CPUC Staff Proposal: Methodology for 2019 IRP Resource-to-Busbar Mapping

CPUC Energy Division
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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 electrical analysis in the California Independent System Operator's (CAISO) annual Transmission Planning Process (TPP). The purpose of this methodology document is to 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.

2. IRP & TPP Context

Through the IRP process, the CPUC generates portfolios of electrical generation, storage and transmission resources designed to meet the state's 2030 greenhouse gas emission reduction targets while minimizing cost and ensuring reliability. Specifically, the IRP develops a Reliability Base Case, a Policy-Driven Base Case and Policy-Driven Sensitivities (the "IRP portfolios") every year. The 2-year cycle of IRP involves developing these portfolios with different approaches, depending on the year: in odd-numbered years RESOLVE[1], a capacity expansion model, is used; in even-numbered years Load Serving Entities' (LSE) plans are used. 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 in the near term, as well as generic future candidate resources. However, the locational specificity of the selected generic candidate resources is limited because of the geographically coarse planning zones used in IRP modeling.

In order to more accurately study the performance of the IRP portfolios at the high voltage system level, the CAISO needs to model the selected generic resources in representative sizes at specific transmission substation locations within each renewable planning zone identified in the IRP portfolios. Consequently, the selected generic resources need to be remapped outside of RESOLVE or LSEs' plans to specific busbars[2] 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, 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.

[1] Further information on RESOLVE is available here: https://www.cpuc.ca.gov/General.aspx?id=6442457210

[2] "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.

3. Scope of 2019 IRP Busbar Mapping

Deep decarbonization of the electric sector to meet California's climate goals is likely to require a transformation of the state's electrical infrastructure, i.e., significant investment in solar, wind and storage, including the associated transmission. In turn, the requirements placed on planning processes, including busbar mapping, are likely to be significant due to the need to co-optimize economic, land use, transmission, and interconnection issues associated with the amount of renewables and storage needed to be online in 2030; and for California to be on the trajectory to achieve the state's SB100 goals[3] by 2045 and 80 per cent below 1990 emissions by 2050.

The busbar mapping methodology outlined in this document is narrowly focused on achieving effective and timely busbar mapping of the utility-scale generation resources in 2019 IRP portfolios, which need to be adopted via a CPUC decision by February 2020 to be able to inform the CAISO's 2020-2021 TPP. Consequently, it is likely that the finalized 2019 busbar mapping methodology will need to be revisited in 2020 to ensure that the co-optimization issues identified above are fully incorporated in the busbar mapping methodology in time to inform the 2021-2022 TPP.

Further, the 2019 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.

Instructions for Stakeholders

- *Stakeholders are requested to provide feedback on the proposed methodology described in this document, which is focused on busbar mapping of the 2019 IRP portfolios*
- *Responses should be as specific as possible in explaining reasoning and citing references*
- *Responses should be documented according to the specific numbered questions raised throughout this document*
- *Initial suggestions on how the methodology could be further improved for busbar mapping in 2020 and beyond will help form a draft workplan in 2020*

The methodology proposed in this document builds on what was used by the agencies in prior years. For 2017 IRP portfolios, the busbar mapping methodology proof-of-concept was posted to CEC Docket 17-MISC-03[4] on February 15, 2018. For 2018 IRP portfolios, the busbar mapping methodology and results were posted to CEC Docket 17-MISC-03 on February 28, 2019, and updated on March 19, 2019.[5]

The proposed 2019 methodology aims to improve on past efforts by:

- Proposing guiding principles to guide the busbar mapping methodology
- Establishing criteria that should be used when mapping resources to busbars
- Identifying for stakeholders the specific busbar mapping steps performed by CPUC, CEC, and CAISO staff

[3] Detailed at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100
[4] Available at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-MISC-03
[5] Ibid.

- Establishing an iterative inter-agency review process that allows the CAISO to identify transmission-related issues with the mapping results before the CPUC transmits the portfolio(s) to the CAISO
- Using commercial interest identified in the CAISO interconnection queues to validate the RESOLVE resource potential

Where applicable, improvements are noted [NEW] in section 5 below.

Questions

i) If storage was to be added to this methodology for 2019 IRP portfolios, how would it need to be revised, noting that current IRP modeling does not explicitly assume any locational information about storage? Would mapping some portion of selected storage for 2019 IRP portfolios (for example, focused on specific areas with high commercial interest in storage as indicated by interconnection queues) be better than mapping none? If so, provide details of how this would be performed.

ii) For 2020 and beyond, how would your recommendation regarding storage change, if at all, at higher levels of renewable and storage penetration associated with lower emissions limits?

iii) The CAISO cannot unilaterally study transmission outside CAISO. For 2020 and beyond, are there ways to address this and, if so, how should busbar mapping methodology be changed to include resources outside CAISO and other Californian BAAs?

4. Guiding Principles

The following principles are intended to guide the busbar mapping process. Later sections of this document detail how to implement these principles:

- 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 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 Allocation Process (GIDAP). This principle can be followed by respecting the transmission sub-zone capability limits, as well as zone limits.[6]
- Successful busbar mapping process should result in IRP portfolios that do not need additional post processing in the CAISO's TPP after the CPUC has transmitted the CPUC adopted portfolios to the CAISO

[6] 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

Questions

iv) Do you agree with the guiding principles? Are there other principles that should be added?

v) For 2020 and beyond, how should these guiding principles change, if at all, at higher levels of renewable and storage penetration associated with lower emissions limits?

5. High-level Busbar Mapping Steps

The 2019 busbar mapping process is completed through a sequenced transfer of information between the CPUC, CEC, and CAISO. Information transfers are proposed to follow this sequence:

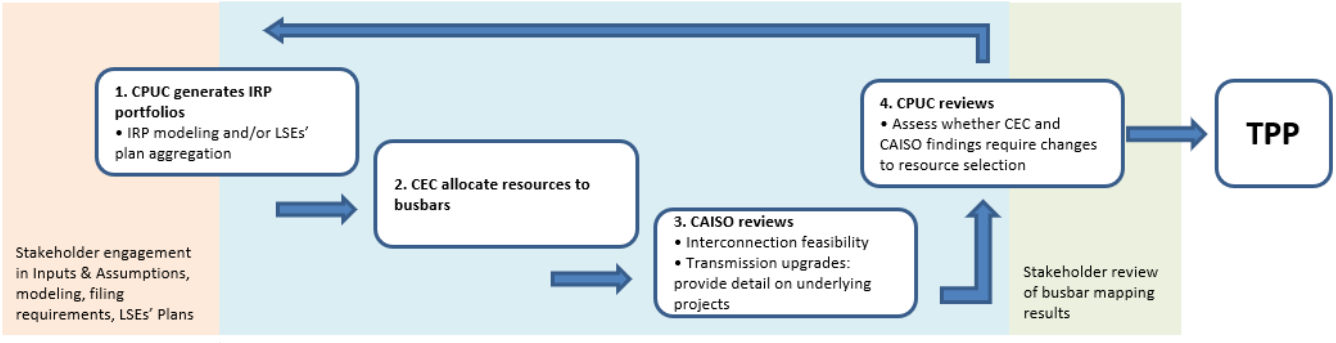
Step 1 - Draft portfolio(s) submitted to CEC for busbar mapping (CPUC)
Step 2 - Draft busbar mapping performed (CEC)
Step 3 - Observations and recommended revisions (CAISO)
Step 4 - Vet mapping results from CEC staff, as well as observations and recommendations from CAISO staff (CPUC)

- 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 steps for busbar mapping and the stakeholder review process has been outlined in figure 1 below.

Figure 1. Flowchart of the 2019 busbar mapping process



CPUC – Step #1

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

- Draft Reference System Plan portfolios selected by RESOLVE in year 1 of the IRP cycle or draft Preferred System Plan portfolios resulting from the aggregation of LSEs' plans in year 2 of the IRP cycle.

- Selected MW, by resource type, by transmission zone (tabular format)[7]
- Resource potential estimates (geographic information system (GIS) data format – polygons and associated attribute tables) to give the CEC further information about the selected resources[8]
    - Prior to the selection of candidate resources in RESOLVE the 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 [NEW]

- Transmission capability information (GIS data format)
- Transmission upgrades triggered in RESOLVE (tabular format)[9]

Questions

vi) Comment on the use of information in interconnection queues as an indication of commercial interest in specific resource types and zones, to validate the resource potential used in RESOLVE. Are there other suitable sources of information that should also be used?

vii) For 2020 and beyond, how should indications of commercial interest be used?

Stakeholder participation:

- Provided an opportunity to comment on the RESOLVE inputs and assumptions (including CAISO transmission capability and cost values), RESOLVE functionality, and the draft Reference System Portfolio (year 1) and draft Preferred System Portfolio (year 2)
- Given the current IRP schedule, it is not possible for stakeholders to vet each specific working version of the draft 2019 Reference System Plan portfolio during the iterative busbar mapping process. However, stakeholders will be able to formally comment on the draft 2019 Reference System Plan, which will have gone through the busbar mapping process, via a CPUC ruling in November 2019

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 report
    - See March 2019 report for example of prior work[10]

[7] For examples from the 2017-18 IRP cycle, see Excel workbooks "Reliability and policy-driven base case," and "Policy-driven sensitivity cases", available at https://www.cpuc.ca.gov/General.aspx?id=6442460548

[8] For examples from the 2017-18 IRP cycle, see GIS Data available at http://www.cpuc.ca.gov/General.aspx?id=6442453965

[9] For examples from the 2017-18 IRP cycle, see RESOLVE Results Viewer, Portfolio Analytics tab, available at https://www.cpuc.ca.gov/General.aspx?id=6442457210

[10] CEC Docket 17-Misc-03, TN# 227311, UPDATED 2019 IRP Portfolio Allocations to Substations, filed March 11, 2019, available at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-MISC-03

The CEC is proposing to use a busbar mapping methodology that is similar to the methodology used in 2018:

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)[11]
    - Areas of Conservation Emphasis, version 3.0 (ACE III) (California Department of Fish and Wildlife, 2018)[12]
    - Terrestrial Connectivity[13]
    - California Agricultural Value (California Energy Commission and Conservation Biology Institute, 2018)[14]

Questions

viii) Do these GIS layers present an effective high-level representation of environmental implications of energy development? Comment on the advantages and disadvantages of using these layers, and/or propose alternative layers.

ix) For 2020 and beyond, how would your recommendation on GIS layers change, if at all?

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.

Questions

x) How should objective numerical scores be calculated from combining the datasets?

xi) How should agricultural value data be used in conjunction with ecological data? Should it be incorporated into the model or used as a separate overlay?

xii) For 2020 and beyond, how would your recommendations on calculating scores and using agricultural value data change, if at all?

[11] Available at https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65
[12] Available at https://www.wildlife.ca.gov/Data/Analysis/Ace
[13] Available at https://www.wildlife.ca.gov/Data/Analysis/Ace#523731772-connectivity
[14] Available at https://databasin.org/datasets/f55ea5085c024a96b5f17c7ddddd1147

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 and a suitable standard radius will be established around each substation. Available substations include those in Californian BAAs, as well as CAISO. 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 will be used when mapping each resource type as follows:

    a. Solar – calculate the share 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 weight of 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, their interconnection cost assumed in the supply curve, and the gen-tie distance it allows, will be compared to the distance to the substation. If the distance to the substation is greater this is means a criterion has not been met; refer section 6 below.

Questions

xiii) What gen-tie distances are typical? Is using a "standard radius" as described above appropriate? (For reference, 15 miles was used in the 2018 busbar mapping process.) If not, is using a range of gen-tie distances more effective? Otherwise, propose an alternative approach.

xiv) For 2020 and beyond, how would your recommendation on gen-tie distances change, if at all?

6) 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 FCDS Capability (MW)" and the "Estimated EODS 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 [NEW].

7) 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, reporting against the criteria outlined in section 6 below [NEW], and any notes needed to interpret and understand the allocation outputs.

Stakeholder participation:

- Given the current IRP schedule, it is not possible for stakeholders to vet each specific working version of the draft 2019 Reference System Plan portfolio during the iterative busbar mapping process. However, stakeholders will be able to formally comment on the draft 2019 Reference System Plan, which will have gone through the busbar mapping process, via a CPUC ruling in November 2019

Questions

xv) Comment on the report layout and level of detail used in past busbar mapping. Are there changes you seek, to enable effective stakeholder review of the results?

xvi) For 2020 and beyond, how would your recommendation on reporting change, if at all?

CAISO – Step #3

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

- Where transmission upgrades are found to be required in Steps 1# and/or #2, CAISO will provide an estimate of the specific transmission upgrades' theoretical 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 [NEW]
    - Where transmission upgrades are found to be required, but are at a scale that exceeds the limit that has previously been studied by the CAISO, there is unlikely to be any further information available, and this will be noted [NEW]
- Provide feedback on the CEC's draft busbar allocations, including verifying:
    - Transmission zone and sub-zone capability limits
    - 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 queues; 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

Stakeholder participation:

- Given the current IRP schedule, it is not possible for stakeholders to vet each specific working version of the draft 2019 Reference System Plan portfolio during the iterative busbar mapping process. However, stakeholders will be able to formally comment on the draft 2019 Reference System Plan, which will have gone through the busbar mapping process, via a CPUC ruling in November 2019
- CAISO observations and any recommended modifications to identified transmission upgrades will be reported in the CEC's mapping 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 section 6 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.

Stakeholder participation:

- Given the current IRP schedule, it is not possible for stakeholders to vet each specific working version of the draft 2019 Reference System Plan portfolio during the iterative busbar mapping process. However, stakeholders will be able to formally comment on the draft 2019 Reference System Plan, which will have gone through the busbar mapping process, via a CPUC ruling in November 2019

Questions

xvii) Are improvements needed to Steps #1 to 4 for mapping the 2019 IRP portfolios and if so, what are they?

xviii) For 2020 and beyond, how might Steps #1 to 6 need to change in 2020 to address the challenges of higher levels of renewable and storage penetration associated with lower emissions limits described above in section 3?

6. 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 proposed busbar mapping criteria are as follows:

- Distance to transmission
    - 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[15]. As described in Section 5, 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.

Questions

xix) Comment on the busbar mapping criteria. Are there other criteria that should be used to determine whether the mapping results are appropriate?

xx) For 2020 and beyond, how would your recommendation on criteria change, if at all?

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[15] For reference, a radius of 15 miles was used in the 2018 busbar mapping process