Methodology for Resource-to-Busbar Mapping & Assumptions for the 2021-2022 TPP

CPUC Energy Division
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CPUC Staff Proposal:

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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 in early 2021 to be able to inform the CAISO's 2021-2022 TPP.

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2. Document Revisions

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

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 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,[4] 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

[1] ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-03-30.pdf
[2] ftp://ftp.cpuc.ca.gov/energy/modeling/Busbar_Mapping-Methodology-2020-02-21.pdf
[3] https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/IRP_Busbar_Mapping-Methodology-2019-10-18.pdf
[4] Further information on RESOLVE is available here: https://www.cpuc.ca.gov/General.aspx?id=6442459770

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

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

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or LSEs' plans to specific busbars[5] in the transmission system before the portfolios can be transmitted to the CAISO and be considered as inputs to the TPP.

In order to disaggregate the zonal resource amounts into allocations to specific busbars CPUC staff and CEC staff translate the tabular format of the portfolios into geographic map format, while considering higher resolution information about transmission infrastructure and land use. This methodology identifies the guiding principles, busbar mapping steps, and the associated criteria for making these considerations.

4. Scope of Busbar Mapping for 2021-2022 TPP

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 2030; and for California to be on the trajectory to achieve the state's SB 100 goal[6] of 100% clean electricity by 2045, as well as 80 percent below 1990 emissions by 2050.

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 by early in the 2021 calendar year to be able to inform the CAISO's 2021-2022 TPP. 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 2020-2021 TPP.[7] That methodology was informed by stakeholder feedback on the Staff Proposal for the 2020-2021 TPP, and staff experience during implementation of the process for the portfolios transmitted for 2020-2021 TPP. It contains details of the processes used in prior years.

This methodology for mapping resources in IRP portfolios for the 2021-2022 TPP aims to improve on past efforts by:

- Updating guiding principles to ensure the busbar mapping methodology is aligned with latest policies and incorporates latest stakeholder input (for example scoring criteria

[5] "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.
[6] Detailed at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100
[7] Available at: https://www.cpuc.ca.gov/General.aspx?id=6442464144

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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 (LCT) 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, CPUC staff instead provided the CAISO with guidance on how to determine thermal generator retirement within the TPP process. Prior to 2020-2021 TPP this guidance had been communicated in a document called the "Unified Inputs & Assumptions."

Where applicable, improvements on past efforts are noted [NEW] in the sections below.

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 be consistent to the extent practical and feasible 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 planned procurement indicated in LSEs' plans and the level of commercial interest in the CAISO and other relevant interconnection queues.
- The allocations should avoid, or at least minimize, intra-zonal congestion that would otherwise be addressed – depending on the specific projects ultimately procured – through local transmission upgrades identified in the Generation Interconnection and Deliverability

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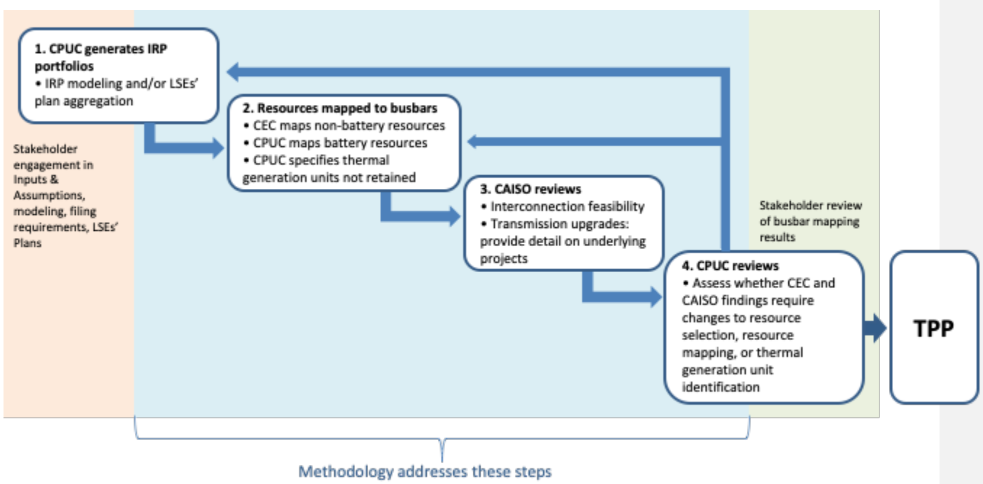
Allocation Process (GIDAP). This principle can be followed by respecting the transmission sub-zone capability limits, as well as zone limits.[8]

- 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.

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:

[8] Further described in the CAISO's 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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Step 1 - Draft portfolio(s) submitted to CEC for busbar mapping (CPUC)
Step 2 - Draft busbar mapping performed (CEC)
Step 3 - Observations and recommended revisions (CAISO)
Step 4 - Vet mapping results from CEC staff, 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)

The mapping of batteries is conducted by CPUC staff under Step 2 in parallel with the mapping of non-battery resources by CEC staff. The detailed battery mapping steps are outlined in Section 8: Battery Storage.

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 point of interconnection
    - Selected new resources: MW, by resource type, by transmission zone (tabular format)[9]. 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.
    - Resource potential estimates (geographic information system (GIS) data format – polygons and associated attribute tables) to give the CEC further information about the selected resources[10]
        - Prior to the selection of candidate resources in RESOLVE the total capacity (MW) and online date of resource potential will have been validated by comparing the resource potential in the RESOLVE planning zones with the commercial interest as indicated by the interconnection queues in those planning zones
- Transmission capability information (GIS data format)
- Transmission upgrades triggered in RESOLVE (tabular format)[11]

Stakeholder participation:

- Stakeholders will be provided an opportunity to comment on the RESOLVE inputs and assumptions (including CAISO transmission capability and cost values),

[9] 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
[10] For example, see GIS Data available at http://www.cpuc.ca.gov/General.aspx?id=6442453965
[11] 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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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

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
  - See February and March 2020 CEC Busbar Mapping Results workbooks for examples of prior work[12]

The CEC is using a busbar mapping methodology that is similar to the methodology used in prior years:

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 GIS layer 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)[13]
   - Areas of Conservation Emphasis, version 3.0 (ACE III) (California Department of Fish and Wildlife, 2018)[14]
   - Terrestrial Connectivity[15]
   - California Agricultural Value (California Energy Commission and Conservation Biology Institute, 2018)[16]

3) The 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 data will either be incorporated into the model or used as a separate overlay to compare different substation allocations.

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[12] Available at https://www.cpuc.ca.gov/General.aspx?id=6442464144
[13] Available at https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65
[14] Available at https://www.wildlife.ca.gov/Data/Analysis/Ace
[15] Available at https://www.wildlife.ca.gov/Data/Analysis/Ace#523731772-connectivity
[16] Available at https://databasin.org/datasets/f55ea5085c024a96b5f17c7ddddd1147

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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. Available substations are a subset of substations which are considered when assigning the portfolios. This subset of substations is identified in the following manner:

    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.[17]

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

        1. part of the CAISO

        2. identified as currently operational

        3. identified as having both multiple buses and bus voltages of 161 kV and above; except in cases of remote resources where the only available buses are of lower voltages.

    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 transmission zone GIS layer and substations that fall within one of the transmission zones are retained in the available substation data subset.

    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 that economically feasible interconnection power lines (gen-ties) typically fall within. This standard radius, as well as busbar voltage - the other key driver of interconnection cost - will be used when mapping each resource type as follows:

    a. Solar – calculate the amount of renewable resources with lower environmental implications within each substation radius. Allocate the

[17] Available at:
https://cecgis-caenergy.opendata.arcgis.com/datasets/california-electric-substation
https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-substations

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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.

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. For resources which fall outside the standard substation 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.

7) CEC staff will 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 overarching transmission zone and the nested constraints within, or triggering upgrades where intended. Any triggered transmission upgrades will be highlighted by CEC staff 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, in each transmission zone. 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.

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 #3

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

- Without new modeling or formal assessments, if the CAISO staff determines conceptual transmission upgrades are likely to be required based on the mapping in Steps #1 and/or #2, the CAISO will provide an estimate of the conceptual transmission upgrades' in-service date.
    - This is important because the theoretical in-service date for the upgrade might not align with the on-line date for the selected candidate resources that triggered the transmission upgrade
    - If the transmission upgrades likely to be required are at a scale that exceeds any that has been studied by the CAISO, there is unlikely to be any further information available, and this will be noted
- 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 estimates[18]. If not, then the CAISO staff will provide interpretation, which may include reference to the latest CAISO Business Practice Manual deliverability methodology[19].
    - Interconnection feasibility, including electrical suitability and physical space availability at each substation, if this information is available from the transmission owner
    - Status of active and previously queued resources as indicated by interconnection queue; which is a supplemental check to the upstream validation of resource potential performed by the CPUC staff as described in Step #1 above
- If the CEC staff maps portfolio resources to substations in BAAs other than the CAISO, then the CAISO staff will consult appropriate planning entities during the resource modeling phase of TPP. These planning entities may recommend adjustments to locations and size of resources in their BAAs mapped by the CEC staff. 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

[18] Available at: http://www.caiso.com/Documents/WhitePaper-TransmissionCapabilityEstimates-InputtoCPUCIntegratedResourcePlanPortfolioDevelopment.pdf
[19] Available at: https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Generator%20Interconnection%20and%20Deliverability%20Allocation%20Procedures

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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 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

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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, 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 zones. Such inter-zonal 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.

8. Battery Storage Mapping Steps

Introduction

Mapping battery storage to busbars differs significantly to the methodology for non-battery resources described earlier in this document for reasons including: RESOLVE provides no locational information about selected new batteries; RESOLVE provides flexibility in siting storage due to not directly linking the battery storage to solar, wind or other input resources; land use considerations and environmental implications associated with siting batteries are very different in nature, and busbar mapping of battery storage provides the opportunity to consider local values not modeled in RESOLVE.

The 2020-2021 TPP battery mapping effort relied entirely on commercial interest data indicated by the CAISO Generator Interconnection Queue and supplemented by the material modification assessment (MMA) requests received by CAISO in December 2019. The benefits of this methodology were two-fold: it was a simple approach that allowed for completion of

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the mapping effort within the short timeframe, and it satisfied the CAISO requirement that locations should be specified for all resources in the portfolio. However, because this method was not directly related to specific policy objectives, it was difficult to demonstrate how the battery mapping effort could be used to achieve a range of state-wide goals.

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

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 and also address some of the specific issues highlighted during feedback from the battery mapping effort for the 2020-2021 TPP portfolios. 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.

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

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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 directive that ensures costs are minimized.

Policy Objective #1: Minimizing Ratepayer Costs

The first policy directive 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.[20] Stakeholder comments from the 2020-2021 TPP battery mapping effort identified a need to increase the amount of co-located battery resources. 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.[22] 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 deliverabilty (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, 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

[20] 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

[22] Available at: http://www.caiso.com/Documents/Sep16-2020-Tariff-Amendment-Hybrid-Resources-Phase-1-ER20-2890.pdf

Deleted: The meaning of the term "co-located", as used in this busbar mapping methodology, is not as narrow as the definition used by the CAISO[21]. The granularity of the information available does not allow CPUC staff to delineate whether these resources are "hybrid" or "co-located" based on the CAISO definition

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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. This is being considered because not all DACs fall within LCR areas. This round will consider the alignment of LCR opportunities with disadvantaged communities and/or those facing air quality concerns.

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, to avoid triggering unnecessary transmission development. 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 SB535[23]. 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

[23] Available at: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

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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.

Outline of Battery Mapping Steps

1. Identify primary substation list – substations to be considered and their assigned transmission zones
    a. This step will utilize the substations identified in the non-battery mapping.
    b. All substations located in transmission constraint zones, with voltage >= 161 kV, unless otherwise indicated in the non-battery mapping.
2. Identify the transmission headroom available for the transmission zone
    a. This step will consider the transmission headroom available for the transmission of each busbar using the most recent TPP base scenario, prior to any non-battery busbar mapping
    b. This step will utilize the CAISO whitepaper data
    c. This step will recognize the nested zones transmission constraints
3. 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 utilize the new CAISO transmission deliverability methodology[24].
    c. Specifically, this step will transfer the FD status of the solar resources already allocated to the battery storage resources
    d. This will preserve the amount of FD provided by the substation and prevent triggering a transmission upgrade
4. 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 LSEs' plans
5. Identify whether the substation is in an LCR area
    a. Batteries mapped to LCR areas will be prioritized based on the CAISO's Draft 2030 Local Capacity Technical study results[25], 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.

[24] Available at: http://www.caiso.com/Documents/Presentation-OpportunitiesforAddingStorageatExistingorNewGenerationSites-Nov4-20
[25] Available at: http://www.caiso.com/Documents/Presentation-2020-2021TransmissionPlanningProcess-Sep242020.pdf

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This step will utilize information from the non-battery busbar mapping exercise

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6. 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
7. 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
8. Identify whether the substation is in a zone that has high curtailment
    a. This step will utilize the CAISO 2020-2021 Transmission Planning Process[26]
    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
9. Allocate batteries based on identifications 1-8 using the following order and considerations.
    a. Assignments of nameplate capacity of battery resources will be up to a maximum of 90% of available transmission headroom within renewable transmission zones[28].
        i. Beyond these zones the 90% constraint is not applied.
    b. 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
    c. After the LCR system and local capacity value stand-alone resources are mapped, system-only stand-alone resources will then be mapped.
    d. After steps b and c are executed for substations within the CAISO renewable transmission zones, batteries will be assigned to substations located in "Ex-zones" using the same order in b. and c.
    e. After completing the mapping of the stand-alone, batteries will be assigned to substations with FD solar resources using the order in step 9a.
        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 allocated and where commercial interest for battery storage is shown.
        iii. The limit of either 90% of the allocated solar capacity or to the maximum amount of commercial interest.
        iv. 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.

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[26] Available at: http://www.caiso.com/Documents/Presentation-2020-2021TransmissionPlanningProcess-Nov172020.pdf

[28] The transmission capability limits included by the CAISO in their May 2019 white paper titled "Transmission Capability Estimates as an input to the CPUC Integrated Resource Plan Portfolio Development," were developed specifically for solar resources and assuming that those resources would be dispatched at 90 percent of installed capacity. For example, if CAISO indicated a 1000 MW existing transmission capability limit for a zone, that indicates that the existing transmission system can handle approximately 900 MW of dispatched solar.

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Co-located batteries will be given priority. The co-located batteries will be sized to a maximum of 60% of the solar resource[27]. Batteries will first be assigned to substations with transmission headroom, FCDS solar resources,

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After the co-located battery assignments, stand-alone batteries will be assigned to substations without any solar resources using the following order¶
Substations contained within DACs, non-attainment status areas, and LCR areas with transmission headroom.¶
Substations contained within LCR areas with transmission headroom.¶
Substations contained within DACs with transmission headroom.¶
Substations contained within non-attainment status areas with transmission headroom.¶

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Contain a high quantity of commercial interest for co-located solar and battery resources¶
Have been filled primarily with solar resources¶
No transmission has been approved by the CAISO to accommodate resource development in this transmission zone¶
Assign batteries to transmission zones identified under step d.¶
For transmission zones/sub-zones with headroom, assess whether any substations with collocation commercial interest did not have any solar mapped to them in the base case portfolio transmitted for the 2020-2021 TPP. Identify whether other substations in the same transmission zone were assigned solar resources to their limit. If so, redistribute the solar resources among the substations within the same transmission zone and sub-zone to allow for colocation of batteries before adding more solar. ¶
If there are battery resources still unassigned after the steps described in steps a through f above, then batteries will be assigned to the "Ex" zones using the same order described in a through f above. ¶
¶
***Alternative Option* – battery mapping steps:**¶ ... [18]

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f. If there are still unassigned battery resources after steps a through e have been executed, then batteries will be assigned manually based on further interaction with 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 substances, map to substations where exceedance has occurred.

   iii. Both mappings will follow the steps below:

      1. Prioritize outer transmission zones where non-battery busbar mapping in any of the three scenarios has triggered transmission upgrades.
      2. Prioritize substations within these outer transmission 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

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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)
  - 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
  - Busbar allocation in given area should abide by the estimated transmission capability in each zone and sub-zone, triggering only those upgrades which are determined to be cost-effective during the formation of the IRP portfolios
  - 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
  - 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.
- 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.

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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, 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 gen-tie lengths that exceed the following thresholds (standard radius):[29]
            1. Solar: 19.8 mi[30] (90th percentile, planned facilities) [NEW]
            2. Wind: 18.7 mi[31] (90th percentile, planned facilities) [NEW]

[29] 90th percentile of planned facilities, per publicly available filings: EIA (last) (2019). Preliminary Monthly Electric Generator Inventory (Based on FormEIA-860M as a Supplement to Form EIA-860).[Online]. Available at: https://www.eia.gov/electricity/data/eia860m/.11

[30] 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

[31] 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 "USWTDB" https://doi.org/10.5066/F7TX3DN0. Source data for planned facilities: U.S. Energy Information Administration, Form 860, public filings https://www.eia.gov/electricity/data/eia860m/.11

b. Level 2 non-compliance threshold:
   i. Resources for which the busbar allocation results in gen-tie lengths that exceed the following thresholds (standard radius):
      1. Solar: 10.7 mi (75th percentile, planned facilities) [NEW]
      2. Wind: 10.3 mi (75th percentile, planned facilities) [NEW]

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 161-230kV. 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. [NEW]

d. For out-of-state resources staff will take the following approach:
   i. For out-of-state land area availability [NEW]
      1. Use the spatial wind and solar resource potential information available in the "Low-impact land use pathways to deep decarbonization of electricity" study[34] 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 (Full deliverability or energy only)
         1. Applied first to all sub-zones
         2. Applied next to all outer zones

3a. Available land area
   a. Level 3 non-compliance threshold:
      i. Exceeds 100% of candidate project area land within the standard radius [NEW]
   b. Level 2 non-compliance threshold:
      ii. Resources for which the busbar allocation results in exceedance of 75% of the land area estimated to be available to accommodate a resource [NEW]

[34] 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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***Alternative Option* - distance to transmission:**
The above text is based on publicly available data characterizing planned renewable energy facilities, available through federal Energy Information Administration filings (form 860-M).

An alternative is to use the data for existing solar[32] and wind [33] facilities instead of planned facilities. The mean interconnection distance is slightly higher for planned facilities (5.8 mi for solar, 7.7 mi for wind) than for existing facilities (4.8 mi for solar, 5.7 mi for wind).

Staff proposes to use planned facilities as a more relevant indicator for likely trends in future development.

***Alternative Option* – interconnection cost:**
The above text describes the use of a single standard radius for each of wind and solar to assess distance to transmission, and a focus on considering voltage when the standard is exceeded.

An alternative is to define a different standard radius for each typical busbar voltage level, by resource type. This would enable a more granular consideration of interconnection cost and would involve effectively checking distance and voltage together.

A further alternative is to review and update, where necessary, interconnection cost assumptions in RESOLVE to reflect the latest expected interconnection costs for each resource or resource zone. This would avoid manual checks and re-optimizations.

Staff proposes using a single standard radius, supplemented with checks of voltage by exception, to balance accuracy with the practicalities of implementing a manual process. Staff recommends that RESOLVE's inputs and assumptions are updated with stakeholder input in time for 2022-2023 TPP. There is insufficient time to do this for 2021-2022 TPP.

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***Alternative Option* - out-of-state land area availability:**
The above text is based on using the publicly available, peer-reviewed, and published "Low-impact land use pathways to deep decarbonization of electricity" study.

An alternative is to use the data from the 2009 Western Renewable Energy Zones study[35] (WREZ Report). In the WREZ Phase 1 Report the Qualified Resource Areas (QRAs) were mapped and the WREZ Phase 1 process was identified. QRAs were defined as areas of high quality and dense renewable energy resources with enough capacity to potentially justify the construction of a high voltage transmission line for interstate transmission of renewable energy. QRAs needed to meet size, resource quality, environmental and technical criteria. The WREZ Zone Identification and Technical Analysis (ZITA) working group developed the economic and technical criteria to identify QRAs. The WREZ Environment & Lands (E&L) working group developed the environmental criteria to identify QRAs. Staff believes the resulting spatial data is now outdated, and the spatial granularity is coarse, but notes that the data has been through stakeholder vetting in public forums. ... [19]

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3b. Available low-value land area

a. Level 3 non-compliance threshold:
   i. Exceeds 75% of high-value land (terrestrial) within the standard radius, for four or more of the following [NEW]:
      1. Intactness
      2. Biodiversity
      3. Connectivity
      4. Rarity
      5. Native species
      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 20% of the low-environmental-implication land area estimated to be available to accommodate a resource

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) in transmission zone without any commercial interest; or
   ii. Commercial interest in transmission zone is evident, yet selected resource amount is higher or lower by more than 3,000 MW

b. Level 2 non-compliance threshold:
   i. Commercial interest in transmission zone is evident, yet selected resource amount is higher or lower by more than 2,000 MW

5. Consistency with prior year's mapping

a. Level 3 non-compliance threshold:
   i. 1,000 MW or greater reduction from prior year (to identify material absolute changes from prior year's mapping)

b. Level 2 non-compliance threshold:
   i. 60% or greater reduction from prior year (to identify changes that may be smaller in absolute terms yet are still significant in percentage terms)

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The above text is based on using the exceedance thresholds of 100% and 75% for available land, and 75% and 20% of low-value land, and four or more of the underlying GIS data layers. These thresholds are based on staff's experience from prior years' mappings. Because solar has a relatively high power density (45 MW/km2)[41], available land area is not typically a binding constraint, but wind energy's lower power density (2.7 MW/km2)[42], makes it much more sensitive to land area availability. Staff has chosen thresholds numerically, and iteratively, based on data, rather than based on any theoretical limit.

An alternative is to set land area utilization limits based on desired resource diversity or geographic diversity targets, or to change the land area utilization thresholds as new information becomes available. For example, the decreasing specific power of wind energy as more low-wind-speed turbines with higher rotor diameters become commercially available may drive higher land area requirements.[43]

Staff proposes to use the thresholds identified in the main text above based on experience, to balance accuracy with the practicalities of implementing a manual process.

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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:

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 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.

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. Refer to Section 8: Battery Storage Mapping Steps for related guidance. 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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