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

CPUC Energy Division
September 2025

Table of Contents

1. Document Purpose

Resource-to-busbar mapping ("busbar mapping") is the process of refining the geographically coarse portfolios produced in the California Public Utilities Commission's (CPUC) Integrated Resource Plan (IRP) proceeding, into plausible network modeling locations for transmission analysis in the California Independent System Operator's (CAISO) annual Transmission Planning Process (TPP). The purpose of this methodology document is to memorialize and communicate the steps the CPUC, CAISO and California Energy Commission (CEC) will take to implement the process and provide transparency and opportunity for stakeholder comment.

The busbar mapping methodology outlined in this document is focused on achieving effective and timely busbar mapping of the utility-scale resources in IRP portfolios, which need to be adopted via a CPUC decision to be able to inform the CAISO's annual TPP.

2. Document Version History

The table below outlines the evolution of this document, listing and linking previous versions of the busbar mapping methodology. Key updates added in the current version are outlined in Section 4 below.

Version	**Revision Notes**
October 18, 2019[1]	Staff Proposal for the 2020-2021 TPP
February 21, 2020[2]	Improvements informed by stakeholder feedback on the Staff Proposal, and staff experience during implementation of the process for the 2020-2021 TPP
March 30, 2020[3]	Addition of methodology for battery resources for the 2020-2021 TPP
October 23, 2020[4]	Staff Proposal for the 2021-2022 TPP
January 7, 2021[5]	Final Methodology for the 2021-2022 TPP
August 1, 2021[6]	Staff Proposed Methodology & Assumptions

[1] https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/IRP_Busbar_Mapping-Methodology-2019-10-18.pdf

[2] ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-02-21.pdf

[3] ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-03-30.pdf

[4] https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M348/K816/348816247.PDF

[5] ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar%20Mapping%20Methodology%20for%202021-2022%20TPP_V.2021-01-07.pdf

[6] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2019-2020-irp-events-and-materials/ruling_proposed-psp.pdf

December 21, 2021[7]	Methodology for Resource-to-Busbar Mapping & Assumptions for the Annual TPP
October 5, 2022	Updates to the Methodology for the 2023-2024 TPP Ruling
January 9, 2023	Updates to the Methodology for the 2023-2024 TPP Proposed Decision[8]
July 17, 2023	Proposed Updates to the methodology to be implemented for the 2024-25 TPP[9]
October 5, 2023	Updates to the Methodology for the 2024-2025 TPP Ruling[10]
September 12, 2024	Updates to the Methodology for the 2025-2026 TPP Ruling[11]
September 29, 2025	Updates to the Methodology for the 2026-2027 TPP Ruling

3. IRP & TPP Context

Through the IRP process, the CPUC generates portfolios of electrical generation, distributed energy resources, storage, and transmission resources designed to meet the state's greenhouse gas emission reduction targets for the electric sector while minimizing cost and ensuring reliability. In order to ensure alignment between the planning and development of generation, storage, and transmission resources, where the ability to serve the grid is often interdependent, the CPUC's IRP process coordinates closely with the CAISO's TPP. The IRP process develops a resource portfolio(s) annually as a key input to the TPP base case studies, which includes a reliability base case portfolio and a policy-driven base case portfolio. The CPUC may also transmit additional resource portfolios as inputs for sensitivity studies that either provide alternative portfolio(s) that are within a reasonable range of plausible future scenarios or that gather additional transmission information for future portfolio development. These are collectively referred to as "IRP portfolios."

The IRP cycle involves developing these portfolios with RESOLVE[12], an electric sector capacity expansion model, and Load Serving Entities' (LSEs') IRP plans. Upon formal CPUC adoption of

[7] "Methodology for Resource-to-Busbar Mapping & Assumptions for the TPP" (2021). CPUC. https://files.cpuc.ca.gov/energy/modeling/Busbar%20Mapping%20Methodology%20for%20the%20TPP_V2021_12_21.pdf

[8] "Methodology for Resource-to-Busbar Mapping & Assumptions for the 23-24 TPP" (2023). CPUC. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/2023-2024-tpp-portfolios-and-modeling-assumptions/busbarmethodologyfortppv20230109.pdf

[9] "Draft Methodology for Resource-To-Busbar Mapping for the Annual TPP" (July 17, 2023), CPUC Integrated Resource Planning Group. 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/draft_mappingmethodology_07-17-23.pdf

[10] "Methodology for Resource-to-Busbar Mapping for the Annual TPP" (Oct. 5, 2023). CPUC Integrated Resource Planning Group. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/2023-2024-tpp-portfolios-and-modeling-assumptions/mapping_methodology_v10_05_23_ruling.pdf

11 "Methodology for Resource-to-Busbar Mapping for the Annual TPP" (September 12, 2024). CPUC Integrated Resource Planning Group. 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

[12] Further information on RESOLVE is available here: https://www.cpuc.ca.gov/irp/

the IRP portfolios, they are transmitted to the CAISO to be used as inputs to the TPP. The adopted IRP portfolios include a mix of existing resources, resources under development and scheduled to come online (or retire) in the near term, as well as generic future candidate resources. However, the locational specificity of the selected generic candidate resources is limited because of the geographically coarse planning zones used in IRP modeling.

In order to more accurately study the performance of the IRP portfolios at the high voltage system level, the CAISO needs to model the selected generic resources in representative sizes at specific transmission substation locations within each renewable planning zone identified in the IRP portfolios. Consequently, the selected generic resources need to be remapped outside of RESOLVE or LSEs' plans to specific busbars[13] in the transmission system before the portfolios can be transmitted to the CAISO and be considered as inputs to the TPP.

To disaggregate the selected zonal resource capacities and allocate to specific busbars, CPUC staff and CEC staff translate the tabular format of the portfolios into geographic map format and consider higher resolution information about transmission infrastructure and land use. This methodology identifies the guiding principles, busbar mapping steps, and the associated criteria for conducting this process.

4. Scope of Busbar Mapping

Deep decarbonization of the electric sector to meet California's climate goals is likely to require a transformation of the state's electrical infrastructure, i.e., significant investment in solar, wind and storage, including the associated transmission. In turn, the requirements placed on planning processes, including busbar mapping, are likely to be significant due to the need to co-optimize economic, land use, transmission, and interconnection issues associated with the amount of renewables and storage needed to be online in the next decade. This will be critical for California to stay on a trajectory to achieve the state's SB 100 goal[14] of 100 percent clean electricity by 2045, as well as 80 percent below 1990 emissions by 2050.

This busbar mapping methodology is regularly updated to ensure that the co-optimization issues identified above are fully incorporated in the busbar mapping methodology in time to inform annual TPP modeling.

Further, the methodology is focused on resources within CAISO and other Californian Balancing Authority Areas (BAA) selected to serve CPUC IRP jurisdictional LSEs. Selected resources outside CAISO and other Californian BAAs are represented at CAISO boundaries so that their in-CAISO effects can be studied in the TPP.

The methodology outlined in this document builds on the previous methodologies listed in Section 2 and takes into consideration stakeholder feedback. This methodology for mapping resources in IRP portfolios will serve as a living document for continued use in the annual TPP and other

[13] "Busbar" and "substation" are used interchangeably in this document. A busbar, a specific connection point within a substation, is the more accurate term. The mapping process need only identify the applicable substation to connect a resource, so long as the availability of a feasible busbar there has been considered.
[14] Detailed at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

resource mapping efforts as needed. The document will be updated to incorporate changes or improvements as needed at appropriate junctures of future cycles.

This version of the methodology includes the following changes compared to the last released version, Updates to the Methodology for the 2025-2026 TPP Ruling (released September 12, 2024):

- Integrated PTO feedback and per-unit cost guide data to estimate the economic feasibility to interconnect at individual busbars. PTOs provide interconnection data and feedback on existing headroom (pre-TPD allocation); number or available interconnection positions and upgrade condition; and available area within the fence line; The additions are initially used for a subset of busbars that have high demonstrated commercial interest, and/or have had large mapped totals from previous TPPs, in order to estimate interconnection cost for each busbar as a function of PTO, tie-in voltage, and feasibility.
- Replaced the High Fire Threat Districts[15] with the 2024 USFS Wildfire Hazard Potential map[16] and classified USFS fire threat data into consistent low/medium/high bins to align with the busbar mapping criteria alignment levels of 1-5.
- Updated methodology and land-use and environmental criteria that inform environmental evaluation
- Extended the CEC Protected Area Layer (PAL) to cover in-CAISO regions in western Arizona and southern Nevada. Clarified how interconnection queue data from neighboring balancing area authorities is used to estimate commercial interest.
- Updates to the non-retention logic for gas capacity located within a disadvantaged community, and for generators without any local effectiveness factor data from the CAISO Local Capacity Technical Report.
- Adjustments to transmission capability criteria in mapping to Local Capacity Requirement (LCR) areas to first prioritize existing gas capacity that is the primary resource displaced
- Minor grammar, syntax, and clarifying corrections.

5. Guiding Principles

The following principles are intended to guide the busbar mapping process. Later sections of this document detail how to implement these principles, and criteria with which to assess whether the implementation is effective.

- The more granular resource and transmission cost, land use, environmental impact, and interconnection optimization done in the busbar mapping process should align with CPUC policy requirements, maintain reliability, and minimize cost to ratepayers. To the extent practical and feasible with the aforementioned criteria, busbar allocation should be consistent with the higher-level optimization that occurs during the IRP portfolio development process.
- Busbar allocations should, to the extent possible, reflect state-level land use and environmental planning priorities. Additionally, allocations should seek to reduce reliance on greenhouse gas and air pollutant emitting fossil-fueled resources, particularly to reduce or eliminate their impacts to historically burdened communities.

15 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M162/K550/162550016.PDF
16 https://www.fs.usda.gov/rds/archive/catalog/RDS-2020-0016-2

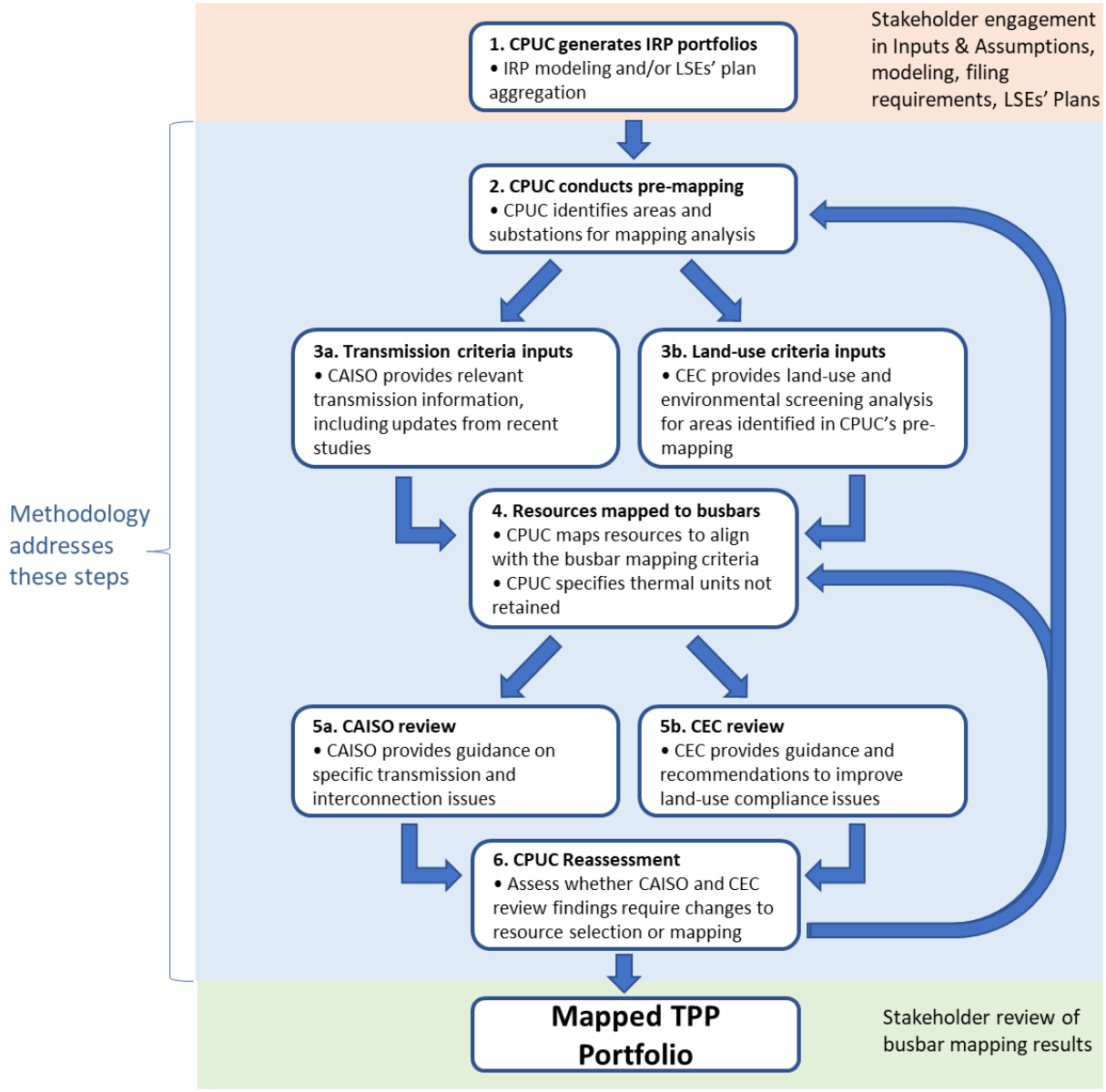
- Busbar allocations should generally reflect the expected outcome of LSE procurement activity in response to policy requirements, maintaining reliability, and minimizing cost to ratepayers. This is achieved by observing to the extent practical and feasible the planned procurement indicated in LSEs' plans and the level of commercial interest in the CAISO and other relevant interconnection queues.
- The allocations should strive to minimize transmission congestion and potential increases in costs to ratepayers by respecting transmission constraint limits[17] and utilizing only identified transmission upgrades demonstrated to be cost-effective for ratepayers or necessary to achieve policy or reliability requirements. The allocations should minimize local congestion and overloads, where known, understanding that these are typically addressed through local transmission upgrades, and seek to improve reliability and reduce opportunities for market power in load pockets.
- A successful busbar mapping process should result in IRP portfolios that minimize post processing in the CAISO's TPP.
- Consistency with prior year mapping results for equivalent TPP cases is important to the IRP and TPP processes. 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. Where significant changes are proposed in the resource mapping from one year to the next, these should be explicitly justified.

[17] Further described in the CAISO's July 2023 White Paper "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" available at: https://www.caiso.com/Documents/Presentation-UpdatedTransmissionCapabilityEstimates-use-CPUCsResourcePlanningProcess-Jul5-2023.pdf

6. High-level Busbar Mapping Steps

The busbar mapping process is completed through a sequenced transfer of information between the CPUC, CEC, and CAISO. It is an iterative process, as demonstrated by Figure 1.

Figure 1. Flowchart of the busbar mapping process



7. Detailed Busbar Mapping Steps

The busbar mapping effort follows this sequence of steps and information transfers between CPUC, CEC, and CAISO staff:

Step 1 - Draft portfolio(s) generated and shared with CEC and CAISO staff (CPUC).

Step 2 – CPUC staff lead the pre-mapping effort, identifying potential substations and potential transmission upgrades for mapping analysis based on the RESOLVE results (CPUC).

Step 3 – CEC and CAISO staff provide analysis and information necessary for mapping and criteria analysis.

- Step 3a - Detailed transmission and substation interconnection information is analyzed and provided by the CAISO staff and the Participating Transmission Owners (PTOs) for transmission and interconnection related criteria. (CAISO)
- Step 3b - Land-use and other environmental screens are analyzed and provided by CEC staff for use in land-use and environmental related criteria. (CEC)

Step 4 – Using the criteria information provided by CAISO (Step 3a) and CEC (Step 3b), staff map the portfolio resources to busbars and conduct criteria alignment analysis. (CPUC)

- In this step, CPUC staff also communicates assumptions made on which thermal units are not retained (see Section 9 Thermal Generator Retirement Assumptions).

Step 5 – CAISO and CEC staff review, provide guidance, and make recommendations on potential improvements or mapping adjustments.

- Step 5a – CAISO staff review the mapping results and provide specific guidance and recommendations on transmission and interconnection related concerns. (CAISO)
- Step 5b – CEC staff review the mapping results and provide specific guidance and recommendations on land-use related concerns. (CEC)

Step 6 – CPUC staff review CAISO and CEC staff's feedback and the mapped resources criteria alignment to determine if additional adjustments are necessary. If changes are needed to improve criteria alignment, staff begin a new round of mapping at Step 4 or, if additional information is required, Step 2. (CPUC)

Step 7 – Mapped IRP portfolio(s) formally transmitted to the CAISO. (CPUC)

In previous mapping iterations, staff utilized separate processes for mapping renewable generation and battery storage. These efforts have been combined, and the discussion of each step below represents the mapping of both battery and non-battery resources.

<u>CPUC – Step #1</u>

The CPUC staff will utilize and provide to CEC and CAISO staff the following materials for the annual busbar mapping process:

- IRP portfolios generated by RESOLVE and/or resulting from the aggregation of LSEs' plans, as applicable.
    - New Baseline resources: megawatts (MW), by unit, by location.

        - This information will identify new resources, including their point of interconnection, that have recently come online or are contracted and in-development resources which are included in the IRP modeling baseline but were not included in calculating the most recent CAISO transmission capability limits.
    - In-development, recently online and LSE-planned resources not included in IRP modeling baseline: MW, by resource type, by location.
        - This information will identify recently online resources not included in the modeling baseline whose locations need to be accounted for in the mapping results.
        - This will also identify LSE-contracted resources and other in-development resources that were also not captured in the modeling baseline.
        - Contracted and in-development resources included in this information identified as out-of-CAISO and needing Maximum Import Capability (MIC), both their locations and LSE-noted or proposed CAISO intertie point.
    - Selected generic new resources: MW, by resource type, location, and applicable transmission constraints.[18]
    - Resource potential estimates (geographic information system (GIS) data format – polygons and associated attribute tables) to give the CEC further information about the selected resources.[19]

Stakeholder participation:

- Stakeholders will be provided an opportunity to comment on the RESOLVE inputs and assumptions, RESOLVE functionality, and the proposed portfolios for busbar mapping.
- Stakeholders will be provided opportunities to comment on this busbar mapping methodology. Further, stakeholder feedback during TPP may demonstrate the opportunity to better fulfill the guiding principles outlined in this document. Small changes to allocations may be made during TPP at CAISO staff's discretion in coordination with the CPUC.

<u>CPUC – Step #2</u>

[18] For example, see Excel-based Results Viewer available as part of the 25-26 Transmission Planning Process Ruling and Ruling Development Materials RESOLVE Package analysis zip file, dated September12, 2024. https://files.cpuc.ca.gov/energy/modeling/LTPP/Final%20TPP%2025-26%20RESOLVE%20Package.zip

[19] For example, see the CEC 2023 Land-Use Screens for Electric System Planning GIS Data visualization tool: https://www.energy.ca.gov/data-reports/california-energy-planning-library/land-use-screens/cec-2023-land-use-screens-electric

For resources included in the portfolio, CPUC staff will conduct pre-mapping analysis to provide substation level granularity for the CEC and CAISO to conduct the criteria analysis necessary for the mapping process. Staff will do the following:

- Identify candidate substations for potential resource mapping and the potential resources and MW amounts that may be mapped to them. This exercise utilizes the RESOLVE modeling results and/or LSE plans and alignment with transmission capability limits, commercial development interests, and consistency with previous TPP's mapping criteria (See Section 8 for detailed criteria descriptions) to identify candidate substations and potential MW amounts to map to those substations.
- Identify transmission upgrades triggered in RESOLVE and additional potential upgrades through preliminary analysis considering additional information not included in RESOLVE capacity expansion analysis.[20]
- Transmit the substation information and the identified potential resource types and MW amounts to CEC staff to conduct its land-use and environmental mapping analysis and to CAISO staff to obtain additional transmission and interconnection information for these substations.

CPUC staff will identify the candidate substations from a set of available substations, including those that are planned and approved. Available substations include substations outside of the CAISO, both in other Californian (Balancing Area Authorities) BAAs and out-of-state BAAs. For resources mapped to out-of-CAISO substations, staff will also identify both the probable interconnection point outside of the CAISO and the likely intertie/scheduling point with the CAISO system. For resources mapped to areas not near planned or existing system-level transmission infrastructure or requiring new or upgraded interconnection points, CPUC staff may assume new or upgraded substations/buses in an approximate location and consult with CAISO staff in subsequent steps to identify probable existing system tie-in points and transmission needs.

A subset of total available substations is considered when mapping the portfolios. This subset of substations is created using the following methodology to identify substations:

- Geographic Information System (GIS) datasets for California substations are combined with the GIS data set for U.S. substations to help identify available substations for out-of-state resources.[21]
- The combined set of substations is queried to select substations that meet any of the criteria:
    - Included in the transmission capability and constraint information available from CAISO, adjusted to account for newly added baseline resources not included in the baseline used by CAISO to establish the transmission limits.

[20] For example, see Excel-based Results Viewer, available as part of the 25-26 Transmission Planning Process Ruling and Ruling Development Materials RESOLVE Package analysis zip file, dated September 12, 2024. https://files.cpuc.ca.gov/energy/modeling/LTPP/Final%20TPP%2025-26%20RESOLVE%20Package.zip

[21] Data originally downloaded at https://data.ca.gov/dataset/california-electric-substation2 for California substations and https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-substations for US substations. Datasets have subsequently been unavailable over security concerns.

Transmission capability estimates are additionally adjusted to account for transmission upgrades which have already been approved.

- Have location information (GIS data) available from CEC, U.S. Homeland Infrastructure Foundation-Level Data (HIFLD), or other source.
- Identified as currently operational or planned.
- Identified as having both multiple buses and bus voltages of 115 kV and above; except in cases of remote resources where the only available buses are of lower voltages.
- Identified in CAISO interconnection queue. In some situations, when queue projects are listed as interconnecting to substations not currently included in the candidate substations set, staff may identify the nearest linked substation already in the set as the point of commercial interest.
- Identified in project documents for new, approved powerline projects are examined to identify the mapped locations of proposed substations and they are hand-digitized to add them to the available substation dataset.

CAISO – Step #3A

CAISO staff will provide detailed system-level transmission constraint and upgrade information. Additionally, CAISO and CPUC staff will engage with key Participating Transmission Owners (PTOs) to obtain substation-specific interconnection and upgrade cost information. CPUC will work with both CAISO staff and PTO staff to obtain updated data commercial development interest and in-development projects.

- CAISO staff will provide relevant system-level transmission capability and transmission upgrade data as well as transmission constraint areas information. Key data includes:
  - CAISO White Paper on Transmission Capability Estimates for use in the CPUC's Resource Planning Process[22], which provide transmission capability estimates for on-peak and off-peak deliverability; estimated costs, construction times, and additional MW capacity of identified transmission upgrades, and descriptions of the transmission constraint areas.
  - CAISO staff guidance on additional substation inclusions in the various transmission constraint areas.
  - If data is available, estimates of the impacts to the relevant transmission constraints due to upgrades identified and approved in previous TPPs but not included in the White Paper.
  - Relevant information and data from Local Capacity Requirement studies and other CAISO studies that are utilized in the busbar mapping criteria analysis.

[22] "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" (2024). CAISO https://www.caiso.com/library/transmission-capability-estimate-inputs-for-cpuc-integrated-resource-plan-aug-29-2024

- CPUC and CAISO staff will engage with the PTOs to obtain substation level interconnection availability and feasibility information for key substations identified in the CPUC staff's pre-mapping work. If the information can be provided, staff will seek the following from PTOs to inform mapping criteria analysis:
    - Additional cost estimates for interconnecting resources to the PTOs substations under a variety of interconnection conditions.
    - Substation-level data on the number of available positions for interconnections and possible upgrades to enable additional interconnections, including their scope, complexity, and potential costs.
    - Substation-level data on factors that could limit interconnections such as fault duty limits or physical infrastructure constraints.
- CPUC will work with CAISO staff and submit requests to PTOs to gather updated data on the interconnection queue and in-development resources, including:
    - Updated CAISO interconnection queue information and Transmission Plan Deliverability (TPD) allocations.
    - Additional data in-development or under construction projects data that are not included in the existing resource baseline or in CPUC staffs existing dataset of in-development resources.
    - Additional information on out-of-CAISO resources requiring MIC and their likely intertie/scheduling points.

Stakeholder participation:

- The CAISO has its own stakeholder process for the development of the transmission capability information provided to the CPUC through its White Paper on transmission capability estimates[23].
- Information provided by CAISO staff and the PTOs, if not determined to be confidential, will be reported in the mapping results and/or in the CPUC's report.
- Stakeholders will be provided opportunities to comment on this busbar mapping methodology and to review the mapped resource portfolios.

<u>CEC – Step #3B</u>

CEC staff will develop the land-use and environmental implications information necessary to conduct busbar mapping criteria analysis. CEC staff will assess land-use and environmental implications for the resource technologies at the substations and in the regions identified by CPUC staff in the pre-mapping effort (Step #2) utilizing the following methodology.

- CEC staff will utilize their land use screens and additional screening datasets (see Section 8 for information on the specific data incorporated into the mapping criteria) to identify the potential environmental and land use implications of the portfolio's

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

renewable resources. Screens will be applied using the approaches described in the CEC's *Land-Use Screens for Electric System Planning* Commission Report[24] (Land-Use Screens Report).

- CEC and CPUC staff will establish several radii around each identified substation and potential resource mapping area to guide CEC's analysis (see Section 8 for specific mile distances used in criteria analysis) for solar and wind. Staff will also establish specific analysis guidance for each resource type. The CEC's Land-Use Screens Report outlines the unique approaches for assessing the land-use and environmental implications of solar, onshore wind, and geothermal resources in the state of California.
- CEC staff will apply the land-use and environmental screens to the resource potential estimates within the established radii for the candidate substations. Using GIS modeling and analysis, CEC staff will derive estimated resource potential acreages within the various land-use and environmental implication factors for each substation.
- Several datasets CEC staff will use for land-use and environmental analysis are limited to the state of California. Since the portfolios may include resources out of state (such as western Arizona and southern Nevada), staff expands the PAL for these regions in Arizona and Nevada from the same nationally available datasets as in-state (Protected Areas Database of the United States and Bureau of Land Management). Lower implication land continues to be defined as the remaining areas with Western Electricity Coordinating Council (WECC) Risk Category 2.
- CEC staff will develop a spreadsheet to report the results of their land use analysis. It will include acreage amounts and estimated MW amounts of resource potential by substation under the various land-use and environmental analysis implications levels, as well as the percentage of potential resource area around each substation that falls under the various screens' implication levels. It will include details of the specific methodology applied if changes or updates were made, and any notes needed to interpret and understand the allocation outputs. Reported results will enable application of the criteria alignment thresholds (outlined in the Busbar Mapping Criteria Section 8) by CPUC staff in Step #4.
    - CEC and CPUC staff will use fixed power density assumptions for the solar and wind to estimate potential MW values from the resource potential acreage. Staff use a 40 acres/MW assumption for onshore wind resources and use a 10 acres/MW assumption for utility-scale solar.[25] In both cases, these values represent a conservative density assumption beyond the direct infrastructure footprints themselves, incorporating both indirect impacts of the resource

[24] Hossainzadeh, Saffia, Erica Brand, Travis David, and Gabriel Blossom. 2023. *Land-Use Screens for Electric System Planning: Using Geographic Information Systems to Model Opportunities and Constraints for Renewable Resource Technical Potential in California.* California Energy Commission.
https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-SIT-01

[25]Based on feedback from stakeholders including comments submitted to the CEC in the development of the Land-Use Screens for Electric System Planning Commission Report.
https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-SIT-01.

deployment and the implications for conflicting land uses. Staff recognize that the actual land impact for individual projects may vary from these default alues and could consider modifying these assumptions during busbar mapping, on a case-by-case basis, to improve alignment with other criteria.

Stakeholder participation:

- In developing the *Land-Use Screens for Electric System Planning* Commission Report, CEC staff led an in-depth stakeholder engage process to receive input and recommendations in developing and implementing the key land-use and environmental screen utilized in busbar mapping.[26] The data inputs into these screens were updated.; a full list of updated data sources is available on Slide 68 of the August 19, 2025 Modeling Advisory Group Webinar slide deck[27].
- The CEC's analysis results will be reported in the mapping results and/or in the CPUC's report.
- Stakeholders will be provided opportunities to comment on this busbar mapping methodology and to review the mapped resource portfolios.

CPUC – Step #4

Using the transmission and interconnection information provided by CAISO staff and PTOs (Step #3a), and the land-use and environmental analysis information provided by the CEC (Step #3b), CPUC staff will map the portfolio resources, both generation and storage, to substations using the busbar mapping criteria, described in the Section 8. In mapping the resources to busbar, CPUC staff will do the following:

- CPUC staff will map the portfolio resources, both generation and storage, using the information and analysis from Steps #2 and #3. In doing so, staff apply the criteria thresholds detailed in Section 8 seeking to maximize the mapped resources' alignment with the criteria and minimize major non-compliances.
- CPUC staff will utilize the information provided by CEC staff in Step #3b to assess mapped solar, onshore wind, and geothermal resources calculate alignment with the land-use, environmental, and distance to transmission criteria.
- CPUC staff will use the transmission and substation interconnection information provided by CAISO staff and obtained from the PTOs in Step #3a to perform the criteria alignment analysis for the system level transmission capability and substation level interconnection viability criteria.
- CPUC staff will utilize the CAISO interconnection queues, queues from the PTOs, other Balancing Authority Areas queues, and additional development information to analyze mapped resources alignment with the Commercial Development interest criteria.

[26] Commissioner Workshop on Land Use Screens. Hosted March 13, 2023, by California Energy Commission. https://www.energy.ca.gov/event/workshop/2023-03/commissioner-workshop-land-use-screens

27 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-2026-2027-tpp/final_2025_busbar_mappingmag_presentation_cec.pdf

- Due to limitations of the data and analysis, land-use and environmental criteria analyses are not applied to storage resources, except likely pumped storage hydro locations, and some renewable generation categories including biomass/biogas, distributed solar, out-of-state wind on new transmission, and offshore wind. CPUC staff still apply the other criteria to these resources and use the following additional resource specific approaches:
    - Biomass or Biogas – Allocation of the biomass/biogas resources to substations prioritizes proximity to biomass or biogas energy resource areas. Biomass/biogas energy resources areas are identified as regions with high energy potential for forest biomass, agricultural biomass and dairy biogas, and municipal waste biogas.[28] Staff will apply specific analysis under the Community and environmental (societal) impact factors criteria (See Section 8) to the mapping of biomass/biogas resources.
    - Distributed Solar – This resource represents in-front of the meter solar resources less than a few MWs in size, corresponding to commercial-scale rooftop solar and community solar). Resource potential is assessed based on resources identified in LSE plans and potential projects in the interconnection queues of the lower voltage transmission systems.[29] These resources are mapped to the nearest CAISO system level substation or the likely CAISO system interconnection point.
    - Offshore Wind – Allocation of offshore wind resources prioritizes existing offshore wind energy areas and considers identified potential future offshore wind areas utilizing information from the CEC AB 525 study work[30] and continuing research by the National Renewable Energy Lab (NREL).
    - Pumped Storage Hydro – For locations with identified pumped storage hydro potential which could serve as the resources for mapped long-duration storage, staff will conduct tailored environmental criteria analysis described in Section 8, which includes portions of the environmental criteria applied for renewable resources and some additional datasets.
- CPUC staff, using the process established in the Thermal Generator Retirement Assumptions in Section 9 will identify thermal generation units not retained and should be assumed as offline for the transmission planning process.
- For resources mapped to locations outside of the CAISO's balancing area, CPUC staff will identify their out-of-CAISO locations and likely CAISO intertie point. Staff will identify the resources as utilizing existing Maximum Import Capability (MIC) or requiring expanding the MIC at the specified intertie. In the latter case, staff will account for the resource within the appropriate CAISO transmission constraints and

[28] CPUC staff utilized information from the California Air Resources Board's 2015 Assessment of the Emissions and Energy Impacts of Biomass and Biogas Use in California (LINK) and CEC's PIER Program's 2013 Biomass Energy in California's Future: Barriers, Opportunities, and Research Needs Report (LINK)
[29] CPUC staff utilized the Wholesale Distribution Access Tariff interconnection queues for PG&E, SCE, and SDG&E.
[30] AB 525 Reports: Offshore Renewable Energy. California Energy Commission. Website: https://www.energy.ca.gov/data-reports/reports/ab-525-reports-offshore-renewable-energy

request the CAISO study the resources as MIC expanding in the TPP. Staff will incorporate feedback and recommendations from CAISO staff provided in Step #3A on any additional out-of-CAISO resources seeking MIC and probable intertie locations.

- For resources mapped to locations far from existing system-level transmission or identified as likely needed new or upgraded interconnection points, CPUC staff will work to identify the probable interties and transmission needed to interconnect to the existing system.
- CPUC staff will develop dashboard workbooks for each portfolio to summarize the mapping results and their alignment with the busbar mapping criteria. The dashboard workbooks will also calculate the estimated transmission constraints capability utilization, identify where transmission exceedances occur, and note which transmission upgrades could alleviate the exceedances.

CPUC staff will transmit the portfolio dashboards to CEC and CAISO staff for review in Step #5. Staff will highlight non-compliant resources and alignment issues and identify areas where CEC and CAISO should provide additional information to potentially improve the mapping.

Stakeholder participation:

- Stakeholders will be provided opportunities to comment on this busbar mapping methodology and to review the mapped resource portfolios. Further, stakeholders' feedback during TPP may demonstrate the opportunity to better fulfill the guiding principles outlined in this document. Small changes to allocations may be made during TPP at CAISO staff's discretion.

CAISO – Step #5a

Upon receipt of the review request and the dashboard workbooks from CPUC, CAISO staff will seek to provide the following:

- A high-level review of the draft busbar allocations and the conceptual transmission upgrades that the mapping determined are likely to be required based on the mapping including:
  - Input on any specific transmission issues encountered during the mapping process.
  - Additional information on interconnection feasibility, including electrical suitability and physical space availability at each substation, if this information is available from the transmission owner.
  - New transmission information from ongoing TPP and GIDAP studies.
- Additional feedback on the mapped out-of-CAISO resources, their identified interconnections and MIC implications and if alternative intertie points would be more feasible.
- Feedback on the interconnection assumptions and interties identified for resources mapped to locations without existing transmission or requiring new or upgraded interconnection points.
- If CPUC staff map portfolio resources to substations in BAAs other than the CAISO, then the CAISO staff may consult appropriate planning entities during the resource modeling phase of TPP. These planning entities may recommend adjustments to locations and size of

resources mapped in their BAAs. In such cases, the CAISO will consult the CPUC and CEC staff before incorporating any subsequent busbar allocation changes to the portfolios. Staff will engage with TPP stakeholders and/or IRP stakeholders if the changes may result in a materially different transmission outcome, in terms of constraints or upgrades. All changes will be publicly documented.

- Observations, problems encountered, and recommended portfolio modifications that might be needed.

CEC– Step #5b

Upon receipt of the review request and the dashboard workbook from CPUC, CEC staff will seek to provide the following:

- Specific guidance on any land-use related concerns from the mapping results.
    - Particularly locations where mapped resources exceedance of land-use or environmental impact implications thresholds may be a particular issue.
- Recommendations for remapping options that address any raised concerns with the mapped resources non-alignment with the land-use and environmental impact criteria.

Stakeholder participation:

- Stakeholders will be provided opportunities to comment on this busbar mapping methodology and to review the mapped resource portfolios. Further, stakeholders' feedback during TPP may demonstrate the opportunity to better fulfill the guiding principles outlined in this document. Small changes to allocations may be made during TPP at the CAISO staff's discretion.
- The CEC and CAISO staff's observations and any recommended modifications to identified transmission upgrades from Steps #5a and #5b will be reported in the mapping results and/or in the CPUC's report.

CPUC Step #6

CPUC staff will review the analysis by CEC staff (Step #5b), as well as observations and recommendations from CAISO staff. (Step #5a) Using the busbar mapping criteria, described in the Section 8 and the resulting portfolio dashboards developed in Step #4, CPUC staff will determine whether the mapping results are ready to be transmitted to the CAISO for TPP, or require a further round of mapping. Resource selections with multiple high priority criteria violations will be considered for adjustments or further rounds of mapping.

If a further round of mapping is required, CPUC staff may reallocate resources between transmission constraint areas. Such changes should not result in material changes to the expected cost, reliability or emissions performance of the portfolio. Depending on the extent of mapping adjusted required, CPUC staff may seek additional input information for the criteria analysis beginning the round of remapping at Step #2. If relatively minor adjustments are required, CPUC staff may only utilize the criteria information already provided and begin the next round at Step #4. Staff will update the dashboard workbooks for each portfolio to track the mapping changes and to reflect the resulting changes to the criteria alignment.

CPUC Step #7

If the busbar mapping working group determines no further rounds of mapping adjustments are needed in Step #6, the mapping results are ready to be transmitted to the CAISO for the TPP. Working group staff will finalize the dashboard workbooks for each portfolio and a final staff report summarizing the mapping results and the mapping process for public release. Mapped portfolios will be adopted and transmitted to the CAISO through a CPUC Decision.

8. Busbar Mapping Criteria and Implementation

Busbar Mapping Criteria

The busbar mapping process should result in plausible network modeling locations for the portfolios, assuming the portfolios do not violate predetermined busbar mapping criteria. If the busbar mapping results in any of the criteria not being met, then the violation(s) would require interagency discussion and potentially necessitate the remapping of portfolio resources. The busbar mapping criteria, the guiding principles around the criteria, and the datasets and analytical approach for the criteria are as follows:

- System level transmission capability
    - Selected resource allocation to a given busbar should abide by all the estimated system level transmission constraints that apply to that busbar, triggering only those upgrades which are determined to be cost-effective or necessary to meet policy and reliability requirements. Mapped resources should also utilize existing transmission and selected upgrades optimally and cost-effectively and seek to limit congestion, improve dispatch in locally constrained areas, and co-locate with compatible resources when possible.
    - Transmission capability limits for both CAISO's estimated Full Capacity Deliverability Status Capability (FCDS) and the estimated Energy Only Deliverability Status Capability (EODS) of identified transmission constraints, the information on previously identified transmission upgrades, and the resource specific output factor assumptions for resources' transmission capability utilization are sourced from the most recent version of the CAISO's white paper – Transmission Capability Estimates for use in the CPUC's Resource Planning Process[31] and the results of the most recently completed TPP Report[32]. Staff will also incorporate updated constraint and upgrade information identified in ongoing TPP and GIDAP studies provided by CAISO staff through working group communications.
    - Information on locally constrained areas is sourced from the CAISO's analysis of LCR areas using the CAISO's Local Capacity Technical study results. One key dataset particularly for mapping battery storage resources is the results showing the level of 4-hour battery storage that can provide both system and local capacity value within each LCR area. Mapping stand-alone storage up to the CAISO identified limits, renewable resources, and co-located storage to LCR areas will be prioritized particularly in areas where such mapping would aid in the displacing of existing fossil fuel resources.

31 White Paper – 2024 Transmission Capability Estimates for use in the CPUC's Resource Planning Process: Link for the most recent White Paper, https://www.caiso.com/library/transmission-capability-estimate-inputs-for-cpuc-integrated-resource-plan-aug-29-2024, posted on 8/29/2024.
32 Most recent CAISO Board approve report: 2024-2025 Transmission Plan, https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/2024-2025-Transmission-planning-process

- Staff will seek to limit mapping large amounts of renewable generation to areas with high renewable curtailment without co-locating storage resources or identifying cost-effective transmission upgrades. Co-locating storage with renewable generation is a transmission criteria mapping priority, as it enables complementary utilization of the CAISO identified transmission capability.
- If mapped resources result in a transmission constraint capability exceedance and the CAISO identified upgrade is assessed to not be cost effective or there is no identified upgrade, then these issues will be flagged and addressed in a further round of mapping. Staff may seek to reallocate resources to other areas with substations that have spare transmission capability or more cost-effective upgrades.
- Busbar mapping process may map resources to an existing or planned substation that mapping analysis shows would trigger a transmission upgrade that has not been previously studied or identified by the CAISO. Such resources will be highlighted, and CAISO staff input will be sought per Step #3, with assumptions and implications documented. During the TPP that follows, the specific assumed interconnection and transmission solutions for those resources should be tested.

- Substation level interconnection viability
  - Mapped candidate resources should fall within a viable distance of transmission, considering economic, land-use, and environmental perspectives, and be able to interconnect to transmission of an appropriate voltage in a viable and cost-effective manner.
  - Interconnection viability criteria analysis is divided into three aspects:
    - Viable distance to transmission – The resource interconnection path should be viable from an economic perspective, environmental and land use perspective (i.e., path that does not unreasonably cross high-environmental implication areas, water bodies, or dense urban areas), resource type perspective (i.e., longer interconnection paths may be more reasonable for wind and geothermal resources), as well as a project size and interconnecting voltage perspective (i.e., a longer gen-ties may be economically feasible for larger amounts of selected resources connecting to higher voltage transmission).
    - Interconnection to transmission of appropriate voltage – Mapped resources should interconnect to transmission voltage appropriate for the MW number of resources mapped. Staff will seek to minimize expected interconnection costs for ratepayers by limiting mapping of 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 resources without significant upgrades.
    - Accessibility and costs of interconnecting to the substation-level transmission infrastructure – Mapped resources should utilize cost-effective interconnections to the transmission system. Staff will analyze interconnection opportunities and potential upgrade costs at substations being considered for busbar allocation, considering the number of resources

being mapped and potential project sizes. Priority will be given to substations with known available open positions and cost-effective minor upgrades (e.g., in fence line bus expansion). Substations requiring more complex and costly expansions (e.g. beyond existing fence-line upgrades or configuration overhaul) will also be considered along with the potential for new substation development. Mapping to substations at or near their fault/short-circuit duty limits and substations that cannot be expanded will be limited appropriately.

- As necessary, staff will also seek to identify approximate locations and estimated costs of new substations for areas not within interconnection distance of a voltage appropriate existing substation or near substations which cannot be cost-effectively expanded to accommodate additional resource interconnections.
- Staff will also seek information from the participating transmission owners (PTO) on substations' available positions, potential need for upgrades, opportunities to expand the footprint, and additional factors that could impact interconnections. The list of substations included in this request will be those that showed mapped resource totals at or above the default capacity limit, or that indicated commercial interest totals at or above the substation's default capacity limit in previous cycles and analyses.
- Staff will interpret the feedback from the PTO to identify what upgrade is needed for mapped resources to interconnect. The exact implementation will vary depending on the level of detail provided by each PTO but will aim to follow the below categorization:
  - Short circuit duty limitation: the PTO feedback indicates that the substation is exceeding or is close to exceeding the short circuit duty limitation of the substation.
  - New substation: the PTO feedback indicates that the substation has no current or future positions available and no opportunities to expand the substation's footprint within or beyond the existing fence line.
  - Substation expansion: the PTO feedback indicates that the substation has no current or future positions available but could expand the existing footprint.
  - Additional positions: the PTO feedback indicates that the substation has limited current or future position availability with the ability to add additional positions.
  - Minimal upgrades: the PTO feedback indicates that the substation has multiple positions available and requires minor upgrades.
- In conducting this analysis, staff will utilize the CAISO's PTOs per unit cost guides[33] for upgrade cost estimates. Upgrade cost estimates will be developed for each upgrade, PTO, and substation voltage. These costs will be categorized across interconnection feasibility criteria aligned with those used throughout the mapping process.

[33] CAISO's 2025 Final Per Unit Cost Guides by PTO, http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=333D05E6-0D61-4503-BF6E-B48F24835F2E

- Staff will assign each substation an interconnection feasibility score based on the cost of the upgrade needed to interconnect additional resources at the substation.
    - Commercial interest information will be used to estimate average and likely project MW sizes to incorporate into the interconnection analysis.
    - For resources initially mapped to substations that analysis determines to not have an appropriate level of interconnection capability or require major interconnection related upgrades assessed to not be cost-effective, staff will seek to remap those resources to better-suited existing or potentially new substations.

- Land-use implications and feasibility
    - Resources allocated should not exceed available land area to accommodate the resources within the viable distance of the substation and should limit the potential implications, i.e., potential impacts to or conflicts with existing and future land use applications. Mapping will prioritize areas of lower potential land-use implications and higher feasibility for resource development, while seeking to limiting locating resources to areas of high potential implications and likely more difficult development potential.
    - Staff will incorporate the following geospatial datasets and analysis for the land use feasibility criteria:
        - CEC's Core Land-use Screen – This land-use screen addresses several state policy priorities, including sustaining agriculture and protecting natural lands that support biodiversity. CEC staff developed this screen by incorporating geospatial analyses representing land-use planning considerations related to biodiversity, croplands, landscape intactness, and terrestrial climate resilience on top of a base exclusion layer consisting of technical-economic exclusions and administratively protected areas. The details of this screen and its development are found in the CEC's Land-Use Screens Report. Mapped resources should avoid areas of high potential implications as identified by this screen or fulling utilizing the low potential implication area. Staff seek to prioritize resource mapping that utilizes only a limited portion of the low potential implications area within the identified distance of the selected substation.
        - Parcelization – CEC staff have developed and updated a parcelization dataset that assesses the level of fragmentation of land that could be used for developing renewable energy resources. The assessment considers the average number of unique parcels within 0.5 miles of any point (using a 90-meter resolution grid) within a given parcel boundary. In 2025, the parcel datasets were updated to the most recent publicly available parcel data from individual counties. An area of many small parcels has high parcelization while an area of fewer large parcels has low parcelization. Priority will be given to low parcelization areas due to their higher commercial development attractiveness, both in terms of fewer landowners for the generation site, and fewer landowners for the interconnection path route to the substation. However, it should be noted that current solar development indicates that development is possible on a moderate amount of parcelization. Therefore,

these areas will not be excluded. Mapped resources should seek to avoid mapping to areas of high parcelization. The details of this screen and its development are found in the CEC's Report on parcelization.[34]

- CEC's Cropland Index Model – This model developed and updated by CEC staff as part of the CEC's Land-Use Screens Report evaluates land used to produce crops using several datasets. The index model identifies cropland with higher and lower implications to screen out areas with more factors that support high-value cropland. In identifying substations for resources, staff seek to prioritize mapping to areas in the lower potential implications category. Staff do not seek to exclude mapping resources to areas of higher implications, noting that such lands may still be suitable and attractive for development particularly in areas facing significant water scarcity as identified by the next dataset. Staff will apply the Cropland Index Model analysis to the mapping of utility-scale solar resources but not onshore wind resources.
- Critically Overdrafted Ground Water Basins[35] – Groundwater basins subjected to critical overdraft as defined by the Sustainable Groundwater management Act (SGMA)[36] and identified by the California Department of Water Resources. Within critically overdraft basins, local management agencies are charged with achieving groundwater sustainability through integrated land-use planning and repurposing agricultural lands to less water intensive uses, one of which is clean energy development. When mapping solar resources, staff seek to prioritize mapping to areas within a critically overdrafted basin; however, staff are not seeking to limit mapping to areas that are not in critical overdraft.
- High Fire Threat – The U.S. Department of Agriculture Forest Service (USFS) maintains national wildfire hazard datasets of annual burn probability and fire intensity; the 2nd edition of the USFS Fire Hazard Map was published in 2024.[37] When mapping resources, staff will seek to limit mapping resources to and corresponding potential transmission upgrades in areas with elevated annual burn probability.

- The geospatial analysis methods used to create CEC's Core Land-use Screen and CEC's Cropland Index Model are described in the CEC's Land Use Screens Report, while the Parcelization Staff Report outlines the creation of the parcelization dataset. Input datasets to the creation of these products are updated to the most recent version, if available.

---

[34] Hossainzadeh, Saffia, Raechel Damiani, Gabriel Blossom. 2024. Calculating Parcelization for Electric System Planning. California Energy Commission. Publication Number: CEC-700- 2023-007-SF. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-MISC-03

[35] "Critically Overdrafted Basins" (2020). California Department of Water Resources. https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins

[36] "Overview of the Sustainable Groundwater Management Act (SGMA)." California Department of Water Resources. https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management

[37] Scott, J. H., et. al. "Wildfire Risk to Communities: Spatial datasets of landscape-wide wildfire risk components for the United States (2nd Edition)," Forest Service Research Data Archive. https://www.fs.usda.gov/rds/archive/catalog/RDS-2020-0016-2.

- Staff will seek to identify areas not within interconnection distances of existing substations that have very low implications and very favorable criteria alignment to assess the potential and cost-effectiveness of mapping resources to a proposed new substation in the location.
- If the available land area is insufficient to accommodate selected resources within reasonable distance to the substation, or if the resources have high potential implications, then these issues will be flagged and addressed in a further round of mapping. Possible solutions may include remapping the resources to other more favorable substations, or if the amount of resources mapped can cost-effectively interconnect from a further distance, reconduct the land use analysis with a larger radius that still aligns with the interconnection viability criteria.

- Environmental (conservation and biological) impact factors
  - The overall purpose of this criteria is a more detailed breakdown of several datasets utilized in the CEC's Core Land-use Screen to identify high implications for conservation and biological diversity planning priorities. Resources mapped should not exceed the amount of lower potential implications areas of the conservation and biological diversity datasets. Mapping will prioritize resources amounts that utilize only a certain percentage of the lower potential implication areas to avoid potential development impacts to areas of higher potential implications.
  - Staff incorporates the following geospatial datasets and analysis for the conservation and biological environmental impact factors:
    - California Department of Fish and Wildlife's (CDFW's) Areas of Conservation Emphasis (ACE) Terrestrial Connectivity[38], Biodiversity[39], and Irreplaceability.[40] These three datasets represent the states biological diversity planning priorities. In mapping resources, staff seek to avoid mapping to areas of high implication for each of these datasets represented by ranks 4 and 5 for ACE Connectivity, rank 5 in ACE Biodiversity, and ranks 4 and 5 for ACE Irreplaceability and prioritizing mapping resource amounts that utilize only a limited percentage of the lower implication area around the selected substation.
    - Terrestrial Landscape Intactness[41] – A measure of landscape condition based on the extent to which human impacts such as agriculture, urban development, natural resource extraction, and invasive species have disrupted the landscape across California developed by the Conservation Biology Institute utilizing a multicriteria evaluation model using more than 30 data

[38] "Terrestrial Connectivity" (2018). California Department of Fish and Wildlife. https://wildlife.ca.gov/Data/Analysis/Ace#523731772-connectivity
[39] "Terrestrial Biodiversity Summary" (2018). California Department of Fish and Wildlife. https://wildlife.ca.gov/Data/Analysis/Ace#523731770-species-biodiversity
[40] "Terrestrial Irreplaceability" (2018). California Department of Fish and Wildlife. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150816&inline
[41] Degagne, R., Gough, M., Heyerdahl, J., Joseph, G. 2025. Landscape Intactness Modeling for Statewide California Assessment: CAL FIRE 2025 Update. From DataBasin.org: https://databasin.org/datasets/c07f8b8acbd34ccfa53d4efefafc6f75/

layers. As with the ACE data layers, staff seek to avoid mapping to areas of high implications and prioritize mapping resource amounts that utilize only a limited percentage of the lower implication area.

- Wetlands[42] – Mapped resources should avoid impacting lands classified as wetlands and staff seek to prioritize mapping to areas that do not have large portions of the potential development land categorized as wetlands.

- As with the datasets utilized for the land-use feasibility criteria, the geospatial analysis methods used to develop these datasets are outlined in the CEC's Land-Use Screens Report.
- Staff will assess both the percentage of area of lower and higher implications that the mapped resources would potentially utilize and the net percentage of higher and lower implications resource potential area around the identified substation. Utilizing a large percentage of the available lower implication land and mapping to a location that has a large percentage of the land around the substation with higher implications can both increase the implications for potential conflicts with the alterative land uses.
- Staff will seek to remap resources that have high potential implications to substations that have more low potential implications area available or, if the amount of resources mapped can cost-effectively interconnect from a further distance, reconduct the analysis with a larger radius that still aligns with the interconnection viability criteria.
- For geothermal resources, analysis will only use regions outside of the Protected Area Layer to calculate acreages of lower and higher-implication land, instead of the entire geothermal field[43].
- For locations with identified pumped storage hydro (PSH) potential staff will incorporate analysis using the ACE Terrestrial Irreplaceability, Biodiversity, and Connectivity datasets and the Terrestrial Landscape Intactness dataset noted above and will include two additional datasets: the ACE Aquatic Rare Species Richness[44] and the ACE Aquatic Irreplaceability[45], if potential locations implicate existing aquatic areas. This analysis relies on high-level data and is meant to show the general conservation and ecological conditions of the area surrounding a potential PSH site. This evaluation is not intended to guide the siting of a generation project or assess project-level impacts. Staff is revisiting this approach due to stakeholder feedback, and intends to engage stakeholders in the future to help inform a revised approach;
- For PSH, staff will also incorporate analysis of likely water sources for the pumped storage as well as availability of existing reservoirs versus the need to build new ones either on- or off-stream. Existing reservoirs and off-stream locations are assessed as

[42] "Habitat and Land Cover (FVEG Derived)" (2022) CA Nature. https://www.californianature.ca.gov/maps/habitat-and-land-cover-fveg-derived
43 https://cecgis-caenergy.opendata.arcgis.com/datasets/CAEnergy::geothermal-resource-potential-by-field/about
[44] "Aquatic Rare Species Richness" (2018). California Department of Fish and Wildlife. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150853&inline
[45] "Aquatic Irreplaceability" (2018). California Department of Fish and Wildlife. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150854&inline

generally having lower potential implications than the creations of new reservoirs and on-stream locations. With respect to water sources, the use of existing reservoir-stored water and groundwater from low overdraft potential basins is assessed as generally have lower potential implications than use of new sources from natural bodies of water or groundwater from basins with high overdraft potential.

Note: Many of the datasets implemented by CEC staff for the above land-use feasibility and environmental impact factors criteria have limited geographic extent (datasets are California-specific). A separate dataset, the WECC's Environmental and Cultural Considerations Data Layer will be used to identify the potential environmental and land use implications of the renewable resources mapped out-of-state. For out-of-state areas, the WECC environmental data later will be applied in a similar manner as the CEC's Core Land-use Screen by seeking to avoid mapping to WECC's Environmental Risk Category 3 (High Risk of Environmental or Cultural Resource Sensitivities and Constraints) and prioritizing limited utilization of land ranked as WECC Environmental Risk Category 2 (Low to Moderate Risk of Environmental or Cultural Resource Sensitivities and Constraints). For future busbar mapping efforts staff are seeking to develop a more robust set of data layers and analysis for out-of-state resources comparable to the in-state data analysis.

- Community and environmental (societal) impact factors
    - Mapped resources should seek to bolster and benefit pollution-burdened and disadvantaged communities where feasible, particularly by reducing emissions and impacts of air-pollutant emitting fossil-fuel generators.
    - For the community and societal environmental impact factors criteria analysis, staff will incorporate the following datasets:
        - SB 535 Disadvantaged Communities – CalEnviroScreen 4.0 dataset[46] identified disadvantaged communities.
        - Inflation Reduction Act Energy Communities – As established under the Inflation Reduction Act (IRA), the communities that qualify projects Energy Community Tax Credit Bonus, includes places with a history of employment in fossil fuel industries and higher unemployment than the U.S. average. Staff will use the most recently available data identifying qualifying energy communities at the time of mapping.[47]
        - Air Quality Standard Non-Attainment Areas – Ozone and $PM_{2.5}$ non-attainment areas from the U.S. Environmental Protection Agency's Green Book[48] datasets.
        - Proximity to existing thermal generators – Staff will identify busbars with existing fossil-fueled thermal plants, as well as the proximity of substations to

[46] "SB 535 Disadvantaged Communities" (2022). California Office of Environmental Health Hazard Assessment. https://oehha.ca.gov/calenviroscreen/sb535

[47] Energy Community Tax Credit Bonus. U.S. Department of Energy. https://arcgis.netl.doe.gov/portal/apps/experiencebuilder/experience/?id=a2ce47d4721a477a8701bd0e08495e1d (Accessed 09/04/2024).

[48] "Nonattainment Areas for Criteria Pollutants (Green Book)" (2023). U.S. Environmental Protection Agency. https://www.epa.gov/green-book

existing thermal plants, and prioritize non-retention of gas capacity identified through the Thermal Generation Retirement Assumptions in Section 9.

- Staff will identify substations and areas within these criteria and give priority to mapping resources to those substations particularly if the resources could assist in reducing the use of existing fossil-fueled thermal resources. Staff will not seek to limit or avoid mapping to areas not identified as within these criteria.
- As noted in Step #4 in Section 7, the SB 535 disadvantaged communities and air quality standard non-attainment areas criteria analyses will be applied for mapping biomass/biogas resources; however, alignment criteria goals will be inverted. Mapping of biomass/biogas should seek to avoid disadvantage communities and air quality non-attainment areas.

- Commercial development interest
  - To the extent possible, busbar allocations should reflect the planned procurement indicated in LSEs' plans and the level of commercial interest in the CAISO and other relevant interconnection queues including queues from other Balancing Area Authorities and participating transmission operators, as well as projects in advanced stages of development that may not be reflected in the interconnection queues identified through working group communications.
  - In considering commercial interest, the staff will:
    - Compare selected portfolio resources to interconnection queues and other sources of potential projects, on a busbar basis.
    - In addition to reviewing the CAISO interconnection queue, staff will also review the interconnection queues of neighboring balancing authorities to identify out-of-state commercial interest planning to connect at known interconnection points.
    - Consider the stage of development as well as the expected online date of the commercial interest.
    - Prioritize alignment with in-development resources, which are resources contracted by LSEs or identified as under construction by PTOs but are not in the current modeling baseline, and other "higher confidence" commercial interest. "Higher confidence" commercial interest are projects that have been assigned transmission plan deliverability (TPD) by the CAISO or resources that have an executed interconnection agreement. Projects that have executed IAs or have completed Phase II in the CAISO interconnection queue have the next level of priority, followed by resources identified in LSE plans but not yet contracted.
    - Commercial interest represented by 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 are weighted as "lower confidence" commercial interest. While not prioritized for mapping, staff use these resources as guidance for areas of commercial development interest.

        - For long-lead time resources, in particular, staff will incorporate other sources beyond the interconnection queues to identify development interest including leased resource areas (e.g., for offshore wind), permits and licensing processes at the Federal Energy Regulatory Commission (FERC) (e.g., for pumped storage hydro), and direct funding support from state or federal agencies.
            - Active Bureau of Ocean Energy Management (BOEM) offshore wind leases and active FERC licenses for pumped storage hydro resources will be considered higher confidence commercial interest.
            - Other potential development interest would be considered lower confidence commercial interest, unless combined with an existing interconnection position.
        - Flag any busbars which have large portfolio selection but no commercial interest or a selected resource amount that is significantly lower or higher than the amount of commercial interest at the substation prioritizing "higher confidence" commercial interest.
    - Busbar allocations occurring at busbars with no commercial interest or that deviate significantly from the amount of commercial interest may be adjusted in a further round of mapping.

- Consistency with prior TPP portfolios
    - 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. Where significant reductions are proposed in the resource mapping from one year to the next, these should be explicitly justified.

Detailed criteria thresholds applied for each dataset noted above are described in the next section below. These criteria and alignment thresholds have been developed for a systematic mapping approach for the entire portfolio across the entire state and several out-of-state regions. The overall mapping goal is to maximize compliance across all these criteria groups with generally no one group taking automatic precedence over the others. Busbar mapping working group staff will seek to address mapped resources not aligned with criteria on an individual situation basis and work to assess if alternative mapping locations would improve alignment within the non-aligned criteria without decreasing overall criteria alignment. Staff recognize some areas may have unique issues that don't fully align with the criteria thresholds developed below. When such issues are known, staff will seek to incorporate the additional information into the analysis for mapping resources in those areas. Certain levels non-alignment could be viewed as acceptable and not require remapping or vice versa as a result of the additional factors (e.g. an expected decline in ability to irrigate land in certain overdrafted groundwater basins will likely reduce cropland acreage in those areas. A higher level of non-alignment with the cropland-index criteria could be more acceptable in those

areas). Staff would note such issues and alignment allowances in the dashboard and mapping report.

Implementation of the Busbar Mapping Criteria

Staff use a "dashboard" to identify whether busbar allocations of a particular round of mapping of a portfolio comply with the criteria described above. This informs whether changes to the allocation may be required. An assessment using the criteria will be implemented and reported in the dashboards with a mapped resource' compliance with the criteria delineated by the five levels of criteria alignment listed below:

- Level 1 – Strong compliance with criteria, alignment with criteria's prioritized or favorable conditions.
- Level 2 – Mostly favorable compliance with criteria, not fully aligned with prioritized conditions but not near to triggering unfavorable criteria conditions.
- Level 3 – Mixed compliance with criteria, little alignment with prioritized conditions, potential alignment with conditions criteria seek to limit or avoid.
- Level 4 – Some noncompliance with criteria, some alignment with conditions criteria seeks to limit or avoid.
- Level 5 – Significant noncompliance with criteria, no alignment with stated criteria, fully meets conditions criteria seek to limit or avoid.

Some criteria assessments will not utilize all five levels of compliance alignment. Those criteria consist of mapping priorities and staff are not seeking to limit or avoid nonalignment with those specific conditions. The criteria data are not available for all resources and all substations. Blank cells and cells labeled "n/a" are shown in the dashboards where there is insufficient data to assess compliance.

Detailed descriptions of the thresholds for compliances levels of the criteria are listed below. Some thresholds have values explicitly set in the descriptions while other thresholds will be set during the mapping process as they rely on mapping specific information and information that will be obtained through the mapping process.

1. **System level transmission capability criteria thresholds:**

   <u>FCDS and EODS transmission constraint limits exceedances</u> – alignment thresholds will be assessed for the FCDS and EODS transmission capabilities separately.

   a. Level 1 alignment: No exceedance in transmission constraint capability
   b. Level 2 alignment: No exceedance with identified cost-effective transmission upgrade
   c. Level 3 alignment: Minor exceedance in a default constraint limit
   d. Level 4 alignment: Large exceedance in a default constraint limit
   e. Level 5 alignment: Exceedance in actual constraint limit where identified transmission upgrade has been assessed to be not cost-effective

   <u>Mapping to LCR areas</u> – alignment thresholds center on the selected substation's location in an LCR area and the amount and type of mapped resources.

a. Level 1 alignment: Mapped resources are stand-alone storage that is within the CAISO identified 4-hr charging limit amount, renewable, or co-located storage in an LCR area, at a substation with existing gas capacity that is the primary resource displaced
b. Level 2 alignment: Same requirement as for Level 1 alignment but for substations without existing gas capacity
c. Level 3 alignment: Same requirement as for Levels 1 and 2 alignments but an identified cost-effective transmission upgrade enables stand-alone storage beyond the charging limit
d. Level 4 alignment: mapped resources are outside an LCR area
e. Level 5 alignment: mapped stand-alone storage exceeds the CAISO identified charging limit and no cost-effective upgrade is identified

2. **Substation level interconnection viability criteria thresholds:**

Distance to interconnection point – Distance criteria alignment is both expected project size dependent and resource type dependent with further distances being considered still economically viable for larger projects and for wind and geothermal resources.

a. Level 1 alignment:
    i. Solar: Area is ≤ 5 miles from substation
    ii. Wind & Geothermal: Area is ≤ 10 miles from substation
b. Level 2 alignment:
    i. Solar: Area is ≤ 10 miles from substation (≤ 15 miles for area with potential projects size of ≥ 400 MW)
    ii. Wind & Geothermal: Area is ≤ 15 miles from substation (≤ 20 miles for area with potential project size ≥ 200 MW)
c. Level 3 alignment:
    i. Solar: Area is ≤ 15 miles from substation (≤ 20 miles for area with potential project size of ≥ 400 MW)
    ii. Wind & Geothermal: Area is ≤ 15 miles from substation (≤ 20 miles for area with potential project size ≥ 200 MW)
d. Level 4 alignment:
    i. Solar: Area is ≤ 20 miles from substation (≤ 30 miles for area with potential project size of ≥ 400 MW)
    ii. Wind & Geothermal: Area is ≤ 30 miles from substation (> 30 miles for area with potential project size ≥ 200 MW)
e. Level 5 alignment:
    i. Solar: Area is > 20 miles from substation (> 30 miles for area with potential project size of ≥ 400 MW)
    ii. Wind & Geothermal: Area is > 30 miles for potential project size < 200 MW

Substation interconnection ease/feasibility – For substations for which PTOs are able to provide the necessary information, the PTO per-unit cost guides will be used to estimate the cost of accommodating new resource interconnections, considering both PTO feedback and substation voltage. The following criteria alignment levels will be applied to each substation based on estimated upgrade cost:

a. Level 1 alignment:

i. The estimated cost to upgrade the substation to accommodate new resources is below $10 million.

b. Level 2 alignment:
   i. The estimated cost to upgrade the substation to accommodate new resources ranges from $10 million to $20 million.
c. Level 3 alignment:
   i. The estimated cost to upgrade the substation to accommodate new resources ranges from $20 million to $50 million.
d. Level 4 alignment:
   i. The estimated cost to upgrade the substation to accommodate new resources ranges from $50 million to $100 million.
e. Level 5 alignment:
   i. The estimated cost to upgrade the substation to accommodate new resources exceeds $100 million.

Interconnection Voltage – The following alignment level thresholds will be applied; however, specific numerical values may be substation- or PTO-dependent and will be established during the mapping process following incorporation of interconnection cost analysis and information solicited from the PTOs. The interconnection voltage analysis is closely linked to the interconnection ease and feasibility analysis and serves as a secondary set of criteria for substations where detailed interconnection information is not available.

a. Level 1 alignment: Mapped resources interconnect to a substation with voltage greater than 100 kV within the range of MW amounts
b. Level 2 alignment: Mapped resources interconnection to a substation with voltage greater than 100 kV at a lower MW amount likely increasing interconnection costs per MW
c. Level 3 alignment: Mapped resource amount is more than the substation's voltage can likely accommodate and may require substation upgrades
d. Level 4 alignment: Mapped resource amount is significantly more than the substation's voltage can accommodate and likely requires major substation upgrades to accommodate resources
e. Level 5 alignment: Mapped resources interconnect to a substation with voltage less than 100 kV, or only a small MW amount of mapped resources interconnect to a 500 kV substation

3. Land-use feasibility criteria thresholds:

CEC Core Land-Use Screen – Alignment thresholds are centered on mapped resources percentage utilization of lower and higher implications areas:

a. Level 1 alignment: Mapped resource amount would utilize less than 20% of the lower implications area
b. Level 2 alignment: Mapped resource amount would utilize less than 50% of the lower implications area
c. Level 3 alignment: Mapped resources amount would utilize less than 80% of the lower implications area
d. Level 4 alignment: Mapped resources amount would utilize less than 10% of the higher implications area

e. Level 5 alignment: Mapped resources amount would utilize greater than 10% of the higher implications area

Parcelization – Alignment thresholds center on mapped resources utilization of low parcelization areas (parcels with a value of 6 or lower) and medium (parcels with a values of 6 to 30) parcelization areas. For higher alignment thresholds the identified substation must have a lower 10th percentile parcelization[49] as well. This additional threshold seeks to reflect overall landscape parcelization around the substation and potential interconnection impacts of higher parcelization. Mapped resources must meet both criteria listed for the alignment level to be categorized at that level.

a. Level 1 alignment:
    i. Mapped resource amount would utilize less than 20% of the available low parcelization area
    ii. Substation's 10th percentile value is less than 12
b. Level 2 alignment:
    i. Mapped resource amount would utilize less than 80% of the available low parcelization area
    ii. Substation's 10th percentile value is less than 20
c. Level 3 alignment:
    i. Mapped resource amount would utilize less than 20% of the available mid parcelization area
    ii. Substation's 10th percentile value is less than 30
d. Level 4 alignment:
    i. Mapped resource amount would utilize less than 80% of the available mid parcelization area
e. Level 5 alignment:
    i. Mapped resource amount would utilize more than 80% mid parcelization area

CEC's Cropland index – Alignment thresholds center on mapped resources utilization of low and high value cropland areas. Higher alignment thresholds also factor in overall cropland value percentages around the mapped to substation. Mapped resources must meet both criteria listed for the alignment level to be categorized at that level.

a. Level 1 alignment:
    i. Mapped resource amount would utilize less than 20% of lower value cropland
    ii. The total resource potential acreage is less than 50% high value cropland
b. Level 2 alignment:
    i. Mapped resource amount would utilize less than 50% of lower value cropland
    ii. The total resource potential acreage is less than 75% high value cropland
c. Level 3 alignment: Mapped resource amount would utilize less than 100% of non-high value cropland

[49] The 10th percentile value for parcelization indicates the value for which 10% of the parcels around the substation have a lower parcelization value.

d. Level 4 alignment: Mapped resource amount would utilize less than 50% of high value cropland
e. Leve 5 alignment: Mapped resource amount would utilize more than 50% of high value cropland

Critically overdrafted groundwater basin – alignment thresholds center on area within mapping distance of identified substation inclusion in a critically overdrafted groundwater basin.

a. Level 1 alignment: The majority of the area around the substation is in a critically overdrafted groundwater basin
b. Level 2 alignment: The majority of the area around the substation is not in a critically overdrafted groundwater basin

Fire threat district – alignment thresholds center on percentage of total area in the mapping radius of identified substation within the high fire threat district. Mapped resources must meet both criteria listed for the alignment level to be categorized at that level.

a. Level 1 alignment:
    i. Less than 20% of the area around the substation has an annual burn probability greater than 0.5%, and
    ii. None of the area has an annual burn probability greater than 2%
b. Level 2 alignment:
    i. Less than 50% of the area around the substation has an annual burn probability greater than 0.5%, and
    ii. Less than 10% of the area has an annual burn probability greater than 2%
c. Level 3 alignment:
    i. Less than 75% of the area around the substation has an annual burn probability greater than 0.5%, and
    ii. Less than 20% of the area has an annual burn probability greater than 2%
d. Level 4 alignment:
    i. Less than 75% of the area around the substation has an annual burn probability greater than 0.5%, and
    ii. Less than 30% of the area has an annual burn probability greater than 2%
e. Level 5 alignment:
    i. Greater than 75% of the area around the substation has an annual burn probability of greater than 0.5%, or
    ii. Greater than 30% of the area has an annual burn probability greater than 2%

4. **Environmental (conservation and biological) impact factors criteria thresholds:** The five datasets included in the conservation and biological impact factors criteria analysis (ACE terrestrial connectivity, ACE biodiversity, ACE irreplaceability, terrestrial landscape intactness, and wetlands) will use the same thresholds identified below. Each alignment level has two analysis thresholds: one centered on the percentage of high and low implications area utilized by the mapped resource amount and the other centered on the total amount of high implications area around the substation. Mapped resources must meet both criteria listed for the alignment level to be categorized at that level. Both analyses are conducted using the radius distance from the substation determined in the viable distance criteria analysis.

a. Level 1 alignment:
    i. Mapped resource amount would utilize less than 20% of the lower implications area within the identified appropriate distance from the substation.
    ii. Total resource potential area around the substation is less than 50% higher implications.
b. Level 2 alignment:
    i. Mapped resource amount would utilize less than 50% of lower implications area.
    ii. Total resource potential area is less than 70% higher implications.
c. Level 3 alignment:
    i. Mapped resource amount would utilize less than 75% of lower implications area.
    ii. Total resource potential area is less than 90% higher implications.
d. Level 4 alignment:
    i. Mapped resource amount would utilize less than 10% of Higher implications area.
    ii. Total resource potential area is less than 95% higher implications.
e. Level 5 alignment:
    i. Mapped resource amount would utilize greater than 10% of Higher implications area.
    ii. Total resource potential area is greater than 95% higher implications.

For analysis of potential PSH resource locations, the total area alignment level analysis will be applied to 5-mile radii distances around identified potential locations for the ACE terrestrial connectivity, biodiversity, and irreplaceability, the terrestrial landscape intactness, and the two aquatic datasets, aquatic rare species richness and aquatic irreplaceability, if necessary. Additionally, the following criteria align will be applied to capture the potential implications of the identified PSH potential locations possible reservoir sites and likely available water sources.

For potential implications of the likely upper and lower reservoirs infrastructure needed in the identified PSH location, the following criteria ranking will be applied:

a. Level 1: Existing off-stream infrastructure
b. Level 2: Existing on-stream infrastructure or new brown field infrastructure
c. Level 3: New off-stream infrastructure
d. Level 4: New on-stream infrastructure

For the potential implications of the likely available water source of the identified PSH location, the following criteria ranking will be applied:

a. Level 1: Existing off-stream reservoir
b. Level 2: Existing on-stream reservoir
c. Level 3: Groundwater from groundwater basin with low overdraft potential
d. Level 4: Groundwater from basin with high overdraft potential
e. Level 5: Natural body of water or critically overdrafted groundwater basin

Note: If the thresholds for the environmental impact factors or the land-use feasibility factors result in significant non-alignment (for example, if approximately a significant

portion of the new resources get flagged at level 4 alignment or higher and remapping efforts cannot significantly reduced the non-compliance without creating a major departure from the logic and optimization objective within RESOLVE) staff may be unable to remap resources to improve compliance and be required to limit remapping. Staff would include in the dashboard and mapping report a discussion of the major non-alignment issues and staff's reasoning for not seeking to reduce non-alignment and seek further stakeholder input if possible. Regardless, staff would seek to adjust the mapping thresholds for future cycles through improvements to the busbar mapping methodology.

5. **Environmental (Societal) and community Impacts Criteria Thresholds:**

   Disadvantaged Communities – alignment thresholds center on whether the selected substation is in or near an identified disadvantaged community.

   a. Level 1 alignment: substation located within a disadvantaged community
   b. Level 2 alignment: substation is within 5 miles of a disadvantaged community
   c. Level 3 alignment: substation greater than 5 miles from a disadvantaged community

   IRA Energy Communities – alignment thresholds center on whether the substation is in an identified IRA energy community.

   a. Level 1 alignment: located in Energy Community
   b. Level 2 alignment: not located Energy Community

   Air Quality Non-Attainment District – alignment thresholds are applied for both Ozone and $PM_{2.5}$ datasets and center on whether the substation is within the respective Air Quality Non-Attainment District.

   c. Level 1 alignment: located in Air Quality Non-Attainment District
   d. Level 2 alignment: not located Air Quality Non-Attainment District

   Proximity to Existing Thermal Generator – alignment threshold center on location of substation of interconnection for mapped resources proximity to an existing fossil-fueled thermal generator.

   a. Level 1 alignment: a fossil-fueled thermal generator interconnects to the same bus
   b. Level 2 alignment: adjacent to an identified thermal generator (< 1 mile from an identified generator)
   c. Level 3 alignment: less than 5 miles from an identified thermal generator
   d. Level 4 alignment: less than 10 miles from nearest identified thermal generator
   e. Level 5 alignment: greater than 10 miles from nearest identified thermal generator

   For mapping biomass and biogas resources staff will apply both the Disadvantaged Communities and Air Quality Non-Attainment District criteria thresholds inverted, prioritizing mapping of the resources away from disadvantaged communities and outside of air quality non-attainment areas.

6. **Commercial Development Interest Criteria Thresholds:** Alignment analysis for commercial development interest is bifurcated into identifying mapped resource that exceeds commercial interest and that is significantly less than commercial interest.

Alignment thresholds are dependent on both magnitude of misalignment and the confidence of the commercial interest. Specific threshold values for the alignment levels will be determined during the mapping process following analysis of the most up to date interconnection queues. This criteria will consider commercial interest identified in the CAISO interconnection queues, as well as those of neighboring balancing authorities with resources that could be delivered to CAISO interconnection points. The criteria levels for when mapped resources exceed the amount of commercial interest are:

a. Level 1 alignment:
    i. Mapped resources align with in-development resources and commercial interest with TPD or an executed IA
b. Level 2 alignment:
    i. Mapped resource amount exceeds the amount of commercial interest with TPD or an executed IA
c. Level 3 alignment:
    i. Mapped resource amount exceeds the amount of higher confidence commercial interest
d. Level 4 alignment:
    i. Mapped resource amount exceeds the total amount of commercial interest
e. Level 5 alignment:
    i. There is no commercial interest at the substation where resources are mapped

The criteria levels for when the mapped resources are less than the various amounts of commercial interest are:

a. Level 1 alignment:
    i. Amount mapped is significantly less than only the total commercial interest
b. Level 2 alignment:
    i. Amount mapped is less than higher confidence commercial interest by a to be specified MW amount
c. Level 3 alignment:
    i. Amount mapped is less than the amount of commercial interest with TPD or an executed IA by a to be specified amount
d. Level 4 alignment:
    i. Amount mapped is significantly less than the amount of commercial interest with TPD or an executed IA by a to be specified amount
e. Level 5 alignment:
    i. Amount mapped is less than the amount of identified in-development and contracted resources

In the busbar mapping dashboard, when presenting the mapped resources' alignment with the commercial interest criteria, staff will distinguish whether the mapped resources alignment level is due to exceeding the amount of commercial interests' threshold criteria or being significantly less than the amount of commercial interest.

7. **Consistency with Prior TPP Portfolio Criteria Thresholds:** Alignment thresholds center on the amount and type of mapped resources at the selected substation compared to the amount and type mapped in the previous TPP portfolios.
    a. Level 1 alignment
        i. Mapped resources amount is greater than or equal to the amount in most similar previous TPP portfolio
    b. Level 2 alignment
        i. Mapped resources amount is greater than or equal to the FCDS and Total amounts mapped in the previous base case
    c. Level 3 alignment
        i. Mapped resources amount is only slightly less than the FCDS or total mapped in previous base case
    d. Level 4 alignment
        i. Mapped resources amount is significantly less than in previous base case
    e. Level 5 alignment
        i. Same threshold has Level 4 alignment and is mapped to a substation within a constraint with a previously identified or approved transmission upgrade

.

9. Other TPP Assumptions

Thermal Generator Retirement Assumptions

RESOLVE reports 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 resource category of thermal generation not retained; however, for busbar mapping for the TPP these resources also 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.

In developing the list, CPUC staff will consider the following impact factors separated into three categories to determine which thermal units will not be retained, in order to specify in the transmitted portfolios which units should be assumed as retired for transmission planning purposes:

Environmental/Community Factors

1. Pollutant/non-attainment Zones: Criteria will prioritize plants in worse PM 2.5 and Ozone non-attainment areas (NAA). NAA status is determined by the Environmental Protection Agency's Green Book of Nonattainment Areas for Criteria Pollutants.[50]
2. Disadvantaged Communities (DACs): Criteria will prioritize plants in or near DACs. Those within DACs will receive highest priority, followed by those within 5 miles, and then those within 10 miles. Those beyond 10 miles receive the lowest priority.
3. NO_x and SO_2 Emission Rates: Criteria will prioritize not retaining resources with higher NO_x and SO_2 emission rates, separately, weighted by their capacity factors. Resources will be sorted into quartiles by plant type (i.e. CCGTs will be binned only amongst other CCGTs and likewise for Peakers) based on weighted emission rates and given priority scores. Resources with the highest emission rates will be given the highest priority. These quartile calculations will be done across both CCGTs and Peakers. Emission rates will be determined from averaging the most recent two years of publicly available US Energy Information Administration (EIA) emissions data[51].

Performance-Related Factors

4. Age: Criteria will prioritize not retaining oldest plants (by plant type). Resources will be sorted into quartiles based on their age by plant type. The oldest quartile of plants will be

[50] "Nonattainment Areas for Criteria Pollutants (Green Book)." U.S. Environmental Protection Agency. https://www.epa.gov/green-book

[51] "Emissions by plant and by region." U.S. Energy Information Administration. https://www.eia.gov/electricity/data/emissions/

given the highest priority. Age is based on CAISO's Master Control Area Generating Capability List[52] info for the resources' commercial online dates.

5. Heat Rate: Criteria will prioritize not retaining resources with higher heat rates. Resources will be sorted into quartiles based on their heat rates by plant type (i.e. CCGTs will be binned only amongst other CCGTs and likewise for Peakers). Highest priority will be given to plants in the highest heat rate quartile. The two most recent years of internal CPUC heat rate data will be utilized.

Local Reliability Factor

6. Local Area Effectiveness Factor (LEF): Criteria will prioritize not retaining resources with low CAISO Local Area Effectiveness Factor percentages. Resources will be sorted into quartiles based on LEF percentages and plants in the highest quartile will be given the lowest priority. Resources with no LEF percentage will be given the lowest priority. This ranking will be done across both CCGTs and Peakers; all resources will be compared together. Staff will utilize Effectiveness factors from the most recent, available CAISO Long-term Local Capacity Technical Study.

CPUC staff will implement scoring criteria based on the six factors to develop an overall prioritized ranking of plants to model as not retained. The scoring system weighs the six factors by their categories as follows:

- The Environmental and Community impact factors combined contribute 50% of the score. The scores of the three factors: DAC, NO_x & SO_2, and Non-Attainment Zone, are summed and provide 50% of the weighted total score.
- The Performance-Related Factors, Heat Rate and Age, are summed and provide 25% of the weighted total score.
- The Local Reliability Factor contributes 25% of the weighted total score.

Two additional screens will exclude certain plants from being selected to be modeled as not retained: exclude the plants in the youngest quartile and exclude plants in the highest effectiveness factor quartile. These two screens will not apply to plants located within DACs. Next, the plants not excluded by these two screens will be given a total weighted criteria score. The plants will be selected to be modeled as not retained based on highest scores until the nameplate MW of plants selected aligns with the total amount of capacity not retained or retired included in the portfolio.

These datasets, impact factors, and scoring criteria were first fully released with the CPUC decision transmitting the 2024-2025 TPP portfolio in the CAISO in February 2024. The application of these criteria at the time can be seen in the busbar mapping supporting documents at the Assumptions for the 2024-2025 TPP (ca.gov) webpage.

CPUC staff will also seek to minimize the creation of additional transmission needs, triggering only cost-effective upgrades and limiting additional costs to ratepayers. Thermal resources identified in LCR areas are particularly likely to require additional transmission if not replaced with an adequate amount of new generation and/or storage. CPUC staff, in consultation with CAISO staff, may seek to limit additional transmission by

[52] "Master Control Area Generating Capability List." CAISO. http://oasis.caiso.com/mrioasis/logon.do

a. Maintaining the retirement of the thermal generation unit in the area with identified transmission needs but adequately replacing the capacity with generation and/or battery storage resources; and/or

b. Restoring the thermal generation units in areas with identified transmission needs and replacing them with an equal amount of alternative generation capacity with comparable criteria rankings modeled off-line in areas with more no transmission needs or more cost-effective transmission solutions.

For portfolios with only RESOLVE selected thermal generation not retained, CPUC staff will assemble a list that specifically does not create additional transmission needs, as RESOLVE modeling of these resources assumed no specific transmission needs. Once the IRP portfolios are transmitted to the CAISO, if within the TPP it is identified that known local area requirements are not met, then CAISO staff may reallocate mapped battery storage from a general CAISO System area to a particular local area to meet the local area requirement up to known battery storage charging limits. If known local area requirements are still not met, then local thermal generation will be restored in reverse order of the list developed using the metrics above.

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.21-10-002 or its successor) determines what resources can provide system and local resource adequacy capacity. Current RA accounting rules indicate that all existing DR programs count to the extent those program impacts are located within the relevant geographic areas being studied for system and local reliability. For its TPP studies the CAISO utilizes data from Supply-Side Resource Demand Response, which is registered in the CAISO market as either dispatchable, Emergency DR (RDRR) or Economic DR (PDR).

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

---- DOCUMENT ENDS ----