
Methodology for Resource-to-Busbar Mapping & Assumptions for The Annual TPP

CPUC Energy Division
August 2021



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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.

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 ³	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 ⁴	Addition of methodology for battery resources for the 2020-2021 TPP
October 23, 2020 ⁵	Staff Proposal for the 2021-2022 TPP
January 7, 2021 ⁶	Final Methodology for the 2021-2022 TPP
July 1, 2021	Staff Proposed Methodology & Assumptions

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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

¹ https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/IRP_Busbar_Mapping-Methodology-2019-10-18.pdf
³ ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-02-21.pdf
⁴ ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-03-30.pdf
⁵ <https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M348/K816/348816247.PDF>
⁶ ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar%20Mapping%20Methodology%20for%202021-2022%20TPP_V.2021-01-07.pdf

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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 test the implications of various policy futures. These are collectively referred to as "IRP portfolios."

The IRP cycle can involve developing these portfolios with different approaches. RESOLVE,⁷ a capacity expansion model, is used to develop portfolios for the Reference System Plan, whereas Load Serving Entities' (LSEs') IRP plans are used to develop a Preferred System Plan portfolio, and a hybrid approach may be used to supplement specific portfolio development. Upon formal CPUC adoption of 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 busbars⁸ 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.

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4. Scope of Busbar Mapping

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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 geothermal 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

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⁷ Further information on RESOLVE is available here: <https://www.cpuc.ca.gov/irp/>

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⁸ "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.

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to ~~stay on a~~ trajectory to achieve the state's SB 100 goal⁹ of 100 ~~percent~~ clean electricity by 2045, as well as 80 percent below 1990 emissions by 2050.

~~This busbar mapping methodology may need to be revisited in future years 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 what was used by the agencies for ~~2021-2022~~ TPP.¹⁰ That methodology was informed by ~~staff experience and stakeholder feedback during the implementation of the process for portfolios transmitted for 2020-2021 TPP in addition to the Staff Proposal for the 2020-2021 TPP.~~¹¹ It contains details of the processes used in prior years.

This methodology for mapping resources in IRP portfolios ~~will serve as a living document for continued use in the annual TPP. The document will be updated to incorporate changes or improvements as needed at appropriate junctures of future cycles. This methodology aims to improve on the methodology developed for the 2021-2022 TPP~~ by:

- ~~Utilizing new CAISO transmission deliverability data for available transmission headroom for full capacity deliverability status (FCDS) and energy only deliverability status (EODS). See Section 6.~~
- ~~Incorporating new transmission constraint divisions based on the new CAISO transmission deliverability data, different from the nested-transmission zones and Ex-zones used in the previous cycle. See Section 5.~~
- ~~For non-battery busbar mapping, incorporating busbar-level granularity of commercial interest rather than zonal-level of commercial interest. See Section 9.~~
- ~~For all resources, incorporating expected online dates for commercial interest into the mapping criteria for allocation to busbars. See Section 9.~~
- ~~Updating the battery busbar mapping steps to account for the locational information for battery resources that will be provided by RESOLVE for the first time. See Section 8.~~
- ~~Removing elements no longer necessary with the implementation of the new CAISO transmission deliverability data, including the 90% transmission utilization limit used in mapping battery resources to busbars, and for co-located battery and solar PV resources, removing the transfer of FCDS status from the solar PV resources to the battery resources. See Section 7 and 8.~~
- ~~Inclusion of an additional battery ranking value applied to substations in proximity of a fossil-fueled plant that has been identified in the Thermal Generator Retirement list. See Section 8.~~
- ~~Updating the busbar mapping process flow chart and the battery and non-battery mapping steps and workflow between the CPUC, CEC, and CAISO. See Section 6.~~

⁹ Detailed at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

¹⁰ Available at: [Portfolios & Modeling Assumptions for the 2021-2022 Transmission Planning Process \(ca.gov\)](#)

¹¹ Available at [Modeling Assumption for the 2020-2021 Transmission Planning Process \(ca.gov\)](#)

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Deleted: <#>Updating guiding principles to ensure the busbar mapping methodology is aligned with latest policies and incorporates latest stakeholder input (for example scoring criteria definitions have been updated to capture stakeholder comments, and battery mapping methodology has been updated to incorporate policy goals)[¶]
Including and updating the criteria that are used when mapping resources to busbars as well as describing how the criteria are implemented (for example, the thresholds for level 3 non-compliance with the "distance to transmission" criterion have been updated based on staff's review of existing and planned wind and solar facilities and their proximity to existing transmission infrastructure). For the 2020-2021 TPP, staff described the process of implementing the criteria only in the reports transmitting the busbar mapping results to the CAISO.[¶]
Updating the battery energy storage mapping methodology to incorporate policy considerations such as minimizing ratepayer cost and minimizing air quality impacts, as well as incorporating CAISO Local Capacity Technical study (LCI) results regarding battery charging capability in local capacity requirement (LCR) areas.[¶]
Updating the treatment of full deliverability status of co-located solar and battery storage resources. The full deliverability status of the solar resources is now transferred to the co-located battery storage resources.[¶]
Inclusion of the methodology CPUC staff use to specify in the transmitted portfolios which existing thermal generation units should be assumed as retired, an assumption required by the CAISO in addition to the portfolio and busbar mapping assumptions. For the 2020-2021 TPP, CPU... [17]

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- Improving the implementation process of the busbar mapping criteria to better capture mapped resources' compliance with the criteria and to incorporate latest stakeholder input and updated data sets. See Section 9.

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, 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 generally represent 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 resource needs identified in PUC modeling and analysis, planned procurement indicated in LSEs' plans, previous planning and procurement decisions, and the level of commercial interest in the CAISO and other relevant interconnection queues.
- The allocations should strive to minimize transmission congestion by respecting transmission constraint limits¹² and 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 identified in the CAISO's Generation Interconnection and Deliverability Allocation Process (GIDAP) rather than the TPP.
- 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.

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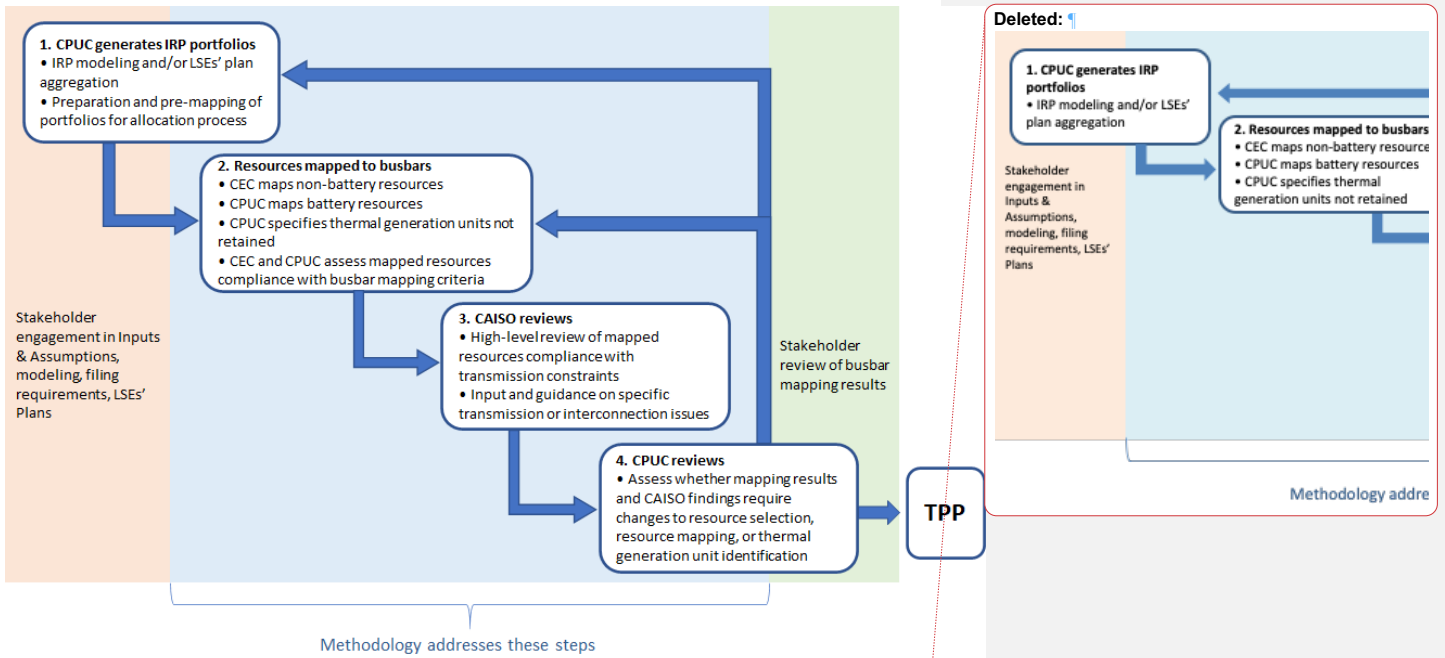
¹² Further described in the CAISO's July 2021 White Paper "Transmission Capability Estimates for use in the CPUC's Resource Planning Process" available at: <http://www.caiso.com/Documents/WhitePaper-2021TransmissionCapabilityEstimates-CPUCResourcePlanningProcess.pdf>
 May 2019 White Paper "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development" available at: <http://www.caiso.com/Documents/TransmissionCapabilityEstimates-CPUC-IRP-PortfolioDevelopmentRedacted.pdf>

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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. Non-Battery Busbar Mapping Steps

Information transfers related to non-battery resources follow this sequence:

- Step 1 - Draft portfolio(s) prepared and shared with CEC for busbar mapping (CPUC)
- Step 2 - Draft busbar mapping performed (CEC and CPUC)
 - Note: Step 2 is further divided into two parts below delineating CEC staff centered work and CPUC staff centered work
- Step 3 - Observations and recommended revisions (CAISO)
- Step 4 - Review mapping results as well as observations and recommendations from CAISO staff (CPUC)
 - Note: Steps 1-4 make up a "round" of busbar mapping.
- Step 5 - Repeat steps 1-4 if mapping results do not conform with mapping criteria
- Step 6 - Successfully mapped IRP portfolio(s) formally transmitted to the CAISO (CPUC)

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The discussion of each step below centers on the mapping of non-battery resources. The detailed battery mapping steps are outlined in Section 8: Battery Storage. The mapping of batteries is conducted by CPUC staff in parallel with the mapping processes of non-battery resources outlined in Step 1 and Step 2, with the CAISO staff reviewing the combined results of mapping battery and non-battery resources in Step 3.

CPUC – Step #1

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

- IRP portfolios generated by RESOLVE and/or resulting from the aggregation of LSEs’ plans, as applicable.
 - Baseline resources: megawatts (MW), by unit, by location
 - This information will also identify new baseline resources, including their point of interconnection, that have recently come online or are in development which were not included in calculating the most recent CAISO transmission capability limits.
 - LSE planned resources: MW, by resource type, by location
 - Selected new resources: MW, by resource type, location, and applicable transmission constraints¹⁴
 - Where the baseline set of resources has been updated after the portfolio of selected resources was formed, CPUC staff should reconcile the two sets of resources to avoid double-counting.
 - For certain resource types selected by RESOLVE, specifically solar and battery resources, CPUC staff will conduct pre-mapping work to provide the granularity of information needed for the CEC to conduct its mapping process.
 - This pre-mapping exercise maps solar and battery resources from the few large regional areas that RESOLVE selects, to geographic specific areas to aid CEC staff in mapping solar resources to busbars and to properly assess transmission compliance with all transmission constraints once the resources are mapped to busbars by the CEC. This process also allows solar and battery resources to be mapped to busbars as co-located resources.
 - CPUC staff will incorporate commercial interest as defined from planned procurement in LSEs’ plans and proposed projects in the interconnection queues when conducting this pre-mapping downscaling for RESOLVE selected resources.

¹⁴ For example, see Excel-based results viewer, dated March 23, 2020, available at <https://www.cpuc.ca.gov/General.aspx?id=6442464143>. See ”Portfolio Analytics” tab

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- o Resource potential estimates (geographic information system (GIS) data format – polygons and associated attribute tables) to give the CEC further information about the selected resources¹⁵
- ~~Transmission upgrades triggered in RESOLVE (tabular format)~~¹⁶

Stakeholder participation:

- Stakeholders will be provided an opportunity to comment on the RESOLVE inputs and assumptions (including CAISO transmission capability and cost values), RESOLVE functionality, and the proposed Reference System Portfolio (year 1) and proposed Preferred System Portfolio (year 2)
- 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.

CEC – Step #2 – Part A

The CEC staff will provide the following materials to the CPUC and CAISO staff after each round of busbar mapping:

- Draft CEC busbar mapping results
 - o See ~~CEC Busbar Mapping Results workbooks from previous cycles for examples of prior work~~¹⁷

The CEC is using a busbar mapping methodology that is ~~summarized as follows:~~

- 1) CEC staff will use the information described in Step #1 above from the CPUC to develop a geographic map for the renewable energy resource technologies and for each portfolio, consistent with the RESOLVE model inputs and assumptions developed by the CPUC.
- 2) CEC staff will create a ~~set of GIS layers~~ to identify the potential environmental and land use implications of the RESOLVE-selected renewable resources. The layer is a combination of the following statewide data and information:
 - Terrestrial Landscape Intactness (California Energy Commission and Conservation Biology Institute, 2016)¹⁸

¹⁵ For example, see GIS Data available at <http://www.cpuc.ca.gov/General.aspx?id=6442453965>

¹⁶ For example, see Excel-based results viewer, dated March 23, 2020, available at <https://www.cpuc.ca.gov/General.aspx?id=6442464143> See “Portfolio Analytics” tab

¹⁷ ~~The 2021-2022 TPP results are available at Portfolios & Modeling Assumptions for the 2021-2022 Transmission Planning Process (ca.gov) and the 2020-2021 TPP results at~~ <https://www.cpuc.ca.gov/General.aspx?id=6442464144>

¹⁸ Available at <https://databasin.org/datasets/c3ec00e8d94a4de58082fdbce91248a65>

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Transmission capability information (GIS data format)¶

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- Areas of Conservation Emphasis, version 3.0 (ACE III) (California Department of Fish and Wildlife, 2018)¹⁹
 - Terrestrial Connectivity²⁰
 - California Agricultural Value (California Energy Commission and Conservation Biology Institute, 2018)²¹
 - NLB (Natural Landscape Blocks)²²
 - Connectivity²³
 - Biodiversity²⁴
 - Rarity²⁵
 - Native species²⁶
 - Irreplaceability²⁷
 - Wildfire Threat²⁸
- 3) The first three datasets above will be normalized and summed to create a comprehensive layer with numerical scores that represent the degree of potential environmental and land use implications if resources are utilized. The California Agricultural Value and Wildfire Threat data will either be incorporated into the model or used as separate overlays to compare different substation allocations.
- 4) The environmental and land use layers will be overlain with the renewable resource potential geographies to identify the environmental implications (low and high) of developing renewable resources, particularly solar resources and where necessary, wind energy resources.
- 5) Available transmission substations, including those that are planned and approved as well as existing, will be identified. Available substations include those in Californian BAAs, as well as CAISO. A subset of total available substations is considered when assigning the portfolios. This subset of substations is identified in the following manner:

¹⁹ Available at <https://www.wildlife.ca.gov/Data/Analysis/Ace>

²⁰ Available at <https://www.wildlife.ca.gov/Data/Analysis/Ace#523731772-connectivity>

²¹ Available at <https://databasin.org/datasets/f55ca5085c024a96b5f17c7d4ddd1147>

²² Available at <https://databasin.org/datasets/e3ee00e8d94a4de58082fdbce91248a65>

²³ Available at <https://data.cnra.ca.gov/dataset/terrestrial-connectivity-ace-ds2734>

²⁴ Available at <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150831>

²⁵ Available at <https://data.cnra.ca.gov/dataset/statewide-terrestrial-rare-species-richness-summary-ace-ds13331>

²⁶ Available at <https://data.cnra.ca.gov/dataset/statewide-terrestrial-native-species-richness-summary-ace-ds1332>

²⁷ Available at <https://data.cnra.ca.gov/dataset/statewide-terrestrial-irreplaceability-summary-ace-ds13341>

²⁸ Available at <https://ia.cpuc.ca.gov/firemap/>

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- i. 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.²⁹
- ii. The combined set of substations is queried to select substations that meet the following criteria:

1. 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 limited³⁰
2. Location information (GIS data) available from CEC or U.S. HIFLD
3. Identified as currently operational or planned
4. 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.
5. Identified as having commercial interest per CAISO interconnection queue

iii. 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.

iv. The substation data is overlain with the CPUC RESOLVE resource potential data and for substations with significant renewable resource potential in reasonable proximity, the resource potential is assigned to the relevant transmission constraint for that substation.

v. During iterative rounds of busbar mapping, individual substations from the identified data sources may be added if additional substation mappings are needed.

6) A suitable standard radius will be established around each available substation. The standard radius will be set to approximate the longest distance factoring the MW size of resources selected that economically feasible interconnection power lines (gen-ties) typically fall within. This standard radius, path viability, and busbar voltage - all key drivers of interconnection cost - will be used when mapping each resource type as follows:

²⁹ Available at <https://data.ca.gov/dataset/california-electric-substation2>
<https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-substations>
³⁰ CAISO transmission capability estimates are available at <http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=82442AF7-0A68-4BFC-86FD-AAE1B066AE5E>

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- a. Solar – calculate the amount of renewable resources with lower environmental implications within each substation radius. Allocate the transmission planning area-level solar resources to substations based on the available lower environmental implication area within the substation radius.
 - b. Wind - compare the location of wind energy resources to each substation radius and allocate the transmission planning area-level wind resources to substations in closest proximity. High- and low-environmental-implication information will be identified, but options for moving the resource to a different substation will be more limited for wind, given the site-specific nature of the resource. For offshore wind, the transmission planning area-level resource is allocated to substations in closest proximity that have been identified as potential offshore winder interconnection points. For out of state wind, the area-level resources are allocated to the point of interconnection substation respecting where the resource is injected into the CAISO system.
 - c. Geothermal – compare the location of geothermal energy resources to each substation radius and allocate the transmission planning area-level geothermal resources to substations in closest proximity.
 - d. Biomass - compare the location of biomass energy resources to each substation radius and allocate the transmission planning area-level biomass resources to substations in closest proximity.
 - e. Location specific long duration energy storage – compare the location of long duration energy storage resources that are limited to a specific geographic area to each substation radius and allocate the transmission planning area-level long duration energy storage resources to substations in closest proximity.
 - f. For resources which fall outside the standard substation radius, or have identified issues likely to significantly increase interconnection costs, CPUC staff will conduct further analysis outlined in Step 2B.
- 7) CEC staff will work with CPUC staff to review the CAISO’s Transmission Capability Estimates to check that resources are not mapped in such a way that departs from the high-level allocation of the IRP portfolios, which should already be respecting capability limits - the existing system “Estimated Full Capacity Deliverability Status Capability (MW)” and the “Estimated Energy Only Deliverability Status Capability (MW)” for each transmission constraint or triggering upgrades where intended. Any triggered transmission upgrades will be highlighted, and examined by the CAISO and CPUC staff in Steps #3 and #4.
- 8) CEC staff will develop a spreadsheet to report out the results of the megawatt allocations by substation, for each renewable energy resource. It will include details of the specific methodology applied, enabling reporting against the criteria outlined in the Busbar Mapping Criteria section below, and any notes needed to interpret and understand the allocation outputs.

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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.

CPUC – Step #2 – Part B

The CPUC staff will provide draft portfolio dashboards to the CAISO and CEC staff after each round of busbar mapping and do the following:

1. CPUC staff will utilize the information provided by CEC staff above to assess mapped resources compliance with land-use, environmental, distance to transmission, and transmission capability limits described in Section 9 Busbar Mapping Criteria and Implementation. Staff will conduct addition review on mapped resources alignment with LSEs' plans and the CAISO and other BAA interconnection queues and consistency with prior years' base case portfolios.
2. With respect to mapped resources' interconnections to substations identified by CEC staff, CPUC staff will conduct, as necessary, further interconnection analysis on mapped resources that fall beyond the standard radius or CEC staff identified possible interconnection path viability issues or a busbar voltage that may lead to additional interconnection costs. For resources that fall beyond the standard radius, staff will compare their interconnection cost assumed in the supply curve, and the gen-tie distance it allows, to the distance to the busbar identified in busbar mapping. ~~If the distance to the substation is greater, then depending on the busbar voltage, this may mean a criterion has not been met; refer to the Busbar Mapping Criteria section below.~~
3. CPUC staff will complete battery mapping as outlined in Section 8: Battery Storage
4. CPUC staff will assess mapped non-battery and battery resources' compliance with existing transmission capability limits and confirm any transmission upgrades triggered alleviate transmission capability exceedances in a demonstrated cost-effective manner. Staff will incorporate the transmission related impacts of battery mapping and account for the co-location of battery storage with mapped solar resource.
5. CPUC staff using the process established in Thermal Generator Retirement Assumptions, Section #10, will identify thermal generation units not retained and should be assumed as retired for the transmission planning process
6. CPUC staff will develop draft dashboard worksheets for each portfolio to summarize the mapping results, their transmission capability limit alignment, and their compliance with the busbar mapping criteria.

Stakeholder participation:

- Stakeholders will be provided opportunities to comment on this busbar mapping methodology and to review the mapped resource portfolios. Further, stakeholders'

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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 #3

During each round of busbar mapping the CAISO staff will provide the CEC and CPUC staff the following:

- A high-level review of the CEC's and CPUC's draft busbar allocations and the conceptual transmission upgrades that the CPUC and CEC determined are likely to be required based on the mapping in Steps #1 and/or #2, 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
- If the CEC and 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, recommended portfolio modifications needed.

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 CAISO's observations and any recommended modifications to identified transmission upgrades will be reported in the CEC's mapping results and/or in the CPUC's report

CPUC – Step #4

CPUC staff will review the draft mapping by CEC staff, as well as observations and recommendations from CAISO staff. Using the busbar mapping criteria, described in the Implementation of the Busbar Mapping Criteria section below and the resulting portfolio dashboards developed in Step #2, 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.

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The CAISO staff will provide feedback on the CEC's draft busbar allocations, including verifying: ¶ Transmission zone and sub-zone capability limits ¶ The CAISO will assess whether the selected new resources by transmission zone (MW) are consistent with the CAISO transmission capability estimates³¹. If not, then the CAISO staff will provide interpretation, which may include reference to the latest CAISO Business Practice Manual deliverability methodology³². ¶ Interconnection

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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. This can be implemented and demonstrated by using RESOLVE directly, or manually while mirroring the resource optimization criteria RESOLVE uses.

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.

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8. Battery Storage Mapping Steps

Introduction

Mapping battery storage to busbars differs from the methodology for non-battery resources described earlier in this document for reasons including:

- The locational information for selected battery storage provided by RESOLVE is not as granular as that provided for resource types such as wind or geothermal;
- RESOLVE provides some flexibility in siting storage due to not directly linking the battery storage to solar, wind or other input resources;
- With charging and discharging, the interaction of batteries with the transmission grid is different than that of generation resources
- Land use considerations and environmental implications associated with siting batteries are different than for other resources; and
- Busbar mapping of battery storage provides the opportunity to consider local values not modeled in RESOLVE.

The methodology used for mapping batteries is centered around the intersection of policy objectives and commercial interest. The feedback from stakeholders and the lessons learned from the previous mapping effort highlighted a few reasons why this update to the methodology is necessary. They include:

- Busbar mapping of batteries presents an opportunity for proactive planning that helps ensure that the battery storage development contributes to achieving the range of state policy goals – like GHG reduction, reliability, and cost minimization – for which the battery resources were selected in RESOLVE;
- Busbar mapping of batteries also allows batteries to contribute to achieving additional policy goals which were not optimized for in the RESOLVE model (i.e. policy goals that require locational specification of batteries); and
- Busbar mapping of batteries can contribute to addressing issues related to operations and retirements of specific plants located in disadvantaged communities (DACs) and locations with high air quality health impacts (areas with non-attainment for ozone and PM 2.5).

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¶ For the 2021-2022 TPP the battery mapping exercise will be

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The execution of the battery mapping effort to achieve the policy objectives will be completed in such a way that they are in accordance with the guiding principles outlined in Section 5: Guiding Principles above. The following sections highlight the proposed policy objectives, the issues to be addressed, and the data required to ensure the execution of the battery mapping will achieve the desired results.

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Stakeholders will be provided opportunities to comment on the battery 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.

Battery Mapping Policy Objectives

The RESOLVE model selects a least-cost optimized portfolio that meets a range of system-level policy goals. To remain consistent, it is important that the battery mapping effort is also grounded in a policy **objective** that ensures costs are minimized.

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Policy Objective #1: Minimizing Ratepayer Costs

The first policy **objective** that will be achieved by this battery mapping effort is a minimization of ratepayer costs. This will be done by maximizing the value of the storage MW and durations selected by RESOLVE as needed to meet system needs, by considering additional locational benefits.

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Issues Addressed:

The execution of the battery mapping effort to achieve this policy directive will address the following issues:

- Increasing the amount of co-located battery resources. Generally, co-located batteries are cheaper than stand-alone batteries.³³ The mapping exercise will be executed in such a manner that siting of co-located batteries will be maximized to the limits of available solar resource for charging and without triggering a need for new transmission development. The meaning of the term "co-located" in this busbar mapping exercise is based on the CAISO tariff definition.³⁴ In addition to the potential tax incentive benefits from solar, co-location of solar and battery storage can be used to prevent exceeding existing transmission capability limits when the battery resources assume the full **deliverability** (FD) status of the solar resource they are co-located with, and the busbar mapping of the storage is not intended to trigger transmission limits. This FD transfer is considered for two reasons, a significant amount of commercial interest in battery storage is co-located and hybrid resources,

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³³ 2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark, Ran Fu et al. NREL. November 2018. <https://www.nrel.gov/docs/fy19osti/71714.pdf>

³⁴ Available at: <http://www.caiso.com/Documents/Sep16-2020-Tariff-Amendment-Hybrid-Resources-Phase-1-ER20-2890.pdf>

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also given the low marginal ELCC of new solar resources in the portfolios (2%), co-location with storage will preserve the FD status of the busbars.

- Reducing congestion. In the CAISO analysis of Local Capacity Requirement (LCR) areas some battery resources are proposed as solutions for allowing increased imports into constrained areas during off peak periods. An additional benefit of siting battery storage resources in LCR areas, particularly LCR areas with solar resources with which the battery resource can be co-located, is to reduce transmission congestion and curtailment. The mapping exercise will be executed in such a way that these benefits will be evaluated, to the extent possible, when assigning battery resources to LCR areas with congestion.
- Reducing opportunities for market power. For certain LCR areas, local RA price premiums exist when natural gas-fired power plants are needed to provide capacity to local areas. In LCR areas with, or approaching, tight load/resource balances, these power plants may have the opportunity to exert market power (for instance, by seeking market exit but necessitating a reliability must run agreement). The execution of the battery mapping exercise will seek to site battery storage resources in such local capacity areas, which can reduce market power and the local price premiums paid to such resources. Concerns around reliability, particularly given the August 2020 rotating outages, require that some additional consideration will need to be given to the impact of the elimination of such premiums on resource retention needed for both local and system reliability.

Policy Objective #2: Minimizing Criteria Pollutants

The second policy directive is borne out of a desire to use the battery mapping effort to achieve additional policy goals which are not necessarily yet considered explicitly in the RESOLVE modeling. The minimization of criteria pollutants is proposed to utilize the batteries, especially the stand-alone resources, to address a range of localized issues which are not represented in the RESOLVE optimization.

Issues Addressed:

The execution of the battery mapping effort to achieve this policy directive will address the following issues:

- Reduction of local emissions, particularly in areas with high air quality impacts. Siting batteries in these areas can reduce local price premiums for the criteria air pollutant emitting fossil-fuel resources, yet those resources may still be required for system RA needs. However, even if emitting plants do not retire, siting batteries in areas with acute air quality concerns has the potential to reduce local power plant emissions, especially in transmission-constrained LCR areas. Similarly, a consideration is the necessity of the emitting resources for system reliability needs.
- Reduction of emissions in Disadvantaged Communities (DACs). Siting of battery resources specifically within DACs may enable pollution reduction in these communities, as well as potential economic benefits from battery storage development. PU Code Section 454.51 requires the CPUC to “...adopt a process for each load-serving entity...to file an integrated resource plan...to ensure that load-serving entities do the following... Minimize air pollutants with early priority on disadvantaged

communities...” among other requirements. LSEs can procure batteries in DACs to prioritize the minimization of air pollutants in these specific communities.

The battery mapping for the 2020-2021 TPP considered LCR areas and the mapping of batteries to ameliorate the issues in those areas. However, the possibility of using batteries to reduce the air quality issues in DACs was not addressed by the methodology utilized to map resources to busbars for the 2020-2021 TPP. The methodology developed for the 21-22 TPP improved on the 2020-2021 TPP battery mapping by explicitly considering the alignment of LCR opportunities with disadvantaged communities and/or those areas facing air quality concerns, and this is maintained in this version of the methodology.

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Battery Mapping Steps

The battery mapping steps detailed below will holistically consider the policy directives described in the previous section. The steps represent a direction for assigning both co-located and stand-alone batteries. To complete this task, information on battery opportunities in LCR areas, local air quality, and characterization of DACs will be used. Additionally, the battery mapping effort will coordinate with the non-battery busbar mapping effort to optimize for collocation with solar resources, and to account for availability of transmission headroom, triggering transmission development where it is determined to be cost-effective. The CalEnviroScreen dataset provides information on emissions, air quality, and DAC assignments. This busbar mapping exercise will consider only DACs located within California as defined by SB535³⁵. Ozone and PM nonattainment areas data from the EPA Green Book also provide information on air quality burdens for areas outside of DACs. GIS level data on local emissions, DACs, and LCR areas will be needed to ensure the mapping effort is consistent with the available data being used in the non-battery mapping efforts. CAISO Local Capacity Technical studies provide information on opportunities to displace LCR resources with battery storage. The non-battery mapping exercise will provide information on the amount of solar that is mapped to a busbar and the available transmission headroom.

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Outline of Battery Mapping Steps

The battery mapping in Step 1 of the process discussed in Section #6 above will be done in two phases:

- First Phase: Battery resources will be assigned to zones based on the zonal battery resource selections results from the RESOLVE capacity expansion analysis.
- Second Phase: A manual check will be carried out to identify if there is any available transmission headroom which was not reflected in the RESOLVE analysis due to the simplified approach used in interpreting the CAISO transmission deliverability data in RESOLVE. If there is any available headroom, coordination with the non-battery mapping analysis will determine whether battery resources will be assigned to these zones or not.

³⁵ Available at: <https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30>

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The battery mapping analysis for Step 2 of the process discussed in Section #6 will utilize the steps described below:

1. Identify primary substation list – substations to be considered and their assigned transmission constraints
 - a. This step will utilize the same substations just as the non-battery mapping.
 - b. All substations located in identified transmission constraint with voltage ≥ 115 kV, unless otherwise indicated in the non-battery mapping.
2. Receive zonal build results from RESOLVE capacity expansion analysis
3. Identify the transmission headroom available for the corresponding transmission constraints for the zone
 - a. This step will consider the transmission headroom available for the transmission of each busbar using the most recent TPP base scenario.
 - b. This step will utilize the most recent CAISO transmission deliverability data
4. Identify how much FD solar and wind is assigned to the substation
 - a. This step will utilize information from the non-battery busbar mapping exercise.
 - b. This step will also utilize the most recent CAISO transmission deliverability methodology.
5. Identify commercial interest at that substation
 - a. This step will use the CAISO Interconnection Queue data
 - b. This step will also utilize information from the non-battery busbar mapping exercise
 - c. This step will also utilize the planned procurement indicated in the most recent LSEs' plans
6. Identify whether the substation is in an LCR area
 - a. Batteries mapped to LCR areas will be prioritized based on the CAISO's 2030 Local Capacity Technical study results³⁷, which show the level of 4-hour battery storage that the CAISO states can provide both system and local capacity value within each LCR area.
 - i. The 4-hour battery storage limit represents the amount of 1 MW-for-1 MW replacement of resources that the battery storage resource can achieve while providing both system and local capacity value within the LCR area
 - ii. Beyond these 4-hour limits, the battery mapping will also allocate system-only battery resources within the LCR areas, unless the 4-hour battery storage quantity is indicated to be a physical constraint for siting in the LCR area.
 - b. Assign a value 1 if the substation is in an LCR area.
7. Identify whether the substation is in a DAC
 - a. This step will utilize the CalEnviroScreen DAC status
 - i. Assign a value 1 if the substation is in a DAC
8. Identify whether the substation is in an air quality standard non-attainment area
 - a. This step will utilize the EPA Greenbook data
 - i. Assign a value 1 for each of the non-attainment areas the substation is in
9. Identify whether the substation is in a zone that has high curtailment

³⁷ Available at: www.caiso.com/Documents/AppendixG-BoardApproved2020-2021TransmissionPlan.pdf

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This will preserve the amount of FD provided by the substation and prevent triggering a transmission upgrade

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- a. This step will utilize the CAISO 2020-2021 Transmission Planning Process [results](#)³⁸
- b. Three tiers of curtailment value are used.
 - i. Greater than 10% but less than 20% - assign a value 0.25
 - ii. Greater than 20% but less than 30% - assign a value 0.5
 - iii. Greater than 30% - assign a value 1

10. Identify whether the substation is in the proximity of a fossil-fueled plant that has been identified by the process established in Thermal Generator Retirement Assumptions, in Section #10

- a. Four tiers of rank values are used
 - i. Distance greater than or equal to 7 miles – assign a value of 0.
 - ii. Distance greater than or equal to 2.5 miles but less than 7 miles – assign a value of 0.25
 - iii. Distance greater than or equal to 0.25 miles but less than 2.5 miles – assign a value of 0.5
 - iv. Distance less than 0.25 mile – assign a value of 1

11. Rank all substations in order of highest rank to lowest rank based on sum of all assigned values.

- a. The rank order represents the priority of a substation for consideration of allocation of battery resources.
- b. If there is no available transmission headroom to assign battery resources at this substation the allocation will move to the next highest ranked substation

12. Allocate batteries based on the rankings from step 11 using the following order and considerations.

- a. Batteries will first be assigned to substations with transmission headroom and commercial interest. Priority will first be given to resources located in LCR areas that will provide both system and local capacity value. The hierarchy followed is shown below
 - i. Substations contained within LCR areas, DACs, non-attainment status areas and high curtailment areas
 - ii. Followed by substations with the highest number of each of the four status categories in descending order of rank
- b. After the LCR system and local capacity value stand-alone resources are mapped, system-only stand-alone resources will then be mapped.
- c. After completing the mapping of the stand-alone **batteries**, batteries will be assigned to substations with FD solar resources using the order in step 12a.
 - i. This step will use the updated CAISO transmission deliverability methodology
 - ii. Based on the results of the non-battery mapping batteries will be assigned to substations with FD solar **and wind are** allocated and where commercial interest for battery storage is shown.
- d. If there are still unassigned battery resources after steps a through **d** have been executed, then batteries will be assigned manually based on further interaction with

³⁸ Available in Section 3.7 of the 2020-2021 TPP at: www.caiso.com/Documents/BoardApproved2020-2021TransmissionPlan.pdf

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Beyond these zones the 90% constraint is not applied.⁴

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The assigned battery resources will receive the FD status of the assigned solar resources such that the total FD value is preserved without triggering transmission upgrades.⁴

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the non-battery busbar mapping and consistency with previous TPP busbar mapping results. The order of assignment is as follows:

- i. Prioritize substations where transmission exceedances have not occurred when resources have been mapped beyond the initial stated transmission headroom values
- ii. If there are no such substations, map to substations where exceedance has occurred.
- iii. Both mappings will follow the steps below:
 1. Prioritize zones where non-battery busbar mapping in any of the three scenarios has triggered transmission upgrades.
 2. Prioritize substations within these zones that have available transmission headroom after accounting for the non-battery resource busbar mapping.
 3. Prioritize substations that have battery commercial interest
 4. Spread the remaining battery capacity evenly across substations that meet criteria 1. through 4.

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9. 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 the IRP portfolios. The busbar mapping criteria are as follows:

- Distance to transmission of an appropriate voltage
 - Selected candidate resources should fall within an economically viable distance to transmission; and the resource interconnection path should be viable from an environmental and land use perspective (i.e., path that does not cross high-environmental implication areas or dense urban areas) as well as a project size perspective (i.e. a longer gen-tie may be economically feasible for a larger MW amount of selected resources).
 - CEC will flag applicable resources for which the recommended busbar allocation results in an exceedance of a predetermined standard radius (explained below). As described in Section 7: Non-Battery Busbar Mapping Steps, the exceedance of the predetermined standard radius does not necessarily mean the busbar allocation is not plausible because the resources might still be economically viable with a longer/higher cost gen-tie.
- Transmission capability limits
 - Selected resource allocation to a given busbar should abide by all the estimated 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
 - Where busbar mapping utilizes planned substations rather than existing substations, this will be highlighted because of the inherently higher uncertainty regarding the substation in-service date
 - Busbar mapping process might also identify resources that cannot interconnect to an existing or planned substation because the resource is triggering a transmission upgrade that has not been previously studied 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.
- Land use and environmental constraints
 - Allocation in each area should not exceed available land area to accommodate the resources, based on environmental information applied in Step #2 above

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- If available land area is insufficient to accommodate selected resources within reasonable distance to the substation, or if the resources have high environmental implications, then these issues will be flagged and addressed in a further round of mapping. Possible solutions may include increasing the gen-tie beyond the standard radius for the particular resources if their interconnection cost estimates allow, or re-optimizing the IRP portfolio(s) with updated assumptions about resource potential informed by this busbar mapping process.
- Commercial interest
 - 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, as well as projects in advanced stages of development identified through working group communications.
 - In considering commercial interest, the CPUC will
 - Compare selected portfolio resources to interconnection queues and other sources, on a busbar basis
 - Take into account the stage of development as well as the expected online date of the commercial interest
 - 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
 - “High-confidence” commercial interest is defined by those projects that have an interconnection agreement executed and resources identified in LSE plans
 - 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 year
 - 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.

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 five key 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 as follows below. “Level 1” refers to strong compliance; “Level 2” to possible or moderate breach of a criterion; and “Level 3” to a likely or material breach,

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indicating that a further round of mapping is required to improve compliance. Blank cells are shown in the dashboards where there is insufficient data to assess compliance.

1. Distance to transmission of an appropriate voltage
 - a. Level 3 non-compliance threshold (i.e., exceedance of this threshold results in Level 3 assessment):
 - i. Resources for which the busbar allocation results in viable gen-tie lengths that exceed a 20 mi. threshold (standard radius) approximated from the 90th percentile for planned solar and wind facilities:^{41,42,43}
 - b. Level 2 non-compliance threshold:
 - i. Resources for which the busbar allocation results in viable gen-tie lengths that exceed a 10 mi threshold (standard radius) approximated from the 75th percentile distances for planned solar and wind facilities.
 - c. Consideration of busbar voltage: When assessing distance staff will check the voltage of the busbar to ensure the combination of gen-tie length and interconnection voltage broadly align with the interconnection cost allowed for in the resource's selection. Accordingly, assessment of compliance with this criterion should not be based solely on the standard radius; in general, the thresholds above apply to busbar voltages in the range of 115-230kV. Further, staff should look for opportunities to minimize expected costs for ratepayers, for example by mapping to a busbar that may be more distant yet with a lower voltage than the alternative busbar.
 - i. Resources allocated to a busbar which exceeds 230kV will initially be considered Level-2 non-compliance and assessed for opportunities to re-map to lower voltage busbar.
 - d. Consideration of the MW amount of selected resources mapped to substation: When assessing interconnection distance and cost staff, will also consider the MW amount of resources selected at a substation and the per MW cost of interconnection. A small MW amount of a selected resource may economically require a shorter gen-tie distance than a potential larger project of the same resource type.
 - e. For out-of-state resources staff will take the following approach:
 - i. For out-of-state land area availability
 1. Use the spatial wind and solar resource potential information available in the "Low-impact land use pathways to deep

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Wind: 18.7 mi⁴⁵(90th percentile, planned facilities) [NEW] ¶

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⁴¹ 90th percentile of planned facilities, per publicly available filings: EIA (last) (2019). Preliminary Monthly Electric Generator Inventory (Based on Form EIA-860M as a Supplement to Form EIA-860).[Online]. Available at: <https://www.eia.gov/electricity/data/eia860m/.11>

⁴² Spatial analysis was performed to check the interconnection distances for existing and planned solar facilities in the U.S. Source data for existing solar facilities: USGS "National Solar Arrays" <https://www.sciencebase.gov/catalog/item/57a25271e4b006cb45553efa>. Source data for planned facilities: U.S. Energy Information Administration, Form 860, public filings <https://www.eia.gov/electricity/data/eia860m/.11>

⁴³ Spatial analysis was performed to check the interconnection distances for existing and planned wind facilities in the U.S. Source data for existing wind facilities: USGS national wind turbine database "USWTDDB" <https://doi.org/10.5066/1-71X3DN0>. Source data for planned facilities: U.S. Energy Information Administration, Form 860, public filings <https://www.eia.gov/electricity/data/eia860m/.11>

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decarbonization of electricity” study⁴⁶ to assess distance to transmission

2. Note this source identifies four levels of wind, solar, and geothermal resource potential, based on four levels of environmental screening criteria. Resource potential from any “Siting Level”, from 1-4, may be used. Siting Level 1 excludes only those areas where development is legally prohibited, and Siting Level 4 excludes all important habitat, intact landscapes, wildlife corridors, and areas with conservation value. Siting Level 2 will be used for out-of-state resources. This excludes wetlands and designated endangered species habitat but does not exclude big game priority habitat or Audubon Important Bird Areas.

2. Transmission capability limits

a. Level 3 non-compliance threshold:

- i. Selected resource exceeds transmission capability for the applicable transmission constraints (FCDS or EODS).

b. Level 2 non-compliance threshold

- i. Selected resource exceeds transmission capability for the applicable default transmission constraint

Note: If the selected resources exceed transmission capability for the applicable transmission constraints but the exceedance is alleviated by a transmission upgrade determined to be cost-effective or necessary then the selected resources are considered compliant with the criteria.

3a. Available land area

a. Level 3 non-compliance threshold:

- i. Exceeds 100% of candidate project area land within the standard radius.

b. Level 2 non-compliance threshold:

- ii. Resources for which the busbar allocation results in exceedance of 100% of the low-value land area estimated to be available to accommodate a resource.

3b. Environmental Impact

a. Level 3 non-compliance threshold:

- i. Exceeds 75% of high-value land (terrestrial) in the resource potential areas within the standard radius, for four or more, or 95% for two or more of the following:
 1. Intactness
 2. Biodiversity
 3. Connectivity
 4. Rarity
 5. Native species

⁴⁶ Grace C Wu, Emily Leslie, Oluwafemi Sawyerr, D Richard Cameron, Erica Brand, Brian Cohen, Douglas Allen, Marcela Ochoa and Arne Olson, “Low-impact land use pathways to deep decarbonization of electricity,” Environmental Research Letters, vol. 15, no. 7, Jul. 2020. doi: <https://doi.org/10.1088/1748-9326/ab87d1>. [Online]. Available at: <https://iopscience.iop.org/article/10.1088/1748-9326/ab87d1>

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- 6. Audubon Important Bird Areas (IBA)
- 7. Important habitat
- 8. Wildfire threat
- 9. Irreplaceability

b. Level 2 non-compliance threshold:

- i. Resources for which the busbar allocation results in exceedance of 50% of the low-environmental-implication land area estimated to be available to accommodate a resource
- ii. Resources for which the busbar allocation results in 75% of two or more, or 95% or more of one

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Notes regarding available land area and available low-value land area criteria:

- Refer to the approaches described above for criterion 1, for out-of-state resources, which are also applicable for criteria 3a and 3b
- If based on review of the portfolios, these thresholds turn out to be too low (for example, if approximately half or more of the new resources get flagged at level 3 non-compliance, and this would trigger further rounds of mapping of a large portion of the portfolio, creating a major departure from the logic and optimization objective within RESOLVE), then staff may adjust these thresholds accordingly.

4. Commercial interest

a. Level 3 non-compliance threshold:

- i. Selected resource (any amount) at a busbar without any commercial interest; or
- ii. Commercial interest at selected busbar is evident, yet selected resource amount is lower by more than an amount to be specified based on the queue data at the time of mapping.

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b. Level 2 non-compliance threshold:

- i. Commercial interest at selected busbar is evident, yet selected resource amount is higher or lower than the "high confidence" commercial interest by an amount to be specified based on the queue data at the time of mapping.
- ii. Commercial interest at selected busbar is evident but the expected online date is a year or more later than the portfolio's resources' online date.
- iii. No commercial interest at selected busbar, but selected resource's modeled online date is beyond expected online dates for any commercial interest.

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5. Consistency with prior year's mapping

a. Level 3 non-compliance threshold:

- i. 500 MW or greater or a 50% or greater reduction from prior year's base case portfolio (to identify material absolute changes from prior year's mapping or changes that may be smaller in absolute terms yet are still significant in percentage terms)

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b. Level 2 non-compliance threshold:

- i. Any reduction from prior year's base case portfolio

Note: If based on review of the portfolios, these thresholds turn out to be too low (for example, if approximately half or more of the new resources get flagged at level 3 non-compliance, and this would trigger further rounds of mapping of a large portion of the portfolio, creating a major departure from the logic and optimization objective within RESOLVE), then staff may adjust these thresholds accordingly.

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10. Other TPP Assumptions

Thermal Generator Retirement Assumptions

RESOLVE reports the aggregate amount of thermal generation not retained by resource category. Unit-specific information is not modeled. Because the TPP studies require modeling of specific units and locations, CPUC staff will apply the following steps to RESOLVE’s aggregate data on thermal generation not retained in order to specify in the transmitted portfolios which units should be assumed as retired for transmission planning purposes:

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1. Rank all existing thermal generation units by age in the categories of combined cycle (CCGT), combustion turbine (Peaker), reciprocating engine (ICE) and combined heat and power (CHP). Staff recognizes there are additional economic considerations on CHP operations.
2. Model offline the oldest units, up to but not exceeding the total amount selected in RESOLVE, broken down by resource category up to the limits below. While CHP is not specifically modeled in RESOLVE and therefore cannot be one of the thermal generator types not selected for retention, CHP often operates similarly to a CCGT unit, so CPUC staff will retire CHP and CCGT up to the limit for the CCGT category in the table below.
3. CPUC staff will share the specific list of retired units with CAISO, and *if necessary*, through consultation, CPUC staff will assemble a list that does not create additional transmission needs. This will include in the following order:
 - 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 in reverse order of the list developed in steps 1 and 2.
4. If specific local units are turned back on in step 3.b. then an equal amount of additional system generation capacity will be modeled off-line following steps 1 and 2.

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The above steps aim to minimize any post-processing work by the CAISO. 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 in steps 1 and 2.

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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. 17-09-020 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, fast-response Reliability Demand Response Resources (RDRR) or slow-response Proxy Demand Response (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.

Separately, and coupled with the CPUC's annual Load Impact Protocols (LIP) filings,⁴⁷ IOUs are to submit a second, updated filing. Thus, the data for the TPP is first filed in mid-February, followed by the LIP final Report filing in April, which is then followed by the updated filing in August of the same year.

While we recognize that the annual TPP Study Plan that concludes in March already incorporates busbar-level details, this additional reporting will validate the results from the earlier filings.

Because the data requirements specified in both filings contain confidential information, the CPUC expects the CAISO and the IOUs to exchange data using their own non-disclosure agreements.

Contact and recipient details for these filings will be provided by the CAISO. Both the TPP and updated filings are to contain the following:

1. Portfolio aggregate ex-ante load impacts (in MW), by program, for 1-in-2 under CAISO's August system peak, for each of the full ten-year forecast period, disaggregated by Western Electricity Coordinating Council (WECC) transmission level busbar, in plain Excel format. The WECC busbar shall be identified by two columns (fields):
 - a. WECC busbar number as used in CAISO power flow models;
 - b. Substation identifier/name (for example, [22256, ESCNDIDO] for SDG&E; [24214, SANBRDNO] for SCE; and [33207, BAYSHOR2] for PG&E). This applies to all

⁴⁷ D. 08-04-060 in R. 07-01-041, "Decision Adopting Protocols for Estimating Demand Response Load Impacts" LIP Final Reports are filed annual on April 1.

dispatchable IOU DR programs and does not include non-dispatchable programs such as Time-of-Use (TOU) rates;

- c. The final year of the forecast (furthest into the future), for all program operating hours (not just the Resource Adequacy [RA] operating window). Disaggregate the data into four geographic zones: PG&E Bay, PG&E Valley, SCE, and SDG&E. PG&E Bay is defined as the Greater Bay Area Local Capacity Area (LCA) and PG&E Valley is defined as everything else in PG&E. This requirement applies to all dispatchable and non-dispatchable programs.
2. The methods and assumptions for disaggregating DR impacts by WECC transmission level busbar shall be standard and uniform across each IOU and documented in a supplemental report. To the extent this data does not sufficiently mask individual customer load information, the IOUs shall provide both a public version of the data with individual customer load information masked, and a confidential version of the data with complete information. The IOUs shall make the confidential dataset known and available to the CAISO (with applicable NDAs) by the annual deadline for its request for stakeholder input on “unified planning assumptions” for the TPP.

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