated cost). CPUC staff note that North Coast offshore wind mapped to the Humboldt 500 kV bus is a key driver of this exceedance and thus a transmission solution is likely needed to ensure deliverability of the offshore wind. If an upgrade is found necessary in the CAISO's TPP, CPUC staff encourage the CAISO to consider less costly alternatives, e.g., the 23-24 TPP Report identified a new Fern Road to Tesla line as costing $1.4 – 2.0 billion.

In the 2040 portfolio, resource mapping results in seven constraint exceedances, four in the Greater Bay study area and three in the North of Greater Bay study area, as seen in Table 81. The three in the North of Greater Bay study area are the same as in 2035. The increased exceedance in the Bellota-Weber 230 kV Line constraints makes the need for an upgrade more likely and CPUC staff view the cost of the identified 2024 White Paper upgrade, costing an estimated $400 million, as an effective transmission solution given the amount of resources behind the constraint including LDES and onshore wind resources. The identified White Paper upgrade is not estimated to provide sufficient capacity to alleviate the exceedance, so an alternative option may be necessary and would be assessed in the TPP study.

In the Greater Bay study area for the 2040 mapping, as noted in Section 6.4.A, the upgrade for the Birds Landing-Contra Costa 230kV Line may not be triggered given resources mapped and similar level of exceedance as in the 2039 portfolio for the 24-25 TPP. If an upgrade is necessary, CPUC staff note the White Paper upgrade is an effective solution to this exceedance. The exceedance in Windmaster-Delta pumps 230 kV Line likely needs the identified White Paper upgrade, which CPUC staff consider an effective solution that would provide an estimated increase in capability of 6,034 MW and cost $417 million. The small exceedance in the Tesla-Tracy-Pump 230 kV Line #2 constraint is also alleviated by the same upgrade. For the Tesla-Bellota 230 kV Line constraint exceedance, the White Paper upgrade is not estimated to provide sufficient capacity to alleviate the exceedance so an alternative option may be necessary and would be assessed in the TPP study. The Wyoming wind mapped as interconnecting on new transmission to the Tesla 500 kV bus is a key driver of both exceedances. Given the uncertainty around the actual location of any new transmission for the identified Wyoming Wind resources, CPUC staff encourage additional analysis of any potential upgrades needed based on exceedances where the mapped Wyoming wind is a key driver.

The 1,607 MW of offshore wind mapped to a new Humboldt 500 kV substation is included in both the 2035 and 2040 portfolios. CPUC staff note that the amount is the same as in the 23-24 TPP base case portfolio which resulted in CAISO approving transmission upgrades with an estimated cost between $3.1-4.5 billion. Since these are already approved upgrades, these are not included in the

total cost estimates of additional transmission that could be triggered by the mapping results discussed below.

The 2035 and 2040 mapped portfolios both include 1,150 MWs of wind mapped to Northeastern California outside of existing CAISO territory aligning with substations in the Nevada Energy (NVE) balancing area and modeled in busbar mapping as interconnecting to the CAISO system at the Malin intertie if using existing transmission. A similar amount of wind was previously mapped in the 2039 portfolio for the 24-25 TPP, which is still ongoing. Preliminary analysis from the 24-25 TPP indicates that these wind resources could utilize existing MIC capacity at Malin; however, the ability of the NVE and Bonneville Power Administration (BPA) systems to enable delivery to Malin is limited. Thus, these wind resources will either require upgrades to portions of the NVE-BPA system or a new transmission line to 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, however, have the added benefits of strengthening CAISO's interconnection to NVE's northern grid and serving as another point of import for Northern Nevada area resources including geothermal. Either option would involve multiple balancing area authorities and likely new, not previously studied solutions. Given the uncertainty and complexity around such potential upgrades, CPUC staff recommend CAISO conduct additional analysis and potentially engage with NVE and BPA to identify potentially co-beneficial solutions before approving any upgrades driven by these resources.

In the 2040 portfolio, staff again mapped Wyoming wind on new transmission (1,707 MW) as interconnecting at the Tesla 500 kV substation. This mapping aligns with the 1,500 MW of Wyoming wind mapped in the 2039 portfolio for the ongoing 24-25 TPP. Working Group staff aligned this mapping with a potential transmission solution in CAISO's 20-year Transmission Outlooks, which identified this high-level solution with an estimate cost of $2.5 billion in the 2021-2022 Outlook and $4-5.2 billion in the 2023-2024 Outlook. This mapping provides 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 8 GW interconnecting in the Southern California study areas south of Path 26). A new Northern California injection location could also help alleviate the need for additional in-CAISO upgrades in that area and potential Path 26 related upgrades. CPUC staff note that this solution is not driven by any specific transmission project being planned and is not a mandate to assume this specific intertie if alternative, more effective solutions are available, such as 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 have been included in the characterization for the Wyoming wind resource in the RESOLVE model, based on the TransWest Express line and other options, the specific cost assumptions for delivery at Tesla have not been characterized. Additionally, the transmission cost assumptions in RESOLVE for Wyoming Wind are lower than those identified in the recent 2023-2024 20-year Transmission Outlook. Given the uncertainties around such transmission, CPUC staff intended to conduct further modeling and analysis to assess the cost and benefits of interconnecting Wyoming wind on new transmission to Northern California and recommend CAISO similarly conduct additional analysis on potential transmission solutions before recommending any upgrades driven by the Wyoming Wind for approval.

As noted above, any upgrades identified as needed exclusively due to Northeastern California and Wyoming wind resources will have a high degree of uncertainty and warrant further study.

Excluding those resources, for the 2035 portfolio, the mapped resources in the Greater Bay and North of Greater Bay study areas could need transmission upgrades costing between $1.6 – 3.1 billion (2022 constant dollars). For the 2040 mapped portfolio, including potential new transmission for both the Northeastern California and Wyoming wind, potential transmission solutions needed could cost between $9.2 – 12.5 billion. These estimates reflect the range of cost for the potential new transmission needed (beyond what has already been approved as the release of this report) for the mapped portfolio resources based on CPUC staff analysis using the 2024 White Paper and other data. based on CPUC staff analysis using the 2024 White Paper and other data.

Table 81: Summary of CAISO 2024 White Paper constraint exceedances in the PG&E North of Greater Bay and Greater Bay study areas caused by the updated mapping results for the 2035 and 2040 base case mapped portfolios.

Base Case (2035) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
PG&E North of Greater Bay	Collinsville-Tesla 500 kV Line	3,379	7,706	3,733	75	1,263	275	285	574	(600)	None	8,645	$ 2,852	High
	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	(102)	(115)	26	$ 180	High
	Bellota-Weber 230kV Line	1,661	2,539	411	436	1,599	84	93	947	(293)	None	460	$ 400	Low
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	546	3,673	416	25	1,140	57	187	289	(862)	None	6,034	$ 417	Low
	Birds Landing-Contra Costa 230kV Line	656	1,176	333	75	527	151	140	423	(199)	None	1,766	$ 700	Low

Base Case (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
PG&E North of Greater Bay	Collinsville-Tesla 500 kV Line	3,379	7,706	3,733	430	2,163	275	285	1,224	(1,553)	None	8,645	$ 2,852	High
	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	(102)	(115)	26	$ 180	High
	Bellota-Weber 230kV Line	1,661	2,539	411	2,088	2,199	84	93	2,857	(1,141)	None	460	$ 400	High
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	546	3,673	416	45	1,465	57	187	419	(1,190)	None	6034*	$ 417	High
	Tesla-Tracy-Pump 230 kV line #2	4,574	10,136	2,632	101	2,910	157	220	986	(114)	None	3521*	-	Low
	Tesla-Bellota 230 kV line	3,154	4,254	2,688	258	2,722	150	256	1,224	(1,391)	None	300	$ 1,700	High
	Birds Landing-Contra Costa 230kV Line	656	1,176	333	330	717	151	140	903	(428)	None	1,766	$ 700	Low

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

*Same upgrades for two of the exceeded constraints

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

Mapped Resources Summary

Table 82 and Table 83 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 2035 and 2040 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 82: Updated mapping results (2035 & 2040) for the PG&E Fresno study area by resource type.

PG&E Fresno	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	**FCDS**	**EODS**	**FCDS**	**EODS**	**Total**	**FCDS**	**EODS**	**Total**
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	2	-	8	-	**9**	8	-	**9**
OnshoreWind	61	-	430	70	**561**	430	70	**561**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	50	-	29	**79**	-	29	**79**
Solar	791	1,131	680	1,722	**4,324**	4,730	6,882	**13,534**
Battery_4hr	2,308	-	-	-	**2,308**	-	-	**2,308**
Battery_8hr	35	-	665	-	**700**	2,730	-	**2,765**
LDES	-	-	140	-	**140**	140	-	**140**
Total by Status	**3,196**	**1,180**	**1,923**	**1,821**	**8,120**	**8,038**	**6,981**	**19,395**

Table 83: Updated mapping results (2035 & 2040) for the PG&E Kern study area by resource type

PG&E Kern	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	**FCDS**	**EODS**	**FCDS**	**EODS**	**Total**	**FCDS**	**EODS**	**Total**
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	-	-	23	-	**23**	23	-	**23**
OnshoreWind	-	-	113	-	**113**	113	-	**113**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	2,924	-	**2,924**	2,924	-	**2,924**
Distributed Solar	-	19	-	32	**50**	-	32	**50**
Solar	200	663	630	1,309	**2,802**	1,560	3,174	**5,597**
Battery_4hr	493	-	-	-	**493**	-	-	**493**
Battery_8hr	-	-	410	-	**410**	1,210	-	**1,210**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**693**	**682**	**4,100**	**1,341**	**6,816**	**5,830**	**3,206**	**10,411**

Transmission Implications

Table 84 highlights the CAISO's 2024 White Paper transmission constraints with exceedances for the mapped 2035 and 2040 portfolios in the PG&E Fresno and Kern study areas based on the busbar mapping transmission calculations. The table is split into the identified on-peak exceedances and off-peak exceedances for 2035 and 2040. The table shows the resources mapped within each constraint, the calculated exceedance level, the identified 2024 White Paper upgrade, and CPUC staff estimated likelihood of the upgrade being triggered. In the 2035 and 2040 portfolios, resource mapping results in no exceedances in the PG&E Kern study area. The PG&E Fresno area has two on-peak exceedances in the 2035 mapping and eight exceedances (six on-peak and two off-peak only) in 2040, as seen in Table 84.

In 2035, the two exceedances will likely require transmission solutions, particularly the Chowchilla-Le grand 115kV Line constraint as it has no available on-peak deliverability. CPUC staff view the identified 2024 White Paper upgrade for the Chowchilla-Le grand 115kV Line constraint, which costs an estimated $550 million and provides 1,211 MW of capability, as an effective solution given the amount and type of resources mapped. CPUC staff note that the identified upgrade has an estimated time to construct that would make it not available in the 2035 timeframe; however, if the constraint were to become binding in a TPP policy study, the CAISO would seek to identify a potentially different solution with the shorter timeline needed. CPUC staff view the Borden-Storey #1 230kV line constraint's identified White Paper upgrade, estimated at $50 million, which would provide over 1,200 MW of additional deliverability, as an effective transmission upgrade.

The 2040 portfolio mapping results in four additional on-peak exceedances: the Gates 500/230kV TB #11 constraint, which has a 2024 White Paper upgrade estimated to cost $35 million and to provide 10,038 MW of capability; the Tranquility-Helm 230kV Line constraint, which has an upgrade estimated to cost $1,500 million and to provide 2,274 MW of capability; the Schindler 115/70kV TB #1 constraint, which has an upgrade estimated to cost $370 million and to provide 3,160 MW of capability; and the Mustang-Henrietta 230 kV line constraint, which has an upgrade estimated to cost $830 million and to provide 2,479 MW of capability. The two off-peak only exceedances occur in the Gates 500/230kV TB #12 constraint, which has the same upgrade as the Gates 500/230kV TB #11 constraint, and the Oro Loma-El Nido 115kV Line constraint. The Oro Loma-El Nido 115kV line exceedance is a relatively small off-peak exceedance and the 2024 White Paper upgrade, estimated to cost $330 million, does not provide enough additional EODS capability, as it was studied, to alleviate the exceedance.

All four of the identified on-peak upgrades are effective solutions given the number of resources mapped in 2040 and the number of additional resources in these areas in the 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. For the 2035 portfolio, the mapped resources in the PG&E Fresno area likely need transmission upgrades costing an estimated $600 million (2022 constant dollars), and for the 2040 portfolio, potential transmission upgrades could cost up to $3.6 billion.

In both the 2035 and 2040 mapped 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, based on past feedback from the Working Group staff 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 lease area. However, CPUC staff note that recent interconnection studies suggest the Diablo Canyon 500 kV substation may have difficulty accommodating additional gen-ties for offshore wind. CPUC

staff request that CAISO also assess the potential to interconnect Morro Bay offshore wind at a new Morro Bay 500 kV substation, first identified in the 21-22 TPP offshore wind sensitivity with a then estimated cost of $110 million, if it is more cost-effective.

Table 84: Summary of CAISO 2024 White Paper constraint exceedances in the PG&E Kern and Fresno study areas caused by the Updated mapping results for the 2035 and 2040 base case mapped portfolios.

Base Case (2035) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	On- & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
PG&E Fresno	Chowchilla-Le grand 115kV Line	-	158	320	125	242	6	70	214	**(427)**	**(39)**	1,211	$ 550	High
	Borden-Storey #1 230kV line	412	780	320	455	1,113	6	70	1,061	**(935)**	**None**	1,247	$ 50	High

Base Case (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	On- & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
PG&E Fresno	Gates 500/230kV TB #12	5,406	3,581	780	4,248	4,360	16	70	7,492	**None**	**(1,708)**	14,825*	$ 35	Medium
	Gates 500/230kV TB #11	5,337	5,027	780	4,708	4,618	30	70	8,393	**(493)**	**(1,079)**	10,038*	-	Medium
	Tranquility-Helm 230kV Line	2,921	2,777	320	2,808	2,849	8	70	4,726	**(566)**	**(497)**	2,274	$ 1,500	Medium
	Chowchilla-Le grand 115kV Line	-	158	320	675	457	6	70	844	**(774)**	**(757)**	1,211	$ 550	High
	Schindler 115/70kV TB #1	-	50	-	300	20	-	-	30	**(223)**	**(191)**	3,160	$ 370	High
	Borden-Storey #1 230kV line	412	780	320	1,655	1,743	6	70	2,791	**(1,745)**	**(1,161)**	1,247	$ 50	High
	Oro Loma-El Nido 115kV Line	528	308	150	275	260	6	50	636	**None**	**(240)**	3,192	$ 330	Low
	Mustang-Henrietta 230 kV line	5,581	5,617	3,187	3,593	3,246	7	50	6,394	**(828)**	**(2,089)**	2,479	$ 830	High

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

*Same upgrades for two of the exceeded constraints

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

Mapped Resources Summary

Table 85 and Table 86 summarize the resources mapped to the SCE Northern and Metro Study Areas, respectively. The tables summarize the identified in-development resources and mapped generic resources for the mapped 2035 and 2040 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. The SCE Metro study area includes the Lugo 500 kV substation, which represents in busbar mapping imports into the CAISO using the Intermountain Power Plant (IPP) HVDC transmission line from Utah. Thus, mapped Utah geothermal interconnecting through IPP is included in Table 86. Additionally, 1,750 MW of New Mexico wind on new transmission is modeled as interconnecting to Lugo, per high level analysis from the 2023-2024 20-year Transmission Outlook.

Table 85: Updated mapping results (2035 & 2040) for the SCE Northern study area by resource type

SCE Northern Area	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	-	**-**	-	-	**-**
Biomass	-	-	-	-	**-**	-	-	**-**
OnshoreWind	-	-	674	-	**674**	674	-	**674**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	24	-	-	**24**	-	-	**24**
Solar	427	1,383	751	225	**2,786**	1,251	2,335	**5,396**
Battery_4hr	3,224	-	-	-	**3,224**	-	-	**3,224**
Battery_8hr	454	-	55	-	**509**	1,130	-	**1,584**
LDES	200	-	200	-	**400**	200	-	**400**
Total by Status	**4,305**	**1,407**	**1,680**	**225**	**7,617**	**3,255**	**2,335**	**11,302**

Table 86: Updated mapping results (2035 & 2040) for the SCE Metro study area by resource type.

SCE Metro	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	366	-	23	-	**389**	23	-	**389**
Biomass	6	-	-	-	**6**	-	-	**6**
OnshoreWind	-	-	-	-	**-**	-	-	**-**
OOS Wind	-	-	1,750	-	**1,750**	1,750	-	**1,750**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	13	-	-	**13**	-	-	**13**
Solar	10	10	-	-	**20**	-	-	**20**
Battery_4hr	1,891	-	-	-	**1,891**	-	-	**1,891**
Battery_8hr	10	-	-	-	**10**	600	-	**610**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**2,282**	**23**	**1,773**	**-**	**4,078**	**2,373**	**-**	**4,678**

Transmission Implications

Between the two study areas, no exceedances in the 2024 White Paper constraints occur based on the busbar mapping transmission calculations. Preliminary 24-25 TPP policy results indicate the potential need for a transmission upgrade for the Midway-Whirlwind 500 kV line constraint, with a range of potential upgrade solutions that are ongoing further assessment as part of the 24-25 TPP. The mapped results for 2035 have a comparable amount of resources as the 2034 portfolio in the 24-25 TPP and thus any upgrade needs identified will likely be consistent.

The 2035 and 2040 mapped portfolios both included 1,750 MW of New Mexico wind on new transmission. As discussed in Sections 6.2 and 6.4.A, this amount of New Mexico wind is in addition to 3,100 MW mapped as interconnecting at Palo Verde and utilizing the SunZia HVDC transmission line. CPUC mapped the New Mexico wind in line with the high-level results from the 20-year Transmission Outlook (2023-2024) which identified a new HVDC transmission line into the Lugo area as a potential transmission solution with an estimated cost of $3.5 – 4.9 billion. CPUC staff note that this solution is not driven by any specific transmission project being planned and is not a mandate to assume this specific intertie if alternative, more effective solutions are available. The 20-year Transmission Outlook also identified an another transmission solution for interconnecting additional New Mexico wind to the CAISO at to Palo Verde. An example currently under development is the RioSol transmission line, a proposed AC-line paralleling the SunZia HVDC line. As with the Wyoming wind mapped to the Tesla area in Northern California, the 2023-2024 20-year Transmission Outlook cost estimate represents a higher cost than assumed in RESOLVE modeling for New Mexico wind. Given the uncertainty around the potential transmission solutions, complexity of any transmission line crossing multiple balancing areas, and lack of a clear existing planned transmission line, CPUC staff intend to conduct further modeling and analysis to assess the cost and benefits of interconnecting additional New Mexico wind on new transmission. Even though the resources are in the 2035 mapped portfolio, CPUC staff recommend CAISO similarly conduct additional analysis on potential transmission solutions and alternatives, as well as potential co-benefits for other balancing areas, rather than recommending a specific transmission upgrade for approval in the 25-26 TPP.

7.5 Greater Kramer and Southern Nevada: SCE North of Lugo Study Area and East of Pisgah Study Area

Mapped Resources Summary

Table 87 and Table 88 summarize the resources mapped to the SCE North of Lugo Study Area and the East of Pisgah Study Area respectively. The tables summarize the identified in-development resources and mapped generic resources for the mapped 2035 and 2040 portfolios by resource type and modeled deliverability status. The SCE North of Lugo Study area contains the Greater Kramer area and the SCE system up to the Control substation, which includes the Silver Peak CAISO import intertie. The East of Pisgah Study Area 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 geothermal all modeled as interconnecting with the existing CAISO system's Harry Allen and Eldorado interties.

Table 87: Updated mapping results (2035 & 2040) for the SCE North of Lugo study area by resource type.

SCE North of Lugo	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	10	-	-	-	**10**	-	-	**10**
Biomass	-	-	4	-	**4**	4	-	**4**
OnshoreWind	-	-	330	32	**362**	330	32	**362**
OOS Wind	-	-	-	-	**-**	-	-	**-**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	17	-	7	**24**	-	7	**24**
Solar	275	240	375	284	**1,174**	475	1,003	**1,993**
Battery_4hr	507	-	-	-	**507**	-	-	**507**
Battery_8hr	6	-	107	-	**113**	457	-	**463**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**798**	**257**	**816**	**323**	**2,194**	**1,266**	**1,042**	**3,363**

Table 88: Updated mapping results (2035 & 2040) for the East of Pisgah study area by resource type.

East of Pisgah	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	517	-	**517**	517	-	**517**
Biomass	-	-	-	-	**-**	-	-	**-**
OnshoreWind	-	-	1,052	177	**1,229**	1,052	177	**1,229**
OOS Wind	51	-	4,100	-	**4,151**	4,100	-	**4,151**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	-	-	-	**-**	-	-	**-**
Solar	125	650	761	862	**2,398**	1,541	3,682	**5,998**
Battery_4hr	1,210	-	-	-	**1,210**	-	-	**1,210**
Battery_8hr	-	-	320	-	**320**	1,635	-	**1,635**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**1,386**	**650**	**6,750**	**1,039**	**9,825**	**8,845**	**3,859**	**14,740**

Transmission Implications

Busbar mapping results in two transmission constraint exceedances in the 2035 portfolio and three in the 2040 portfolio for the SCE North of Lugo study area, as well as one in 2035 and two in 2040 for the East of Pisgah study area based on the transmission calculations, as seen in Table 89. The table shows the resources mapped within each constraint, the calculated exceedance level, the identified 2024 White Paper upgrade, and CPUC staff estimated likelihood of the upgrade being triggered.

For the SCE North of Lugo study area, the 2035 and 2040 portfolios exceedance in the Control to Inyokern Area constraint is caused by in-development Nevada geothermal in the baseline seeking to be imported at the Silver Peak intertie. The constraint has an identified 2024 White Paper upgrade that provides approximately 186 MW of additional constraint capacity and costs an estimated $329 million, that would likely be needed to accommodate even the small amount of exceedance observed. CPUC staff view the identified upgrade as not a cost-effective solution for the amount of resources mapped and instead will work with the CAISO to identify an alternative import intertie for the geothermal.

The South of Kramer Area constraint is also exceeded by a small amount in both model years. The exceedance occurs in the default capability of the approved 23-24 TPP transmission upgrade for the constraint. CPUC staff note that the total amount of resources mapped in 2035 behind the constraint is less than previously mapped in the 24-25 TPP and 23-24 TPP base cases, as staff shifted resources to other locations to better align with busbar mapping. In busbar working group analysis, the working group noted that this exceedance may still trigger a smaller reconductoring of the Kramer – Victor 220 kV line with an estimated $50 million cost, but the full TPP analysis will be necessary to confirm if any upgrades would be needed and the scope of such upgrades.

In the 2040 portfolio mapping, mapped additional solar and storage cause a third exceedance in the area, the Calcite to Lugo Area constraint. CPUC staff view the identified 2024 White Paper Upgrade, which costs an estimated $239 million and provides potential 1,046 MW, as an effective solution and note the estimated time to construct of the upgrade is nine years while the exceedance only occurs in the 2040 mapping.

In the East of Pisgah study area, the 2035 mapping results in a small exceedance in the Lugo-Victorville Area constraint, that increases significantly in the 2040 mapping. This small exceedance could potentially trigger the identified upgrade. CPUC staff note the amount of resources mapped is nearly the same as mapped in the 2034 portfolio in the 24-25 TPP base case. In the preliminary policy results for the 24-25 TPP, the CAISO noted the potential need for the identified Trout Canyon – Lugo 500kV line. A key factor to any transmission need is the mapped out-of-state Wyoming and New Mexico Wind with planned interties in this constraint as the El dorado, Harry Allen, and Palo Verde interties are included. The second transmission exceedance in the 2040 portfolio mapping is the Sloan Canyon - Eldorado 500 kV constraint; however, this is a default constraint with an estimated capacity value based on the approved 22-23 TPP upgrades. As discussed in Section 6.4.A, CPUC staff note the magnitude of exceedance may be accommodated by the already approved upgrade.

Similar to the 24-25 TPP portfolio mapping, the portfolio includes 400 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.

The busbar mapping Working Group modeled the out-of-CAISO resources as Maximum Import Capability (MIC) expanding or utilizing in-development CAISO transmission in the East of Pisgah area. 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 apportioned cost of ~$850 million. The busbar mapping Working Group modeled the portfolios' 117.3 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.

In both the 2035 and 2040 portfolio mappings, 3,000 MW of Wyoming wind is modeled interconnecting to the Harry Allen/Eldorado interties; however, only 1,500 MW of this wind can utilize the in-development subscriber PTO TransWest line, which 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. Since both the SWIP-North and TransWest transmission projects have been approved, they are not included in the total cost estimates of additional transmission that could be triggered by the mapping results discussed.

Table 89: Summary of CAISO 2024 White Paper constraint exceedances in the SCE North of Lugo and East of Pisgah study areas caused by the Updated mapping results for the 2035 (Top) and 2040 (Bottom) base case portfolios.

Base Case (2035) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
SCE North of Lugo	Control to Inyokern Area	-	120	-	-	-	13	-	-	**(13)**	**None**	186	$ 329	High
	South of Kramer Area	456	1,190	180	314	411	17	32	300	**(96)**	**None**	N/A	N/A	Medium
East of Pisgah	Lugo-Victorville Area	10,105	12,605	8,302	1,306	4,247	562	177	4,281	**(236)**	**None**	6,800	$ 2,165	Medium

Base Case (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
SCE North of Lugo	Control to Inyokern Area	-	120	-	-	-	13	-	-	**(13)**	**None**	186	$ 329	High
	South of Kramer Area	456	1,190	180	314	411	17	32	300	**(96)**	**None**	N/A	N/A	Medium
	Calcite to Lugo Area	297	552	150	300	422	-	-	804	**(237)**	**(180)**	1,046	$ 239	High
East of Pisgah	Sloan Canyon - Eldorado 500 kV constraint	4,032	4,302	1,660	1,566	2,555	562	50	3,445	**(216)**	**None**	N/A	N/A	Medium
	Lugo-Victorville Area	10,105	12,605	8,302	2,854	6,202	562	177	8,421	**(2,393)**	**None**	6,800	$ 2,165	High

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

As discussed in Section 6.4.A and similar to the New Mexico wind mapped to Lugo in the SCE Metro study area, CPUC staff do not have a specific potential transmission solution identified nor are aware of any specific transmission project being planned for the additional 1,500 MW of Wyoming Wind in both 2035 and 2040. As with the Wyoming wind mapped to the Tesla area in Northern California, the 20-year Transmission Outlook (2023-2024) did identify a potential high-level solution costing an estimated $4.1-5.2 billion, which represents a higher cost than assumed in RESOLVE modeling.

Given the uncertainty around the potential transmission solutions, complexity of any transmission line crossing multiple balancing areas, and lack of a clear existing planned transmission line, CPUC staff intended to conduct further modeling and analysis to assess the cost and benefits of interconnecting additional OOS wind on new transmission. Even though the resources are in the 2035 mapped portfolio, CPUC staff recommend CAISO similarly conduct additional analysis on potential transmission solutions and alternatives, as well as potential co-benefits for other balancing areas, rather than recommending a specific transmission upgrade for approval this TPP cycle.

For the 2035 portfolio, the mapped resources in the two study areas likely need transmission upgrades, potentially costing up to $2.2 billion (2022 constant dollars), not including any additional transmission needed for the Wyoming Wind mapped. For the 2040 portfolio, potential transmission upgrades could cost up to $3.5 – 7.6 billion including potential new transmission for the additional Wyoming wind.

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

Mapped Resources Summary

Table 90 and Table 91 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 2035 and 2040 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 90: Updated mapping results (2035 & 2040) for the SCE Eastern study area by resource type.

SCE Eastern	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	500	-	**500**	500	-	**500**
Biomass	3	-	5	-	**8**	5	-	**8**
OnshoreWind	57	-	231	37	**325**	231	37	**325**
OOS Wind	1,685	-	1,414	-	**3,099**	1,414	-	**3,099**
Offshore Wind	-	-	-	-	**-**	-	-	**-**
Distributed Solar	-	-	-	-	**-**	-	-	**-**
Solar	475	3,399	-	-	**3,874**	900	1,480	**6,254**
Battery_4hr	3,985	-	-	-	**3,985**	-	-	**3,985**
Battery_8hr	100	-	-	-	**100**	680	-	**780**
LDES	-	-	-	-	**-**	-	-	**-**
Total by Status	**6,305**	**3,399**	**2,150**	**37**	**11,890**	**3,730**	**1,517**	**14,950**

Table 91: Updated mapping results (2035 & 2040) for the SDG&E study area by resource type.

SDG&E	In-Development		Mapped Generic (2035)		Total (2035)	Mapped Generic (2040)		Total (2040)
Res. Type (MW)	FCDS	EODS	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	100	-	**100**	100	-	**100**
Biomass	-	-	-	-	**-**	-	-	**-**
OnshoreWind	300	-	960	556	**1,816**	960	556	**1,816**
OOS Wind	-	-	-	-	**-**	-	-	-
Offshore Wind	-	-	-	-	**-**	-	-	-
Distributed Solar	-	1	-	14	**15**	-	14	15
Solar	53	1,138	367	23	**1,581**	735	1,193	**3,119**
Battery_4hr	1,727	-	-	-	**1,727**	-	-	**1,727**
Battery_8hr	50	-	50	-	**100**	860	-	**910**
LDES	-	-	409	-	**409**	409	-	**409**
Total by Status	**2,130**	**1,139**	**1,886**	**592**	**5,748**	**3,064**	**1,762**	**8,096**

Transmission Implications

Table 92 highlights the CAISO's 2024 White Paper transmission constraints with exceedances for the 2035 portfolio (Top table) and 2040 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 2024 White Paper upgrade, and CPUC staff estimated likelihood of the upgrade being triggered.

The SDG&E study area has a single constraint exceedance in both 2035 and 2040 portfolio mappings. The exceedance in the Chicarita 138 kV constraint is driven predominately by in-development battery resources: 300 MW in the modeling baseline corresponding to a project that has already received TPD and 10 MW in the portfolio on the SDGE distribution system in the area. Working group staff note that the 300 MW project with TPD would not likely cause a need for an upgrade alone. CPUC staff, therefore, view that this exceedance is unlikely to require the identified

White Paper upgrade. As always, the full TPP analysis will be necessary to confirm if any upgrades would be needed and the scope of such upgrades.

The SCE Eastern study area has a single constraint exceedance in both 2035 and 2040 portfolio mappings. The exceedance is in the Eagle Mountain constraint which has a 2024 White Paper identified 600 MW capability upgrade costing an estimated $1.2 billion. The exceedance is driven predominately by Imperial geothermal as importing into the CAISO at Mirage from IID, however, there is some solar and storage mapped to the Blythe substation. As discussed in 6.4.A, the studies on this constraint did not center on resources being imported from IID. These resources would likely not require the identified White Paper upgrade but would still need different upgrades at the IID-SCE intertie and IID system.

Both the 2035 and 2040 mapped portfolios include 3,099 MW of New Mexico wind on new transmission mapped as interconnecting to the Palo Verde intertie point. As discussed in the initial mapping results, Working Group staff assumed the wind will utilize the in-development subscriber based SunZia line, though approximately 900 MW may require additional new transmission to reach Palo Verde from SunZia's endpoint at Pinal Central in Arizona. While not a CAISO TAC upgrade, the SunZia project has an estimated cost of $2.6 billion per CAISO's 20-year Transmission Outlook (2021-2022), but since it has already been approved by the CAISO, it is not included in the total cost estimates of new transmission potentially triggered by this portfolio. The Working Group assumed these out-of-CAISO resources are MIC expanding.

In total, the 2035 and 2040 mapped portfolio could require in-CAISO upgrades up to $1.2 billion (2022 constant dollars) plus additional transmission costs to bring out-of-CAISO resource in Imperial and New Mexico to the CAISO border. If the New Mexico wind currently mapped to Lugo was remapped to Palo Verde, this would cause additional exceedances to be observed in the SCE Eastern area that would require additional in CAISO transmission upgrades.

Table 92: Summary of CAISO 2024 White Paper constraint exceedances in the SCE Eastern and SDG&E study areas caused by the updated mapping results for the 2035 (Top) and 2040 (Bottom) base case portfolios.

Base Case (2035) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
SCE Eastern	Eagle Mountain Constraint	-	392	-	-	310	530	-	290	**(840)**	**(51)**	600	$ 1,182	High
SDG&E	Chicarita 138 kV	224	224	-	-	310	-	-	-	**(86)**	**None**	700	$ 100	Low

Base Case (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info		CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capability Increase (MW)	Estimated Cost (millions)	
SCE Eastern	Eagle Mountain Constraint	-	392	-	-	530	310	-	290	**(840)**	**(51)**	600	$ 1,182	High
SDG&E	Chicarita 138 kV	224	224	-	-	310	-	-	-	**(86)**	**None**	700	$ 100	Low

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

7.7 Long Lead-time Resources Sensitivity Portfolio

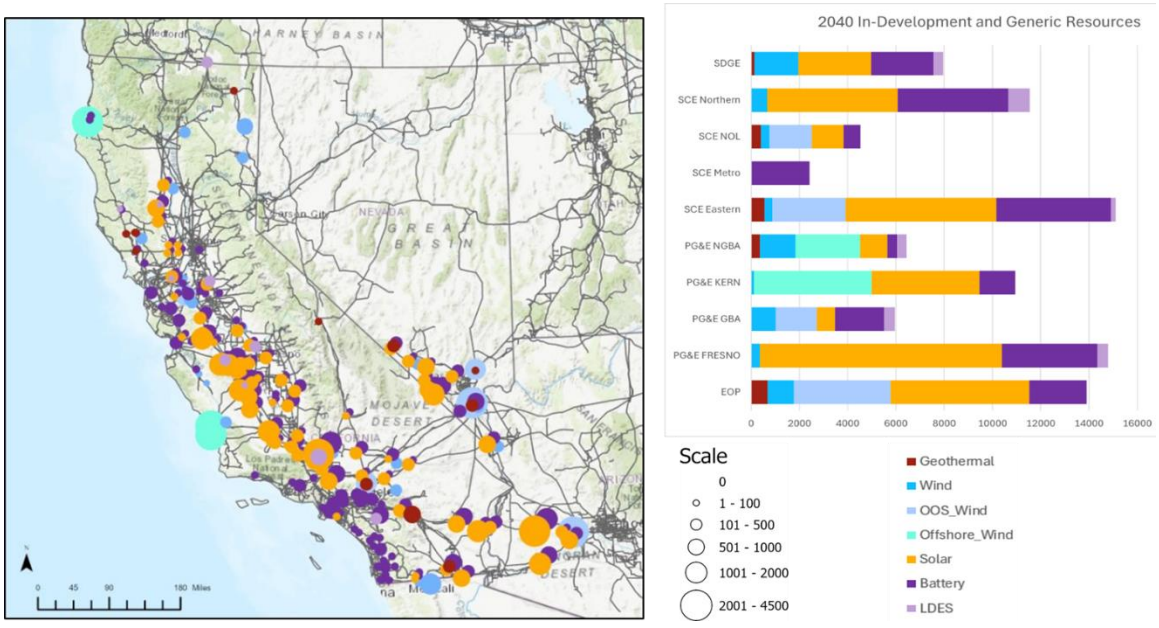
As discussed in Section 4.2, the long lead-time (LLT) resources sensitivity portfolio includes additional amounts of geothermal, LDES, and offshore wind resources in line with the maximum volumes of LLT resources identified in D.24-08-064. In total the LLT resources sensitivity portfolio includes 2.1 GW of geothermal, 7.6 GW of offshore wind, and 2.8 GW of LDES in both 2035 and 2040 model years. Mapping results and busbar mapping criteria analysis for the LLT resources sensitivity portfolio (See Appendix K) were first released with the January 10, 2025, Proposed Decision. Subsequently, staff made remapping adjustments to the mapped resources based on stakeholder comments to the Proposed Decision. The mapping changes for the final results are:

- Remapped a total of 200 MW of geothermal from several substations — Beatty 230 kV (-50 MW Central Nevada geothermal), Eldorado 230 kV (-26.5 MW Northern Nevada geothermal), Imperial Valley 230 kV (-40 MW Imperial geothermal), and Mirage 230 kV (-83.5 MW Imperial geothermal).

- Remapped the 200 MW of geothermal to the NVE Hilltop 345 kV (100 MW) and Malin 500 kV (100 MW) substations to represent geothermal from the SurpriseValley and adjacent California known geothermal areas and from Northern Nevada.

This remapping is reflected in the final mapping results summarized in the Final Dashboard for the 25-26 TPP LLT resources sensitivity portfolio transmitted with the Decision (See Appendix L). Figure 15, shows a geographic summary of the final mapping results for the sensitivity portfolio's 2040 model year.

Figure 15: Busbar mapping results of the 25-26 TPP LLT resources sensitivity portfolio 2040 model year. (Left) Map of the final busbar mapping results. (Right) Chart showing mapping results summed by region. Resources shown in MWs.



The summary of the final mapping results for the LLT resources sensitivity portfolio is shown in Table 93 for the 2035 portfolio and Table 94 for the 2040 portfolio. The in-development resources, shown in the top table in Table 93, are the same as used for the base case portfolio. There are more 4-hr battery resources in-development, 16.2 GW, than contained within the RESOLVE selected portfolio for the LLT resources sensitivity, 11.6 GW, that need to be included in CAISO's TPP analysis . Similar to the nominal base case adjustment (241 MW of 8-hr batteries converted to 482 MW of 4-hr batteries) discussed in Section 6.3, CPUC staff converted a portion of portfolio-selected 8-hr batteries to be 4-hr batteries to align with the in-development resources. The total amount of 8-hr batteries in the 2035 portfolio is not enough to account for all the in-development 4-hr batteries. Additionally, doing so for all 8-hr batteries would exacerbate the TPD alignment in Northern California for the offshore wind. Therefore, staff did a significant conversion of the 8-hr batteries to 4-hr batteries but still mapped some 8-hr storage to the Northern California areas. For both the 2035 and 2040 model years staff allocated 1,126 MW of 8-hr battery storage from the RESOLVE selected portfolio amounts to account for 2,252 MW of in-development 4-hr battery storage. The resulting conversion does capture a significant portion of the additional 4-hr battery storage in-development, but it does still result in 2.4 GW more 4-hr battery storage being included and mapped in addition to the total RESOLVE-selected portfolio.

The generic resources in Table 93 and Table 94 reflect the additional resources in the portfolio not accounted for with the in-development resources. The mapped locations for the LLT resources are summarized below with the full mapping analysis in the Final Dashboard, Appendix L.

Geothermal

Most of the geothermal resources are mapped to out-of-CAISO or out-of-state locations. Of the mapped in-CAISO geothermal, a small amount of in-development geothermal is in the North of Lugo study area while 166 MW of geothermal is mapped to the Geysers area of Northern California. Additionally, 450 MW of Central Nevada geothermal is mapped as in-CAISO interconnecting at the Beatty substation in the East of Pisgah area, although this would, as noted for the base case, require additional transmission or a long gen-tie to interconnect.

The portfolio includes almost 400 MW of geothermal mapped to Utah and interconnecting through the IPP system to enter the CAISO system in the Lugo-Victorville area (SCE Metro study area). Most of this is attributed to identified in-development Utah geothermal resources. An additional 289 MW of geothermal is mapped as Utah and Northern Nevada geothermal but interconnecting to the CAISO in the Eldorado/Harry Allen area interties in Southern Nevada in the East of Pisgah Study Area

Table 93: Summary of final mapping results for the LLT resources sensitivity portfolio 2035 model year by CAISO study area and resource type. (Top) Summary in-development resources; (Middle) Summary of generic resources; (Bottom) Summary of total resources, generic plus in-development.

In-Development Resources	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery		LDES	Total In-Dev.
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	4hr (MW)	8hr (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	25	3	-	-	-	21	28	125	-	5	**207**
PG&E Greater Bay	-	3	91	-	-	10	100	719	-	-	**923**
PG&E Fresno	-	2	61	-	-	50	1,922	2,308	35	-	**4,377**
PG&E Kern	-	-	-	-	-	19	863	493	-	-	**1,375**
SCE Northern Area	-	-	-	-	-	24	1,810	3,224	454	200	**5,712**
SCE Metro	366	6	-	-	-	13	20	1,891	10	-	**2,305**
SCE North of Lugo	10	-	-	-	-	17	515	507	6	-	**1,055**
East of Pisgah	-	-	-	51	-	-	775	1,210	-	-	**2,036**
SCE Eastern	-	3	57	1,685	-	-	3,874	3,985	100	-	**9,704**
SDG&E	-	-	300	-	-	1	1,191	1,727	50	-	**3,269**
Total In-Development:	**401**	**16**	**508**	**1,736**	**-**	**154**	**11,097**	**16,189**	**655**	**205**	**30,961**

2035 – Mappged Generic Resources	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery		LDES	Total Generic
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	4hr (MW)	8hr (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	341	106	1,340	-	2,680	25	280	-	95	385	**5,250**
PG&E Greater Bay	-	9	923	-	-	33	-	-	261	446	**1,672**
PG&E Fresno	-	8	310	-	-	29	1,657	-	-	440	**2,523**
PG&E Kern	-	23	113	-	4,875	32	1,404	-	-	-	**6,447**
SCE Northern Area	-	-	674	-	-	-	750	-	-	700	**2,124**
SCE Metro	23	-	-	-	-	-	-	-	-	-	**23**
SCE North of Lugo	-	4	362	-	-	7	450	-	-	-	**824**
East of Pisgah	678	-	910	3,955	-	-	1,394	-	-	-	**6,937**
SCE Eastern	557	5	268	1,309	-	-	-	-	-	200	**2,338**
SDG&E	140	-	1,516	-	-	-	367	-	-	409	**2,432**
Total 2035 Generic:	**1,738**	**155**	**6,415**	**5,264**	**7,555**	**126**	**6,301**	**-**	**356**	**2,580**	**30,570**

2035 – Mapped Total Resources	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery		LDES	Total Res.
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	4hr (MW)	8hr (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	366	109	1,340	-	2,680	46	308	125	95	390	**5,457**
PG&E Greater Bay	-	12	1,014	-	-	44	100	719	261	446	**2,595**
PG&E Fresno	-	9	371	-	-	79	3,578	2,308	35	440	**6,899**
PG&E Kern	-	23	113	-	4,875	50	2,267	493	-	-	**7,822**
SCE Northern Area	-	-	674	-	-	24	2,560	3,224	454	900	**7,836**
SCE Metro	389	6	-	-	-	13	20	1,891	10	-	**2,328**
SCE North of Lugo	10	4	362	-	-	24	965	507	6	-	**1,878**
East of Pisgah	678	-	910	4,006	-	-	2,169	1,210	-	-	**8,973**
SCE Eastern	557	8	325	2,994	-	-	3,874	3,985	100	200	**12,042**
SDG&E	140	-	1,816	-	-	1	1,558	1,727	50	409	**5,701**
Total 2035 Resources:	**2,139**	**171**	**6,923**	**7,000**	**7,555**	**280.2**	**17,398**	**16,189**	**1,011**	**2,785**	**61,531**

Table 94: Summary of final mapping results for the LLT resources sensitivity portfolio 2040 model year by CAISO study area and resource type. (Top) Summary of generic resources; (Bottom) Summary of total resources, generic plus in-development.

2040 – Mappged Generic Resources	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery		LDES	Total Generic
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	4hr (MW)	8hr (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	341	106	1,471	-	2,680	25	1,099	-	280	385	**6,386**
PG&E Greater Bay	-	9	923	1,707	-	33	650	-	1,318	446	**5,086**
PG&E Fresno	-	8	310	-	-	29	8,097	-	1,620	440	**10,503**
PG&E Kern	-	23	113	-	4,875	32	3,609	-	990	-	**9,642**
SCE Northern Area	-	-	674	-	-	-	3,586	-	904	700	**5,864**
SCE Metro	23	-	-	1,750	-	-	-	-	500	-	**2,273**
SCE North of Lugo	-	4	362	-	-	7	804	-	180	-	**1,358**
East of Pisgah	678	-	1,095	3,955	-	-	4,973	-	1,165	-	**11,866**
SCE Eastern	557	5	268	1,343	-	-	2,380	-	657	200	**5,410**
SDG&E	140	-	1,516	-	-	14	1,828	-	800	409	**4,707**
Total 2040 Generic:	**1,738**	**155**	**6,731**	**8,755**	**7,555**	**140**	**27,026**	**-**	**8,414**	**2,580**	**63,094**

2040 – Mapped Total Resources	Geothermal	Biomass	Onshore Wind	OOS Wind	Offshore Wind	Distributed Solar	Solar	Battery		LDES	Total Res.
CAISO Study Area	FCDS (MW)	FCDS (MW)	Total (MW)	FCDS (MW)	FCDS (MW)	EODS (MW)	Total (MW)	4hr (MW)	8hr (MW)	FCDS (MW)	(MW)
PG&E North of Greater Bay	366	109	1,471	-	2,680	46	1,127	125	280	390	**6,593**
PG&E Greater Bay	-	12	1,014	1,707	-	44	750	719	1,318	446	**6,009**
PG&E Fresno	-	9	371	-	-	79	10,019	2,308	1,655	440	**14,880**
PG&E Kern	-	23	113	-	4,875	50	4,472	493	990	-	**11,017**
SCE Northern Area	-	-	674	-	-	24	5,396	3,224	1,358	900	**11,576**
SCE Metro	389	6	-	1,750	-	13	20	1,891	510	-	**4,578**
SCE North of Lugo	10	4	362	-	-	24	1,319	507	186	-	**2,412**
East of Pisgah	678	-	1,095	4,006	-	-	5,748	1,210	1,165	-	**13,902**
SCE Eastern	557	8	325	3,028	-	-	6,254	3,985	757	200	**15,113**
SDG&E	140	-	1,816	-	-	15	3,019	1,727	850	409	**7,976**
Total 2040 Resources:	**2,139**	**171**	**7,239**	**10,491**	**7,555**	**294.2**	**38,122**	**16,189**	**9,069**	**2,785**	**94,055**

Approximately 700 MW of geothermal is mapped to the Imperial Valley within the IID system and imported into the CAISO at either the Mirage-Devers area intertie between SCE and IID (557 MW in SCE Easter Study area) or the Imperial Valley intertie between SDG&E and IID (140 MW in SDG&E study area).

Finally, 200 MW of geothermal out-of-CAISO geothermal is mapped as interconnecting through Malin in Northern California. 100 MW is mapped to the NVE Hilltop substation and is mapped to the Surprise Valley, a Known Geothermal Area in far Northeastern California. The remaining 100 MW is mapped as Northern Nevada geothermal.

Offshore Wind

The 7.6 GW of offshore wind is split between the Morro Bay Wind Energy Area (WEA) with 4.9 GW and the Humboldt WEA with 2.7 GW. The Humboldt offshore wind is all mapped to the proposed new Humboldt 500 kV substation and may require transmission upgrades in addition to the ones approved in the 23-24 TPP. The Morro Bay offshore wind is split between the existing Diablo Canyong 500 kV substation and a proposed new Morro Bay 500 kV substation.

LDES

Working group staff mapped the LDES resources as a mix of technologies – batteries, pumped storage hydro (PSH), and Adiabatic Compressed Air Energy Storage (A-CAES) – factoring in available information for commercial development interest and other mapping criteria for those technologies. However, CPUC staff note that the resource types identified in the mapping effort are not an explicit endorsement of a specific project or even the specific technology type at that location as other LDES technologies could readily serve the same function at the mapped locations.

A total of 1,509 MW of LDES is mapped to the southern CAISO study areas. The 900 MW mapped to the SCE Northern study area is mapped as 400 MW of A-CAES and 500 MW of PSH. The 409 MW of LDES in the SDG&E study area is mapped as PSH and the 200 MW of LDES mapped to the SCE Eastern study area was mapped as battery storage.

A total of 1,276 MW of LDES is mapped to the Northern CAISO study areas. The 440 MW of LDES in the PG&E Fresno study area is mapped as 140 MW of PSH and 300 MW of batteries. The 446 MW in the PG&E Greater Bay study area is mapped as 346 MW of LDES and 100 MW of batteries, while the 390 MW in North of Greater Bay study area is 315 MW of PSH and 75 MW of batteries.

7.7.A Comparison to Base Case Mapping

In mapping the sensitivity portfolio, staff generally sought to align with the mapping conducted for the base case portfolio. Changes compared to where resources are mapped in the base case are predominately driven by the different resource amounts in the sensitivity portfolio, but some changes also reflect mapping efforts to improve overall criteria alignment, particularly utilizing existing transmission capacity, that is impacted by the mapping of the additional LLT resources. Table 95 shows the mapped differences between the LLT resources sensitivity portfolio and the base case portfolio for 2035 and 2040.

The increased amounts of LLT resources in the sensitivity portfolio are the same in 2035 and 2040, as the LLT resources are forced-in in 2035 and no additional LLT resources are selected by 2040.. In 2035, offsetting these increases were decreases in onshore wind, solar, and storage in the LTT resource sensitivity portfolio. In 2035, the LLT resources portfolio has 972 MW less onshore in-state wind, and those reductions are in the PG&E North of Greater Bay, PG&E Fresno, and East of Pisgah study areas. It also has 2,000 MW less OOS wind and those reductions were predominately a 1,750 MW reduction in New Mexico wind mapped as interconnecting on new transmission to the Lugo area. The 2,062 MW of solar and 1,582 MW of 8-hr battery storage reductions in 2035 are spread across multiple study areas with the largest reductions occurring in the PG&E Fresno and Kern study areas followed by the SCE North of Lugo and East of Pisgah study areas. In 2040, there are smaller reductions in onshore wind with only 656 MW less in-state and 216 MW less OOS wind compared to the mapped base case, but significantly less solar (6,476 MW) and 8-hr battery storage (2,701 MW) than the base case. The majority of the solar reduction occurs in the PG&E Freno area with significant reductions also in the PG&E Kern and Greater Bay areas as well as the SCE North of Lugo study area. Generally, these reductions are more concentrated in the Norther California study areas which correlates with the mapping of the majority of the additional LLT resources to the Northern California study areas.

Table 95: Summary of mapped results differences between the LLT Resources sensitivity and the base case, summarized by study area and resource type. (Top) Comparison of the 2035 model year portfolios; (Bottom) Comparison of the 2040 model year portfolios.

Summary of Differences between 2035 LLT Sens. and Base Case Mapped Portfolios											
2035 Portfolio: Net Difference (MW) In Resources Mapped (LLT Sens. - Base)	Geothermal FCDS	Biomass FCDS	Wind Total	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar EODS	Solar Total	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	243	-	(463)	-	1,073	-	(25)	-	-	385	**1,213**
PG&E Greater Bay	-	-	-	-	-	-	(150)	-	25	136	**11**
PG&E Fresno	-	-	(190)	-	-	-	(666)	-	(665)	300	**(1,221)**
PG&E Kern	-	-	-	-	1,951	-	(535)	-	(410)	-	**1,006**
SCE Northern Area	-	-	-	-	-	-	(226)	-	(55)	500	**219**
SCE Metro	-	-	-	(1,750)	-	-	-	-	-	-	**(1,750)**
SCE North of Lugo	-	-	-	-	-	-	(209)	-	(107)	-	**(316)**
East of Pisgah	161	-	(319)	(145)	-	-	(229)	-	(320)	-	**(852)**
SCE Eastern	57	-	-	(105)	-	-	-	-	-	200	**152**
SDG&E	40	-	-	-	-	(14)	(23)	-	(50)	-	**(47)**
All Areas	**500**	**-**	**(972)**	**(2,000)**	**3,024**	**(14)**	**(2,062)**	**-**	**(1,582)**	**1,521**	**(1,584)**

Summary of Differences between 2040 LLT Sens. and Base Case Mapped Portfolios											
2040 Portfolio: Net Difference (MW) In Resources Mapped (LLT Sens. - Base)	Geothermal FCDS	Biomass FCDS	Wind Total	OOS Wind FCDS	Offshore Wind FCDS	Distributed Solar EODS	Solar Total	Battery_4hr FCDS	Battery_8hr FCDS	LDES FCDS	All Res Total
PG&E North of Greater Bay	243	-	(332)	-	1,073	-	(160)	-	(25)	385	**1,184**
PG&E Greater Bay	-	-	-	-	-	-	(652)	-	(190)	136	**(706)**
PG&E Fresno	-	-	(190)	-	-	-	(3,515)	-	(1,110)	300	**(4,515)**
PG&E Kern	-	-	-	-	1,951	-	(1,125)	-	(220)	-	**606**
SCE Northern Area	-	-	-	-	-	-	-	-	(226)	500	**274**
SCE Metro	-	-	-	-	-	-	-	-	(100)	-	**(100)**
SCE North of Lugo	-	-	-	-	-	-	(674)	-	(277)	-	**(951)**
East of Pisgah	161	-	(134)	(145)	-	-	(250)	-	(470)	-	**(838)**
SCE Eastern	57	-	-	(71)	-	-	-	-	(23)	200	**163**
SDG&E	40	-	-	-	-	-	(100)	-	(60)	-	**(120)**
All Areas	**500**	**-**	**(656)**	**(216)**	**3,024**	**-**	**(6,476)**	**-**	**(2,701)**	**1,521**	**(5,003)**

7.7.B Transmission Implications

Table 96 highlights the CAISO's 2024 White Paper transmission constraints with exceedances for the 2035 sensitivity portfolio for all study areas based on the busbar mapping transmission calculations. The tables show the resources mapped within each constraint, the calculated exceedance level, comparison with the exceedance amounts calculated for the 2035 base case mapping, the identified 2024 White Paper upgrade, and CPUC staff estimated likelihood of the upgrade being triggered. Table 97 and Table 98 show the same analysis for the four northern study areas and six southern study areas respectively for the 2040 mapped sensitivity portfolio.

The 2035 mapping of the LLT resources sensitivity portfolio results in a similar number of 2024 White Paper constraint exceedances with a few differences. The Lugo-Victorville area constraint, which was slightly exceeded in the 2035 base case mapping, is not exceeded, due to less solar and storage being included and mapped in the sensitivity portfolio. The 2035 sensitivity portfolio mapping does include two exceedances not seen in the 2035 base case mapping driven by the additional offshore wind. The 2,680 MW of Humboldt offshore wind results in a default exceedance in the 23-24 TPP approved North Coast transmission upgrades, as the upgrades were approved under analysis that included only 1,607 MW of Humboldt offshore wind. The additional mapped offshore wind may require further transmission upgrades. The CAISO analysis in the 23-24 TPP

Report noted that converting the approved Humboldt to Collinsville 500 kV line to HVDC would be a potential additional upgrade option. The estimated cost differential between the cost of the approved Humboldt-Collinsville 500 kV line and the cost of the HVDC line, both identified in the 23-24 TPP Report, is $1.3 – 1.9 billion. The mapped Morro Bay offshore wind results in an exceedance in the Mustang-Henrietta constraint in 2035, which is also not exceeded in the 2035 base case mapping but is in the 2040 mapping. The identified 2024 White Paper upgrade provides 2,479 MW of additional capacity and costs an estimated $830 million.

For out-of-CAISO transmission implications in 2035, the LLT resources sensitivity portfolio does not include the 1,750 MW of New Mexico wind mapped as interconnecting on new transmission to the Lugo area, while having several hundred MWs more of out-of-CAISO geothermal may require additional transmission in IID and NVE service territories to interconnect to the CAISO.

In 2040, a total of six base case exceedances, five in the Fresno study area and one in the North of Lugo study area, are not observed with the LLT resources sensitivity mapping as significant less solar and storage are mapped to those areas. The North Coast transmission exceedance and the potential additional need for out-of-CAISO transmission identified in the 2035 mapping remain in the 2040 portfolio. The 2040 portfolio now does include the 1,750 MW of New Mexico wind mapped on new transmission to the Lugo area, showing the additional resources only delayed that identified OOS wind need.

Table 96: Summary of CAISO 2024 White Paper constraint exceedances caused by the mapping of the LLT resources sensitivity portfolio 2035 model year, including comparison to exceedances calculated for the mapped 2035 base case results.

LLT Sens. (2035) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance (HSN or SSN)	Calculated Off-peak Exceedance (EODS)	Base Case Largest On-peak Exceedance (HSN or SSN)	Base Case Off-peak Exceedance (EODS)	White Paper Upgrade Info			CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)					FCDS Capability Increase (MW)	Estimated Cost (millions)	Estimated COD	
SCE North of Lugo Area	Control to Inyokern area constraint	-	120	-	-	-	13	-	-	**(13)**	**None**	(13)	None	186	$ 329	2035	Low
	South of Kramer Area Constraint	256	1,190	180	250	406	15	32	250	**(83)**	**None**	(96)	None	N/A	N/A	N/A	Medium
SCE Eastern Area	Eagle Mountain Constraint	-	392	-	-	310	587	-	290	**(897)**	**(108)**	(840)	(51)	600	$ 1,182	2036	High
East of Pisgah Area	Lugo - Victorville area constraint	10,105	12,605	7,860	1,686	3,927	723	50	3,672	**None**	**None**	(236)	None	6,800	2,165	2036	Not Exceeded
SDG&E Study Area	Chicarita 138 kV constraint	224	224	-	-	310	-	-	-	**(86)**	**None**	(86)	None	700	$ 100	2030	Low
PG&E North of Greater Bay Area	Collinsville-Tesla 500 kV Line	3,379	7,706	4,398	50	1,723	518	229	424	**(2,007)**	**None**	(600)	None	8,645	$ 2,852	2038	High
	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	**(102)**	**(115)**	(102)	(115)	26	$ 180	2033	High
	Bellota-Weber 230kV line	1,661	2,539	150	206	1,615	84	50	742	**(144)**	**None**	(293)	None	460	$ 400	2036	Low
	Humboldt Offshore Wind constraint	-	-	2,680	-	-	-	-	-	**(278)**	**(680)**	None	None	N/A	N/A	N/A	Medium
PG&E Greater Bay Area	Windmaster-Delta pumps 230 kV line	546	3,673	416	-	1,215	57	187	139	**(933)**	**None**	(862)	None	6,034	$ 417	2033	Medium
	Birds Landing-Contra Costa 230kV Line	656	1,176	235	50	572	193	107	273	**(234)**	**None**	(199)	None	1,766	$ 700	2038	Low
PG&E Fresno Area	Chowchilla-Legrand 115kV Line	-	158	150	-	172	6	50	39	**(253)**	**None**	(427)	(39)	1,211	$ 550	2041	High
	Borden-Storey #1 230kV line	412	780	150	200	1,033	6	50	830	**(732)**	**None**	(935)	None	1,247	$ 50	2033	High
	Mustang-Henrietta 230 kV line	5,581	5,617	5,138	1,392	1,241	7	50	2,120	**(151)**	**(929)**	None	None	2,479	$ 830	2034	High

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

Table 97: Summary of CAISO 2024 White Paper constraint exceedances in the fourth northern study areas caused by the mapping of the LLT resources sensitivity portfolio 2040 model year, including comparison to exceedances calculated for the mapped 2040 base case results.

LLT Sens. (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance (HSN or SSN)	Calculated Off-peak Exceedance (EODS)	Base Case Largest On-peak Exceedance (HSN or SSN)	Base Case Off-peak Exceedance (EODS)	White Paper Upgrade Info			CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Offshore/ Onshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)					FCDS Capability Increase (MW)	Estimated Cost (millions)	Estimated COD	
PG&E North of Greater Bay Area	Collinsville-Tesla 500 kV Line	3,379	7,706	4,496	369	2,624	518	262	1,124	**(3,004)**	**None**	**(1,553)**	**None**	8,645	$ 2,852	2038	High
	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	**(102)**	**(115)**	**(102)**	**(115)**	26	$ 180	2033	High
	Bellota-Weber 230kV line	1,661	2,539	150	906	2,065	84	50	2,142	**(699)**	**None**	**(1,141)**	**None**	460	$ 400	2036	High
	Humboldt OSW constraint	-	-	2,680	-	-	-	-	-	**(278)**	**(680)**	**None**	**None**	N/A	N/A	N/A	Medium
PG&E Greater Bay Area	Windmaster-Delta pumps 230 kV line	546	3,673	416	20	1,565	57	187	419	**(1,286)**	**None**	**(1,190)**	**None**	6,034*	$ 417	2033	High
	Contra Costa-Windmaster 230 kV line	1,233	3,667	333	20	883	185	140	423	**(5)**	**None**	**None**	**None**	5,601*	-	2033	Low
	Tesla-Tracy-Pump 230 kV line #2	4,574	10,136	2,632	76	2,810	199	220	586	**(53)**	**None**	**(114)**	**None**	3,521*	-	2033	Low
	Tesla-Bellota 230 kV line	3,154	4,254	2,598	206	2,668	150	234	624	**(1,284)**	**None**	**(1,391)**	**None**	300	$ 1,700	2044	High
	Birds Landing-Contra Costa 230kV Line	656	1,176	333	269	762	193	140	803	**(506)**	**None**	**(428)**	**None**	1,766	$ 700	2038	Low
PG&E Fresno Area	Gates 500/230kV TB #12	5,406	3,581	610	2,448	3,765	16	50	6,402	**None**	**None**	**None**	**(1,708)**	14,825	35	2030	Not Exceeded
	Gates 500/230kV TB #11	5,337	5,027	610	2,848	3,933	30	50	7,063	**None**	**None**	**(458)**	**(1,079)**	10,038	-	2030	Not Exceeded
	Tranquility-Helm 230kV Line	2,921	2,777	150	1,403	2,569	8	50	3,786	**None**	**None**	**(566)**	**(497)**	2,274	1,500	2041	Not Exceeded
	Chowchilla-Legrand 115kV Line	-	158	150	150	332	6	50	539	**(435)**	**(142)**	**(774)**	**(757)**	1,211	$ 550	2041	High
	Schindler 115/70kV TB #1	-	50	-	-	-	-	-	-	**None**	**None**	**(223)**	**(191)**	3,160	370	2036	Not Exceeded
	Borden-Storey #1 230kV line	412	780	150	750	1,583	6	50	2,181	**(1,364)**	**(40)**	**(1,745)**	**(1,161)**	1,247	$ 50	2033	High
	Oro Loma-El Nido 115kV Line	528	308	150	50	205	6	50	431	**None**	**None**	**None**	**(240)**	3,192	330	2036	Not Exceeded
	Mustang-Henrietta 230 kV line	5,581	5,617	5,138	2,398	2,796	7	50	5,569	**(1,872)**	**(2,894)**	**(821)**	**(2,089)**	2,479	$ 830	2034	High

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

*Same upgrades for three of the exceeded

Table 98: Summary of CAISO 2024 White Paper constraint exceedances in the six southern study areas caused by the mapping of the LLT resources sensitivity portfolio 2040 model year, including comparison to exceedances calculated for the mapped 2040 base case results.

LLT Sens. (2040) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance (HSN or SSN)	Calculated Off-peak Exceedance (EODS)	Base Case Largest On-peak Exceedance (HSN or SSN)	Base Case Off-peak Exceedance (EODS)	White Paper Upgrade Info			CPUC staff estimated likelihood of being triggered
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Offshore/ Onshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)					FCDS Capability Increase (MW)	Estimated Cost (millions)	Estimated COD	
SCE North of Lugo Area	Control to Inyokern area constraint	-	120	-	-	-	13	-	-	(13)	None	(13)	None	186	$ 329	2035	Low
	South of Kramer Area Constraint	256	1,190	180	250	406	15	32	250	(83)	None	(96)	None	N/A	N/A	N/A	Medium
	Calcite to Lugo Area Constraint	297	552	150	200	180	-	-	504	None	None	(236)	None	1,046	239	2035	Not Exceeded
SCE Eastern Area	Eagle Mountain Constraint	-	392	-	-	310	587	-	290	(897)	(108)	(840)	(51)	600	$ 1,182	2036	High
East of Pisgah Area	Sloan Canyon - Eldorado 500 kV constraint	4,032	4,302	1,671	1,616	2,235	723	50	3,145	(69)	None	(251)	None	N/A	N/A	N/A	Medium
	Lugo - Victorville area constraint	10,105	12,605	8,079	3,204	5,732	723	50	7,821	(1,981)	None	(2,393)	None	6,800	2,165	2036	High
SDG&E Study Area	Chicarita 138 kV constraint	224	224	-	-	310	-	-	-	(86)	None	(86)	None	700	$ 100	2030	Low

** Includes amounts from IRP baseline resources not in the White Paper baseline based on COD

*Same upgrades for three of the exceeded

8. Other Assumptions for TPP

Guidance previously provided to CAISO as part of the annual CPUC portfolio transmittal was included in a document historically called the "Unified Inputs & Assumptions". In more recent years, CPUC and CAISO staff have agreed to any necessary content being 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

RESOLVE models the aggregate amount of thermal generation not retained (due to economic optimization) by resource category. Unit-specific information is not modeled. Resource portfolios may also include forced-in thermal retirements (e.g., as part of portfolios focused on specific policy questions or IRP plans). As an input into RESOLVE, they are specifically not included in the RESOLVE selected resource category of thermal generation not retained; however, for busbar mapping for the TPP these resources need to be accounted for and mapped.

Because the TPP studies require modeling of specific units and locations, CPUC staff will share the specific list of units to model as offline with CAISO. The list is for use in the TPP studies only and should not be interpreted as the CPUC directing retirement of specific gas generators nor the CPUC attempting to assert authority to retire specific units. The Busbar Mapping Methodology (Appendix A) outlines criteria for selecting which specific units to model as not retained.

The 25-26 TPP portfolios have no gas plant retirements in the TPP model years beyond the assumed retirements included in the 2023 IRP modeling baseline, which are not reflected in the portfolio summaries and mapping results. In summary, those baselines retirements are all the gas once-through cooling plants (~3.7 GW) and assumed linear phaseout of in front of the meter combined heat and power plants (CHP) from 2031-2040, with all CHPs (1,964 MW) assumed retired by 2040. These baseline assumptions are the same used for the 24-25 TPP portfolio. CPUC staff recommend utilizing the gas plant list developed for the 24-25 TPP for the locations of the CHP plants captured in the IRP baseline.[23] CPUC staff recommend assuming the same CHP plants identified for the 24-25 TPP 10-year portfolios are also retired in the 25-26 TPP 10-year portfolio and the full CHP list is retired for the 2040 portfolios.

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 successors R. 21-10-002 and R. 23-10-011) determines what resources can provide system and local resource adequacy capacity. For its TPP studies the CAISO utilizes data from Supply-Side Resource Demand

[23] Gas Capacity Not Retained Assumption List for the 24-25 TPP Base Case and Sensitivity Portfolios, 02/15/2024, 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

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.

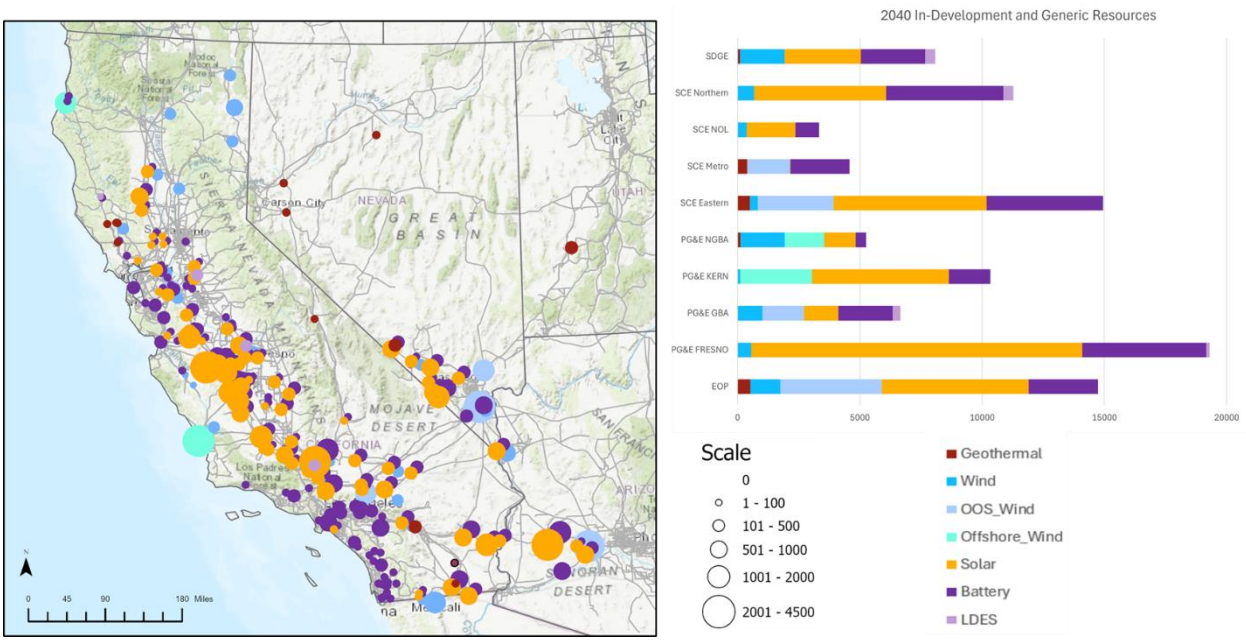
The 25-26 TPP portfolios do not include any model-driven DR resource; however, individual LSEs may have procured DR not captured in the IRP modeling effort. To this end, CPUC staff requests the Investor-Owned Utilities (IOUs), in their capacity as Participating Transmission Owners (PTOs), to submit this 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 long lead-time (LLT) 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, 2035 and 2040. The final mapping results of the 2035 and 2040 mapped portfolios will be transmitted to the CAISO for use in the reliability and policy-driven base case and a policy driven sensitivity in the 25-26 TPP. The final mapping results and the busbar mapping analysis are included in the final mapping dashboards: Appendix D for the base case and Appendix L for the LLT resources sensitivity portfolio.

In total for the base case portfolio in 2040, Working Group staff mapped over 69,500 MW of renewables, including approximately 10,700 MW of out-of-state wind on new out-of-state transmission and 4,500 MW of offshore wind, as well as over 29,200 MW of storage, including approximately 1,300 MW of long duration storage, to substations. Figure 16 depicts a visual map-based representation conveying the approximate locations and amounts of resources mapped for the 2040 base case portfolio.

Figure 16: Map of the updated busbar mapping results for the 25-26 TPP base case portfolio (2040) shown by mapped interconnection location and amount mapped by resource type.

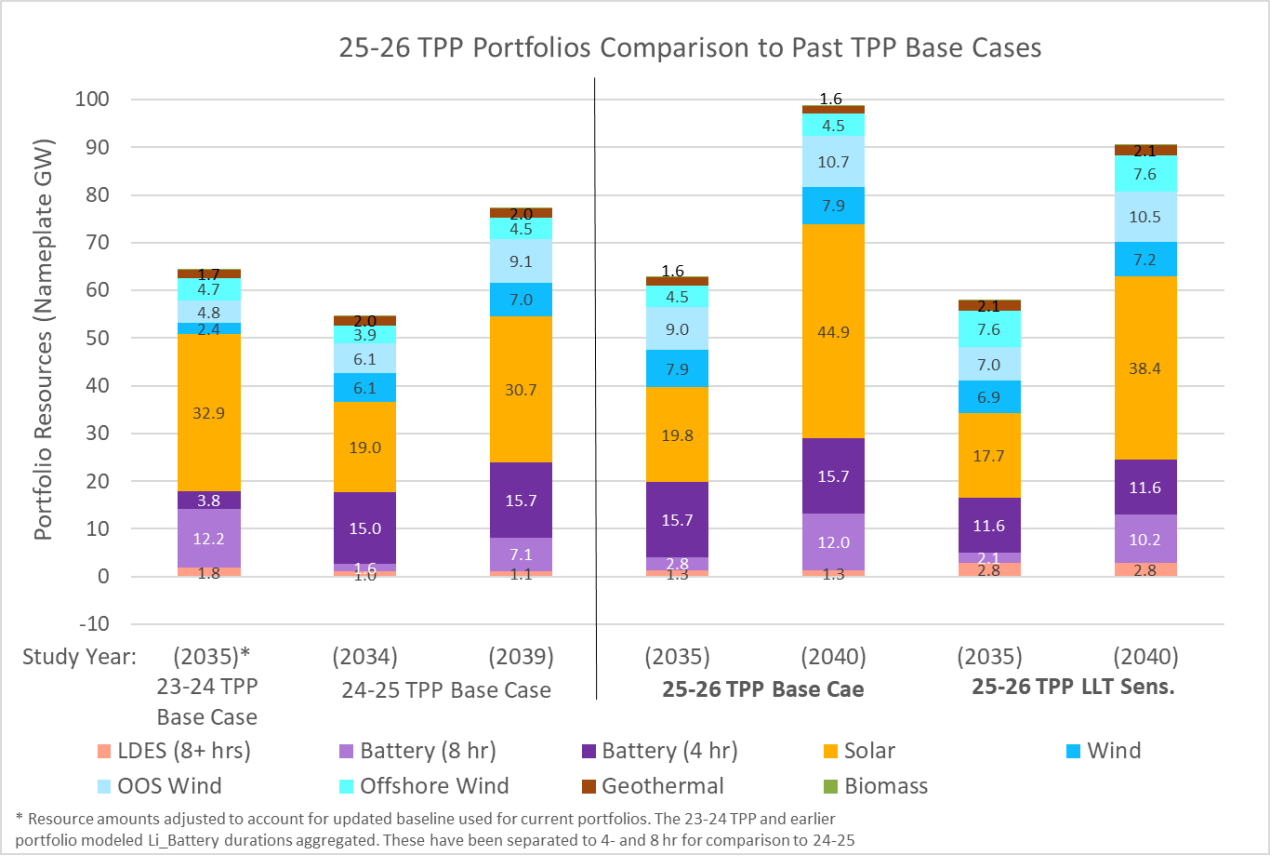


The grid is ever evolving and for this reason the CPUC transmits portfolios to the CAISO annually for transmission planning. A key criterion for busbar mapping is consistency with prior portfolios, particularly base cases. The goal is to capture the most current available information while also ensuring 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 25-26 TPP portfolio could be alleviated by upgrades being studied in current ongoing 24-25 TPP, thereby enhancing transmission planning.

Figure 17 compares the resources mapped in the 25-26 TPP base case portfolio for the two study years, 2035 and 2040, as well as the LLT resources sensitivity portfolio, with the base case portfolio for the current 24-25 TPP and for the previously approved 23-24 TPP.

Figure 17: Final resource comparison of the 25-26 TPP base case portfolio and the LLT resources sensitivity portfolio in the 2035 and 2040 model years with the 24-25 TPP and 23-24 TPP base cases.



In busbar mapping, the Working Group mapped specific resource types to individual substations using an array of data and analysis that are a part of the busbar mapping criteria detailed in the Busbar Mapping Methodology (Appendix A). Several portions of this analysis rely on data attributable to specific projects (e.g., interconnection queue status or permitting status for commercial development interest criteria or probable water source at potential PSH locations). The use of this data and mapping or not mapping resources to a location is not an endorsement or rejection of a specific individual project. Further, the environmental impacts and land-use implications analysis, is not a site-specific review or approval of a project. The busbar mapping criteria analysis is designed to assess generally how favorable and in alignment with the busbar mapping guiding principles both the interconnection to a specific bus and the land around that bus is for an amount of a specific resource type. It is not the approval of a specific project.

The resource mappings for the base case portfolio continue the trend of recent past TPP base case portfolio mapping results. Progressing into the 2035 and 2040 years introduces higher load and more stringent greenhouse gas emissions targets, and results in a significant number of transmission constraint exceedances being identified that will likely require significant transmission upgrades. Based on preliminary CPUC staff estimates derived from the busbar mapping analysis, the 2035 portfolio mapping of the 25-26 TPP base case may need transmission upgrades that cost between $10 billion and $20.4 billion (2022 constant dollars), including both the identified 2024 White Paper upgrades and the full costs of likely out-of-CAISO transmission needed for OOS wind and out-of-CAISO resources. For the 2040 portfolio, that estimated total cost projection of upgrades potentially needed increases to between $19.7 - 30.6 billion.

For comparison, the Busbar Mapping Report for the still ongoing 24-25 TPP identified the potential need for upgrades costing between $10 - $20 billion for 2034 and $20 – 29 billion for 2039. These amounts included an estimated $2.5 – 4.3 billion for North Coast offshore wind transmission upgrades that were subsequently approved by the CAISO in the 23-24 TPP and are not included in the current 25-26 TPP estimates, while the 25-26 TPP amounts include more transmission and more costly estimates for the transmission to access OOS wind resources.

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. Transmission needs and their costs may differ significantly once the portfolio is fully studied by the CAISO through the 25-26 TPP. Additionally, these numbers do not reflect what upgrades may be recommended for approval in the upcoming CAISO's 24-25 TPP Report. The 24-25 TPP could result in approval of upgrades that have been identified as potentially needed for the 25-26 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 2040 or for which construction can be started in future years and still be constructed in time to meet the need.

The updated 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 2024 White Paper. As noted in Sections 7.2 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.

9.1 Guidance on the 2025-2026 TPP Base Case Portfolio

The mapped results for the base case portfolio, 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 24-25 TPP base case which is still the subject of ongoing analysis. The mappings also result in a significant need for new transmission beyond the CAISO's BAA to interconnect the OOS and out-of-BAA wind and geothermal resources to CAISO interties.

The 2024 White Paper upgrades identified as likely needed for the 2035 and 2040 mapping results were mostly in the northern study areas, with the already approved transmission upgrades accommodating most of the resources mapped to the southern study areas. CPUC staff estimate that the potential upgrades within the CAISO for the 2035 portfolio, based on the 2024 White Paper assumptions, have a total cost ranging from $4 – $8.6 billion. In addition, new transmission needed to interconnect additional out-of-state Wyoming and New Mexico wind and Northen California wind in NVE could cost up to $5.7 – $11.8 billion. In the 2040 portfolio, CPUC staff estimate that the in-CAISO upgrades potentially needed could cost between $10.2 – $13.6 billion based on 2024 White Paper assumptions and additional analysis, while offshore wind and out-of-state resources would likely need upgrades costing between $9.7 – $17 billion. Upgrades approved in the 2024-25 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 2024 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 2040 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.

Additional Analysis of Transmission Needs for Out-of-State and In-state Wind on New Out-of-CAISO Transmission

The 25-26 TPP has a significant amount of OOS wind on new transmission in both the 2035 and 2040 model years (9,000 MW and 10,707 MW, respectively). Although the amounts are close to the 9,095 MW in the 2039 model year for the current and still ongoing 24-25 TPP, this amount of out-

of-state wind and the potential transmission solutions has not been studied previously at a detailed level. Only high-level approximate solutions have been identified in the CAISO's two 20-year Transmission Outlooks, with the more recent Outlook having significantly higher cost estimates than assumed in the first Outlook or in IRP modeling. Recent portfolios have only had up to 5-6 GW of OOS wind and CPUC staff and CAISO were able to assess potential transmission solutions from several transmission projects that were already in planning and development. With most of these projects now already approved or allocated, (e.g., SWIP-North approved and SunZia and TransWest as subscriber PTOs) additional solutions, costs, and routes are not well understood and have not been sufficiently studied. In addition to the OOS wind, the 25-26 TPP has 1,150 MW of in-state wind mapped to the area of Northern California serviced by NVE system transmission in both 2035 and 2040. Like OOS wind, aside from the still ongoing 24-25 TPP, potential transmission solutions have not been previously examined. For both resources, the potential transmission solutions are likely to be large, complex, and crossing difficult terrain and multiple BAAs. Additionally, the interconnection points for these resources assumed in the mapping are based only on high-level studies and more optimal and cost-effective alternatives may exist.

Due to these uncertainties, risks, and the complexity and cost of potential solutions, CPUC staff recommend requesting the CAISO conduct additional analysis on potential transmission solutions for these resources to better understand the options, costs, and potential collaborations with other BAAs.

Further CPUC staff recommend requesting the CAISO defer approving any of these potential transmission lines needed for these resources in the 25-26 TPP and, as it is impacted, in the 24-25 TPP. This delay is key; as the 24-25 TPP has 1,405 MW of Wyoming wind and this portfolio has 1,500 MW of Wyoming wind, 1,750 MW of New Mexico wind, and 1,100 MW of Northern California wind included in the 10-year mapping timeframe, which is the portfolio that typically drives CAISO TPP recommendations of transmission approvals. This delay will give time for the CAISO to study potential solutions and CPUC staff to conduct additional analysis to confirm if such solutions are cost-effective.

Specifically, this request refers to the following resources in the 10-year portfolio, in addition to the OOS wind added in the 15-year portfolio:

- 1,500 MW of Wyoming Wind mapped to Eldorado 500 kV not assumed to be utilizing the TransWest line in both the 2035 and 2040 portfolios and the 2034 base case for the 24-25 TPP
- 1,750 MW of New Mexico Wind mapped to Lugo 500 kV in both the 2035 and 2040 portfolios
- 1,150 MW of Northern California wind mapped to three NVE substations (Hilltop 345 kV and new substations near Leavitt and Madeline) in both the 2035 and 2040 portfolios
- 1,707 MW of Wyoming Wind mapped to Tesla in only the 2040 portfolio

CPUC staff also request this ask to be applied to the similarly mapped resources in the 24-25 TPP base case, which includes 1,405 MW of Wyoming wind in 2034, and the 900 MW of Northern California wind mapped to NVE substations and 1,500 MW of Wyoming wind mapped to the Tesla area in 2039.

Alignment with CAISO Queue Resources with Allocated TPD to Preserve Deliverability for Specified Resources.

As was done for the 24-25 TPP and 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/out-of-CAISO and 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.

For this 25-26 TPP, CPUC staff assumed that the deliverability has been preserved for the out-of-CAISO wind and geothermal resources included in the 23-24 TPP during the 2024 TPD allocation and thus CPUC staff have sought to identify the unaccounted for TPD resources, particularly in the East of Pisgah and SCE Eastern areas that need to be included for any additional OOS wind and geothermal resources beyond those amounts.

In addition, this year, CPUC staff have also sought to identify unaccounted for TPD that would impact reserving deliverability for the offshore wind mapped to the North Coast to be included in the TPP analysis. The unaccounted for TPD analysis is included in the 'Unaccountedfor_TPD' tab of the mapping dashboard (Appendix D for the base case's Final Mapping Dashboard)

CPUC staff will engage further with CAISO staff to identify any TPD not already accounted for 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. CPUC staff note that given the above recommendation about delaying any transmission solutions for specific OOS resources, CPUC staff recommend not reserving deliverability or MIC for any of those resources at this time.

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

The 25-26 TPP base case portfolio, in addition to the over 10,700 MW of OOS wind on new transmission by 2040, 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 24-25 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 D). CAISO staff should consult with CPUC staff in considering alternative locations for these imports if the identified locations are not feasible or CAISO staff identify better alternative intertie points.

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. Battery mappings are relatively flexible and 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 24-25 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 the 25-26 TPP portfolio

9.2 Guidance on the Long Lead-Time Resources Sensitivity Portfolio

As described in more detail in Section 7.7 and included in the dashboard in Appendix L, additional offshore wind has been mapped to both Morro Bay and the Humboldt areas to allow the CAISO to study specifically identified potential additional upgrades that would be needed for the increased amount of offshore wind, if any, beyond those already approved in previous TPPs. As in the base case portfolio, of particular interest are potential combinations of interconnections points between the existing Diablo Canyon 500 kV substation and a potential new Morro Bay substation as well as potential other transmission upgrades that may be needed for the additional Morro Bay offshore wind.

The sensitivity portfolio also includes 200 MW of geothermal resources mapped or interconnecting to substations in far Northeastern California in NVE territory, in addition to onshore wind mapped to the area. While the busbar mapping group identified the Malin intertie as the existing point for injection to the CAISO system, CPUC staff ask the CAISO to also assess the potential transmission needs to enable these resources to reach the CAISO system from their locations on the NVE system in Northern California and Nevada.

9.3 Busbar Mapping for Future TPP Cycles

Staff appreciate the feedback and suggestions from stakeholders in comments and replies to the September and October 2024 Rulings and to the January 2025 Proposed Decision. Feedback and suggestions not already addressed in the transmittal for the 25-26 TPP will be a priority for consideration in the draft workplan and mapping methodology updates for 26-27 TPP busbar mapping. The busbar mapping effort for the next cycle will seek to continue to refine the busbar mapping criteria, particularly updating and potentially expanding mapping criteria to better incorporate changes to the CAISO interconnection processes. 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

September 2024 25-26 TPP Ruling version, 09/12/2024: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/mapping_methodology_vruling_2024-09-06.pdf

B. Dashboard for Initial Mapping of Proposed 25-26 TPP Base Case

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 11/1/2024, Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/full-dashboard_25-26tpp_basecase_initial_2024-10-30_v2.xlsx

C. Dashboard for the Proposed Decision Mapping of the 25-26 TPP Base Case

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 01/10/25, Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/full-dashboard_25-26tpp_basecase_pd.xlsx

D. Final Dashboard for the Mapping of the 25-26 TPP Base Case

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 02/20/25

E. Initial Baseline Reconciliation and In-Development Resources (October Ruling version)

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 11/01/24. Link https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/baselinereconcilation_25-26tpp_initial.xlsx

F. Updated Baseline Reconciliation and In-Development Resources (PD version)

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 01/10/25, Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/baselinereconcile_25-6tpp_pdupdate.xlsx

G. Initial Commercial Interest Analysis of CAISO Interconnection Queue (October Ruling version)

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 11/01/24. Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-

ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/mappingcifrom_caisoqueue10_07_2024.xlsx

H. Updated Commercial Interest Analysis of CAISO Interconnection Queue (PD version)

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 01/10/25, Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/mappingcifrom_caisoqueue11-25-2024.xlsx

I. Commercial Interest Analysis of Cluster 15 Applications

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 11/01/24. Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/mappingcifrom_cluster15_apps_09-25-24.xlsxhttps://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

J. CEC Land-use and Environmental Screens Data Workbook (October Ruling version)

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 11/01/24. Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/landuse_envscreens_bysub_25-26tpp_10-31-24.xlsx

K. Dashboard for the Proposed Decision Mapping of the 25-26 TPP LLT Resources Sensitivity Portfolio

Posted to the CPUC's "Assumptions for the 2025-2026 TPP" webpage, 1/10/25. Link: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/assumptions-for-the-2025-2026-tpp/full-dashboard_25-26tpp_lltsens_2025-01-10.xlsx

L. Final Dashboard for the 25-26 TPP LLT Resources Sensitivity Portfolio

Posted to the CPUC's Assumptions for the 2025-2026 TPP webpage, 2/20/25.

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