CPUC Staff Report: Modeling Assumptions for the 2020-2021 Transmission Planning Process Release 1 (TPP Base Portfolios)

CPUC Energy Division
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Contents

1. Document Purpose

Resource-to-busbar mapping ("busbar mapping") is the process of refining the geographically coarse electricity resource portfolios produced in the California Public Utilities Commission's (CPUC) Integrated Resource 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 Report is to communicate the methodology and results of the 2019 busbar mapping process performed by the CPUC, CAISO and California Energy Commission (CEC), for input into TPP, providing transparency and opportunity for IRP and TPP stakeholder engagement.

Further, the CPUC has traditionally provided a document describing planning and modeling assumptions to accompany the portfolios transmitted for study in the TPP annually. It was originally called the "Long-Term Procurement Plan Assumptions and Scenarios" and later the "Unified Inputs and Assumptions". This Report includes the key guidance for TPP studies that was conveyed in the earlier documents, thus superseding earlier guidance and documents.

2. Scope

This release of the Report addresses the busbar mapping of TPP portfolios as follows:

Table 1 Mapping results reported in this document

IRP Portfolio	TPP Portfolio Use Case/s	Mapping Status	Key Report Sections
• 2018 Preferred System Portfolio, with updated baseline (Updated 2018 PSP)	• Reliability Base Portfolio • Policy-driven Base Portfolio • Economic assessments	• Generation resources have been mapped to busbars • Baseline (i.e., existing and contracted) storage resources will be mapped during TPP to the extent possible in coordination with participating transmission owners (PTOs) • Generic storage resources are not mapped, but are made available as potential mitigation solutions during TPP study	• Section 5 • Section 7 • Section 9 • Section 8

• 2019 Reference System Portfolio (to be adopted) • 2019 30 MMT by 2030 Energy Only Sensitivity	• Policy-driven Sensitivity Portfolio 1 • Policy-driven Sensitivity Portfolio 2	• Generation resources will be mapped to busbars in March 2020 • Baseline (i.e., existing and contracted) storage will be mapped during TPP to the extent possible in coordination with PTOs • Generic storage resources will be mapped to busbars in March 2020. • Refer Section 8 for a description of these portfolios.	• Section 8

3. Report Summary

The CPUC's Proposed Decision "2019-2020 Electric Resource Portfolios to Inform Integrated Resource Plans and Transmission Planning" being released on February 21, 2020 recommends transmitting the 2018 Preferred System Portfolio as the TPP Base Cases, and the 2019 Reference System Portfolio and 2019 30 MMT Energy Only Sensitivity as the TPP Policy-driven Sensitivity Cases. This Report release provides busbar mapping results for the TPP Base Cases.

Section 4 describes the methodology used by CPUC, CAISO and CEC staff to conduct busbar mapping.

Section 5 details the inputs CPUC staff provided to the mapping process.

Section 6 summarizes the results of the mapping process, including the steps taken by staff to improve the allocations in order to meet the criteria.

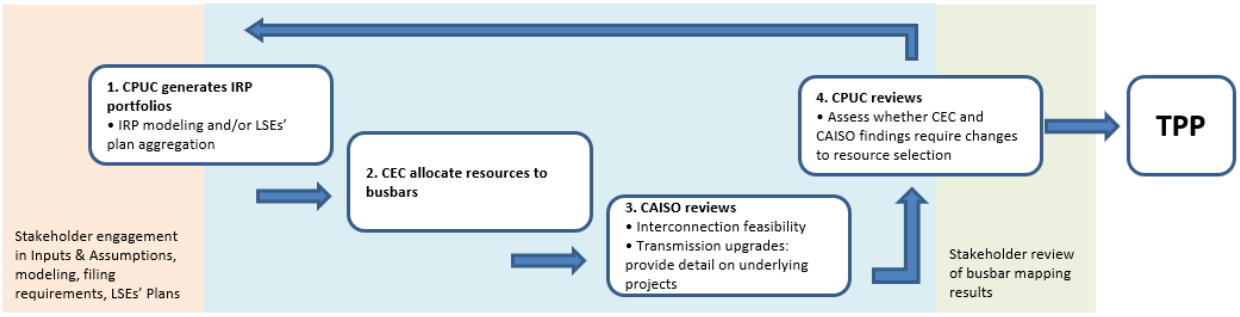
Section 7 presents other information about the portfolios that is required for TPP.

Section 8 draws conclusions regarding mapping the TPP Base Cases describes the TPP Policy-driven Sensitivity Cases, and identifies next steps: Report Release 2 will provide mapping results for the TPP Policy-driven Sensitivity Cases; and CPUC staff will provide details about the workplan for 2020 busbar mapping later this year.

4. Methodology

Staff from the two agencies and the CAISO completed the steps described in the "CPUC Staff Proposal: Methodology for 2019 IRP Resource-to-Busbar Mapping, October 18, 2019" (Staff Proposal), except where improvements were identified, as summarized here. The full, updated Methodology is available as a separate document (see Appendix A).

Figure 1. Flowchart of the 2019 busbar mapping process



Improvements to the Staff Proposal were informed by stakeholder feedback and staff's experience during implementation of the process, as summarized below:

Generation Resources

- "Commercial interest" was added as an additional busbar mapping criterion. This extends one of the guiding principles in the Methodology to explicitly consider the development activity observed in interconnection queues and load-serving entities' (LSE) plans, as applicable. Allocation should generally align with commercial interest.
- "Consistency with prior year" was also added as a criterion. Allocation for the TPP Base Cases should generally align with busbar mapping allocations submitted to CAISO in prior TPP portfolios. Where significant changes are proposed they should be explicitly justified.
- When a further round of mapping is required (due to non-compliance with the criteria) staff may re-allocate resources between transmission zones provided the expected cost, reliability and emissions performance of the portfolio is not materially altered.
    - To support such re-allocation CPUC staff conducted solar cost sensitivity modeling. This is described in Section 6 and the working file is available (see Appendix G).
- Observation of other Californian interconnection queues, in addition to CAISO's, to assess commercial interest
- Out-of-state resources were examined by staff, particularly resources to be delivered to the Riverside East Palm Springs and Greater Imperial transmission zones. Staff examined these resources with respect to commercial interest and consistency with treatment in prior portfolios and confirmed the reasonableness of the delivery point assumptions (Palo Verde and Willow Beach). This was in response to SWPG comments.

- CPUC and CEC staff reviewed comments from stakeholders related to using or adding additional environmental and land use datasets to the Methodology. Suggested additional datasets included:
    - USFWS Critical Habitat for Endangered Species
    - Desert Tortoise Connectivity
    - Core Recovery areas from Species Recovery Plans
    - California-equivalent environmental and land use data sets for out-of-state energy resource areas

  CPUC and CEC staff examined these datasets further and agree that the agencies should work with stakeholders to evaluate use of additional datasets. In the current bus bar mapping exercise, some of these data elements are built into maps used for screening of energy resource locations[1]. Specifically, the USFWS critical habitat mapping and desert tortoise important areas, including habitat connectivity, are represented in the mapping and application of exclusion areas applied in the RESOLVE model.

Energy Storage Resources

Baseline Resources

Existing battery storage units and contracted battery storage projects shall be mapped to busbars to the extent possible during TPP by CAISO staff and the PTOs. Contracted battery storage projects were identified by ruling[2] in the IRP proceeding's Procurement Track. The ruling identified project names which should enable the CAISO to work with the PTOs to identify locations for each project. These projects make specific a large portion of the generic battery storage that has been/is included in the portfolios the CPUC transmits to the CAISO TPP for study.

Generic Resources

For TPP Base Cases, staff is not mapping remaining generic storage to any specific locations, but is instead allowing CAISO to retain the flexibility necessary to apply the storage where it provides value that can be clearly identified through TPP. This approach will reduce the risk of any mapping of storage to busbars potentially masking important transmission reliability risk during TPP assessments.

For TPP Sensitivity Cases, staff is mapping generic storage to specific locations and will describe the approach in the updated version of the Methodology document to be released in March 2020.

Refer to Section 8 below regarding next steps to further improve the Methodology for busbar mapping in 2020 and beyond.

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[1] Available on DataBasin: https://caenergy.databasin.org/galleries/eab0ce3a5be447ce928a310e80c65c8d#expand=208851

[2] http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=323767159

5. Inputs

In order the complete the steps in the methodology described above, the following input is needed: Portfolio of selected resources for 2030, by transmission zone, with Fully Deliverable and Energy-Only MW amounts specified.

TPP also models baseline resources, but since their points of interconnection are known, they are outside the scope of this Report. However, where the IRP baseline list of resources has been updated a significant length of time after a portfolio of selected resources was formed, there is a need to reconcile the two sets of resources.

Updated 2018 PSP

CPUC staff updated the 2018 Preferred System Portfolio, as an input to the busbar mapping process, by reconciling baseline resources as follows:

- Renewable resources added to the 2019 IRP baseline since the formation of the 2018 PSP baseline were identified and categorized by resource type and transmission zone
- Capacities of selected resources in the 2018 Preferred System Portfolio were reduced by the above amounts, to avoid double-counting of resources in TPP modeling
- A portion of generic storage in the 2018 Preferred System Portfolio can be made specific by virtue of specific projects being identified by ruling[3] in the IRP proceeding's Procurement Track

Further detail of these steps is provided in the 2018 Preferred System Portfolio Baseline Reconciliation work file (see Appendix F). The outcome of the reconciliation is shown in the following table:

[3] http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=323767159

Table 2. Overview of steps and outcome of baseline reconciliation

RESOLVE Resource	Additions to 2019 Baseline since 2018 PSP MW	2030 Selected Resources, 2018 PSP as at March 2019 MW	2030 Selected Resources, post Baseline Rec at February 2020 MW
Greater_Imperial_Geothermal	20	1,276	1,256
Northern_California_Geothermal		424	424
Carrizo_Wind		160	160
Central_Valley_North_Los_Banos_Solar	22	-	-
Central_Valley_North_Los_Banos_Wind		146	146
Greater_Imperial_Solar	471	-	-
Inyokern_North_Kramer_Solar	23	577	554
Kern_Greater_Carrizo_Solar	5	-	-
North_Victor_Solar	14	-	-
Riverside_Palm_Springs_Solar	126	1,320	1,194
Riverside_Palm_Springs_Wind		42	42
Solano_Wind		643	643
Southern_Nevada_Solar		2,304	2,304
GLW-VEA_Solar		702	702
Tehachapi_Solar	288	1,013	725
Tehachapi_Wind	169	153	-
Westlands_Solar	290	-	-
Arizona_Solar		-	-
Total	**1,427**	**8,760**	**8,150**

Table 3. Overview of Updated 2018 PSP battery storage portfolio

All values are nameplate MW for the stated duration	Procurement Track Baseline Projects 2022	Original 2018 PSP Not Mapped 2030	Updated 2018 PSP Mapped ** 2030	Updated 2018 PSP Not Mapped 2030
Selected IFOM 1.3 hr		2,104		1,157 *
Baseline BTM 2 hr	120		120	
Baseline BTM 4 hr	250		250	
Baseline IFOM 4 hr	1,184	1,325	1,184	
Existing IFOM 4 hr	138		138	

* calculated by taking difference of 2018 PSP storage and Procurement Track baseline in terms of 4-hour units and then converting back to MW equivalent of 1.3 hour units

** mapping means taking project names and working with PTOs to identify locations of those projects

6. Results

One round of mapping was required to arrive at the allocations for the Updated 2018 PSP (see Appendix B for final CEC Busbar Mapping Results). A summary of the final results is provided in the dashboard at Table 4 below. The remainder of this section outlines the iterations made to reach the final results.

Table 4. Dashboard showing compliance of busbar allocations for the Updated 2018 PSP, following Round 1 mapping, with the criteria

Updated 2018 PSP Post Baseline Rec & Updates; Post Mapping Rnd 1	Selected Resources	Busbar Mapping		Compliance with Criteria [1=Yes, 2=Possible/Moderate, 3=Materially in Breach]					Actions
Resource & Zone	Total MW (After Adjustments)	Count of Substations Allocated To	MW Allocated	1. Distance to Transmission	2. Transmission Capability Limits	3a. Available Land Area	4. Commercial Interest	5. Consistency with Prior Year's Mapping	Further Round of Mapping Needed
Greater_Imperial_Geothermal	1,256	4	1,256	1	1	1	1	1	No
Northern_California_Geothermal	-	1	-	1	1	1	1	1	No
Carrizo_Wind	160	2	160	1	1	2	1	1	No
Central_Valley_North_Los_Banos_Wind	146	1	146	1	1	2	1	1	No
Inyokern_North_Kramer_Solar	554	5	554	1	1	1	1	1	No
Riverside_Palm_Springs_Solar	1,622	2	1,622	1	1	1	2	1	No
Riverside_Palm_Springs_Wind	42	1	42	1	1	1	1	1	No
Solano_Wind	643	5	644	1	1	1	1	1	No
Southern_Nevada_Solar	3,006	5	3,006	1	1	1	1	1	No
Tehachapi_Solar	1,153	2	1,153	1	1	1	2	1	No
Tehachapi_Wind	-	1	-	1	1	1	1	1	No
Arizona_Solar	428	-	428	1	1	1	2	1	No
Sub Total - Renewables	**9,011**	**29**	**9,011**						

Description of Criteria

The dashboard identifies whether the busbar allocations comply with the five key criteria. Each of the criteria are described in the Methodology (see Appendix A). Assessment using the criteria was implemented as follows below. "Level 1" refers to strong compliance; "Level 2" to possible or moderate breach of a criterion; and "Level 3" to a material breach, indicating that a further round of mapping is required to improve compliance.

1. Distance to transmission
    - Level 3 non-compliance threshold (i.e., exceedance of this threshold results in Level 3 assessment):
        - Resources for which the busbar allocation results in gen-tie lengths exceeding 50 miles
    - Level 2 non-compliance threshold:
        - Resources for which the busbar allocation results in gen-tie lengths exceeding 15 miles

2. 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
    - Level 3 non-compliance threshold:
        - Selected resource exceeds transmission capability (FD or EO)
3. Land use and environmental constraints
    - Allocation in each area should not exceed available land area to accommodate the resources, based on environmental information
    - Level 3 non-compliance threshold:
        - Resources for which the busbar allocation results in exceedance of 100% of the land area estimated to be available to accommodate a resource
    - Level 2 non-compliance threshold:
        - Resources for which the busbar allocation results in exceedance of 20% of the land area estimated to be available to accommodate a resource
4. Commercial interest
    - Allocation should generally align with commercial interest per the interconnection queue and/or LSEs' plans as applicable
    - Quantitative thresholds should be considered but may not be able to take into account how significant selected resource amounts are relative to the size of the whole portfolio, nor temporal aspects (for example, interconnection queues may be less relevant signals of commercial interest for long-dated planning years as compared to the near term)
    - Level 3 non-compliance threshold:
        - Selected resource amount of 300 MW or more in transmission zone without any commercial interest; or
        - Commercial interest in transmission zone is evident, yet selected resource amount is higher or lower by more than 3,000 MW
    - Level 2 non-compliance threshold:
        - 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
    - Allocation for the TPP Base Cases should generally align with busbar mapping allocations submitted to CAISO in prior TPP portfolios. Where significant changes are proposed they should be explicitly justified.
    - Level 3 non-compliance threshold:
        - 1,000 MW or greater difference from prior year (to identify material absolute changes from prior year's mapping)

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

Updated 2018 PSP Round 1 Mapping

Prior to Round 1, the mapping showed the following level of compliance with the criteria:

Table 5. Dashboard showing compliance of busbar allocations for the Updated 2018 PSP, prior to Round 1 mapping, with the criteria

Updated 2018 PSP								
Post Baseline Reconciliation, post-Updates	Selected Resources	Busbar Mapping		Compliance with Criteria [1=Yes, 2=Possible/Moderate, 3=Materially in Breach]				Actions
Resource & Zone	Total MW (Updated Baseline)	Count of Substations Allocated To	MW Allocated (Mar 2019)	1. Distance to Transmission	2. Transmission Capability Limits	4. Commercial Interest	5. Consistency with Prior Year's Mapping	Further Round of Mapping Needed
Greater_Imperial_Geothermal	1,256	4	1,276	1	1	1	1	No
Northern_California_Geothermal	424	1	424	3	1	3	1	Yes
Carrizo_Wind	160	2	160	1	1	1	1	No
Central_Valley_North_Los_Banos_Wind	146	1	146	1	1	1	1	No
Inyokern_North_Kramer_Solar	554	5	577	1	1	1	1	No
Riverside_Palm_Springs_Solar	1,194	2	1,320	1	1	3	1	Yes
Riverside_Palm_Springs_Wind	42	1	42	1	1	1	1	No
Solano_Wind	643	5	643	1	1	1	1	No
Southern_Nevada_Solar	3,006	5	3,006	2	3	1	1	Yes
Tehachapi_Solar	725	2	1,013	1	1	3	1	No
Tehachapi_Wind	-	1	153	1	1	1	1	No
Arizona_Solar	-	-	-			2	1	Yes
Sub Total - Renewables	**8,150**	**29**	**8,760**					

To address the level 3 non-compliances shown above, the following steps were taken:

- Northern California Geothermal - CPUC staff substituted this resource with an equivalent amount of solar and battery storage without re-running RESOLVE, but broadly consistent with its objective function, as follows:
    - Allowing for the respective capacity factors of geothermal and utility-scale solar PV, as well as the degree of system-level curtailment typically observed in RESOLVE modeling, CPUC staff estimated approximately 1,285 MW of energy-only solar would be required to substitute for the annual energy delivery of geothermal
    - In addition, CPUC staff estimate the level of battery storage required to substitute for the geothermal to be in the range of approximately 400 to 1,000 MW. The lower end of this range assumes a 1:1 replacement of each MW of geothermal with 1 MW of 4-hour battery storage, whereas the upper end assumes a ratio observed in 2019-2020 IRP modeling. In Section 8 below, the implications of this range for TPP are discussed.
    - Finally, CPUC staff propose that the amount of solar be re-allocated to transmission zones to improve busbar mapping compliance criteria: specifically criteria 2 (transmission capability limits) and 4 (commercial interest). This results in the 1,285

MW of solar being re-allocated from Northern California_Ex to Riverside Palm Springs, Tehachapi and Arizona.

  - To confirm that the inter-zonal reallocation is justified and consistent with RESOLVE's objective function, staff performed solar cost sensitivity modeling. This concluded that the location of solar resources selected in RESOLVE is sensitive to small cost differences between solar resources, yet has an insignificant effect on the CAISO-wide resource portfolio. This means that, other things being held constant, re-allocations of solar between zones can improve compliance with busbar mapping criteria without materially impacting the expected cost, reliability or emissions of a portfolio. The approach and results are provided in Solar Cost Sensitivity Modeling slides (see Appendix G).

- Southern Nevada Solar was re-allocated within the zone (a portion of the resource from El Dorado substation to Mohave substation) in order to improve compliance with criteria 2 (transmission capability limits) and 3a (available land area), as follows:
  - Priority on allocating FCDS MW to substations in GLW-VEA due to their proximity to the resource in the RESOLVE supply curve
  - Remaining FCDS MW to El Dorado 230kV, and then EO MW allocated to El Dorado 230kV, El Dorado 500kV, and Mohave 500kV in order to simultaneously achieve compliance with criteria 2 and 3a. This requires the assumption that solar resources are available outside the specific Southern Nevada resource areas in the RESOLVE supply curve, in proximity to these substations. This assumption is supported by observing the significant relevant capacity currently in the CAISO interconnection queue.

The outcome of the Northern California Geothermal substitution is shown in the table below:

Table 6. Overview of steps and outcomes of re-allocations by CPUC staff

RESOLVE Resource	Additions to 2019 Baseline since 2018 PSP MW	2030 Selected Resources, 2018 PSP as at March 2019 MW	2030 Selected Resources, post Baseline Rec at February 2020 MW	FOR MAPPING Post NoCal Geothermal substitution MW	Notes
Greater_Imperial_Geothermal	20	1,276	1,256	**1,256**	
Northern_California_Geothermal		424	424	**-**	
Carrizo_Wind		160	160	**160**	
Central_Valley_North_Los_Banos_Solar	22	-	-	**-**	
Central_Valley_North_Los_Banos_Wind		146	146	**146**	
Greater_Imperial_Solar	471	-	-	**-**	
Inyokern_North_Kramer_Solar	23	577	554	**554**	
Kern_Greater_Carrizo_Solar	5	-	-	**-**	
North_Victor_Solar	14	-	-	**-**	
Riverside_Palm_Springs_Solar	126	1,320	1,194	***1,622***	Includes 428MW of EO solar as partial substitution of NoCal Geothermal
Riverside_Palm_Springs_Wind		42	42	***42***	
Solano_Wind		643	643	**643**	
Southern_Nevada_Solar		2,304	2,304	**2,304**	
GLW-VEA_Solar		702	702	**702**	Included in "Southern_Nevada_Solar" elsewhere in this report
Tehachapi_Solar	288	1,013	725	***1,153***	Includes 428MW of EO solar as partial substitution of NoCal Geothermal
Tehachapi_Wind	169	153	-	**-**	
Westlands_Solar	290	-	-	**-**	
Arizona_Solar		-	-	***428***	Includes 428MW of EO solar as partial substitution of NoCal Geothermal. Assumed to flow through Riverside_Palm_Springs.
Total	**1,427**	**8,760**	**8,150**	**9,011**	

7. Other Assumptions for TPP

Guidance previously provided to CAISO as part of the annual CPUC portfolio transmittal was included in a document called the "Unified I&A". CPUC and CAISO staff agree that any necessary content be included in this Report. This section describes the additional modeling assumptions the CPUC provides to the CAISO's TPP, besides the portfolio and busbar mapping assumptions described in the rest of this report.

Thermal Retirement Assumptions

The CAISO will assume retirement for resources aged 40 years or more. Resources meeting this criterion will be modeled offline unless they have an existing contract that runs beyond their assumed retirement age and may be turned online as mitigation if reliability concerns are identified.

Demand Response

This subsection provides guidance on modeling treatment of demand response (DR) programs in network reliability studies including allocating capacity from those programs to transmission substations.

The CPUC's Resource Adequacy (RA) proceeding (R.17-09-020 or its successor) determines what resources can provide system and local resource adequacy capacity. Current RA accounting rules indicate that all existing DR programs count to the extent those programs impacts are located within the relevant geographic areas being studied for system and local reliability.

By nature, impacts from DR programs are distributed across large geographies. To be applied in network reliability studies, capacity from DR programs must be allocated to transmission substations in order to facilitate power flow analysis.[4] CPUC staff request the investor-owned utilities (IOUs) to allocate their existing DR programs[5] to substations, with the expectation that the IOUs would submit that information to CAISO through the CAISO's annual TPP Study Plan stakeholder process that solicits input on DR assumptions.[6] The data contains confidential information so the CPUC expects the CAISO and the IOUs in their capacity as PTOs to exchange the data using their own non-disclosure agreements.

[4] The CAISO noted that DR eligible for inclusion in the TPP must be allocated to CAISO-controlled substations and must be a CAISO integrated resource, meaning that resource is mapped to specific "PNodes"

[5] Based on the April 2019 annual Load Impact Reports, using the August portfolio-adjusted 1-in-2 weather year condition ex-ante forecast of load impact coincident with CAISO system peak

[6] http://www.caiso.com/Documents/StakeholderInput-2020-2021UnifiedPlanningAssumptions.html

8. Conclusion and Next Steps

TPP Base Cases

The Updated 2018 PSP's generation resources have been mapped to busbars in accordance with the criteria. The results (available at Appendix B) can be transmitted to the CAISO for use in the Reliability and Policy-driven Base Cases in 2020-21 TPP. The list of non-storage baseline resources is available at Appendix D.

Existing battery storage units and contracted battery storage projects shall be mapped to busbars to the extent possible during TPP by CAISO staff and the PTOs. Contracted battery storage projects in the IRP Procurement Decision (D.19-11-016) baseline (available at Appendix E) make specific a large portion of the generic battery storage that was part of the original 2018 PSP.

Staff is not mapping remaining generic storage to any specific locations, but instead allowing CAISO to retain the flexibility necessary to apply the storage where it provides value that can be clearly identified through the transmission planning process. This approach will also reduce the risk of any mapping of storage to busbars potentially masking important transmission reliability risk during CAISO TPP assessments, as described in CAISO comments.[7]

The amount of storage in the 2018 Preferred System Portfolio for 2030 was approximately 1,325 MW of 4 hour batteries and 2,104 MW of 1.3 hour batteries.[8] Of this Staff approximates that 1,573 MW of 4 hour and 120 MW of 2 hour batteries can be considered firm and mappable through the Procurement Track baseline. The remaining amount is 1,157 MW of 1.3-hour batteries. These, along with the additional 4-hour batteries totaling up to 1,000 MW resulting from replacing Northern California Geothermal during busbar mapping, as described in Section 6 above, are not mapped and shall be best used to mitigate any transmission issues identified by CAISO in the TPP assessments.

CPUC Staff have considered the fact that RESOLVE finds this amount of storage to be cost-effective to support reliability, GHG reduction, and renewable integration needs (i.e. system benefits). For this reason, the CAISO should not include the full capital cost of storage as an assumption in the assessment of transmission alternatives for reliability needs identified.

One option is for CAISO to only include site-specific information on the incremental interconnection cost of battery storage. However, this approach would not capture other incremental costs for storage as a transmission asset such as the opportunity costs associated with its restricted operations to serve a transmission reliability function and potentially the inability to co-site with solar for the Investment Tax Credit (ITC). Some portion of these opportunity costs might be offset by the value of avoiding the transmission investment, though this comparison would need to

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[7] Dec 17,2019 COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION "Without locational mapping, the 46 MMT Alternate Scenario's inclusion of 11,384 MW of generic storage resources undermines the CAISO's transmission planning analysis because the models will not be able to accurately test the flows on the transmission system and identify reliability needs. Similar to concerns expressed above, this could lead to triggering transmission projects that may not have been needed or masking reliability needs that do exist."

[8] See Final Decision April 25, 2019, Table 6, "Portfolios Recommended to be Studied by the CAISO in the 2019-20 TPP: New Resource Mix and Cost Estimates, in 2030." Accessed online at the following URL: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M287/K437/287437887.PDF

occur for each use case, since different transmission needs require different storage operational patterns to be avoided.

CPUC will seek to further coordinate with CAISO to provide a final recommendation in March 2020 on what cost assumptions should be used for the storage identified as suitable for mitigation purposes within the TPP process (1,157 MW of 1.3-hour and up to 1,000 MW of 4-hour batteries).

TPP Sensitivity Cases

CPUC staff expect to transmit to the CAISO two policy-driven sensitivity portfolios in March 2020. These portfolios will be mapped to busbars, communicated via Release 2 of this Report and an updated Methodology document. For now, CPUC staff provide descriptions of these portfolios:

Policy-Driven Sensitivity 1: 2019 Reference System Portfolio (to be adopted)

CPUC staff seek to study the transmission implications of the 2019 Reference System Portfolio, expected to be adopted by the CPUC in early 2020 (RSP). The RESOLVE model does not have the degree of granularity required to conduct a comprehensive transmission impact analysis as a power flow or production cost model does.

Staff plans to test the transmission impacts of the high quantity of storage included in the RSP in this policy-driven sensitivity portfolio. The storage in the portfolio was selected by RESOLVE to meet the 2030 GHG target at least cost while ensuring reliability. This amount of storage demonstrates a shift in portfolio composition as a direct response to various policy-drivers. Although it is impossible to predict exactly where on the transmission system this large amount of storage will be built by 2030, due largely to the high mobility and flexibility of storage, it is important to take this opportunity to understand the potential implications of the storage on the transmission system. Staff will provide a full description of the methodology used to map storage to busbars in the updated version of the Methodology document to be released in March 2020.

Policy-Driven Sensitivity 2: 30 MMT by 2030 Energy Only (EO) Sensitivity

CPUC staff seek to explore whether there are more economically viable alternatives to assuming that new renewables beyond a certain level require full capacity deliverability status (FCDS). The transmission congestion and renewable curtailment information could flow into RESOLVE in the future to inform selection and location of new generation and transmission buildout.

The purpose of this sensitivity is to test whether there are areas in which the benefits of inexpensive transmission solutions can outweigh their costs, by reducing curtailment. In order to test this possibility, staff have developed a scenario in which a high amount of curtailment may occur in certain zones. This portfolio consists of existing and new resources selected to meet a 30 MMT by 2030 GHG target. The resources in this portfolio are mapped to substations assuming energy only transmission limits that have been relaxed per the following description.

Methodology to develop this portfolio:

1. CPUC staff have collaborated with CAISO staff to incorporate less stringent EO limits than previously estimated by the CAISO and provided to the CPUC to support the IRP process..
   - The CAISO provided EO estimates for zones for which the EO transmission capability estimates were previously marked "TBD" (*i.e.*, Westlands, Kern and Greater Carrizo, and Central Valley North/Los Banos)
   - The CAISO increased the EO transmission capability estimates by 10 percent for zones which were fully utilized (FCDS and EO) in the 2019-2020 TPP sensitivity portfolio #1, with the exception of zones for which significant known issues exist for adding more resources
   - The CAISO increased the EO transmission capability estimates for zones with relatively low-cost upgrades by the same amount as the incremental capability provided by the corresponding upgrade

Table 7. CAISO-provided transmission capability estimates with adjusted EO limits to support CPUC's IRP Process

	Transmission capability estimates to support CPUC's IRP process (May 2019)									Provided in November 2019
	Estimated FCDS Capability (MW)				Incremental Upgrade Cost Estimate ($million)				Estimated EODS Capability** (MW)	
Transmission zones and sub-zones	**Existing System**	**Minor Upgrades**	**Major Upgrade #1**	**Major Upgrade #2**	**Existing System**	**Minor Upgrades**	**Major Upgrade #1**	**Major Upgrade #2**	**Existing System**	**Relaxed EO capability*** **
Northern CA	**2,000**		**2,000**				**$ 285**		**3,900**	**3,900**
- Round mountain	500								2,100	2,100
- Humboldt	-								100	100
- Sacramento River	2,000								4,600	4,600
- Solano	600		2,000				$ 322		1,300	1,300
Southern PG&E	**1,100**		**1,000**				**$ 55**		**TBD**	**5,180**
- Westlands	1,100		1,000				$ 55		TBD	3,200
- Kern and Greater Carrizo	1,000		1,500				$ 241		TBD	4,180
- Carrizo	400		700				$ 53		400	1,100
- Central Valley North & Los Banos	1,000		1,000				$ 274		TBD	1,000
Tehachapi	**4,300**	**1,000**				**$ 100**			**5,100**	**6,100**
Greater Kramer (North of Lugo)	600		400				**$ 146**		**600**	**600**
- North of Victor	300		400				$ 485		300	300
- Inyokern and North of Kramer	100		400				$ 485		100	100
- Pisgah	400		400				$ 261		400	400
Southern CA Desert and Southern NV	**3,000**		**2,800**				**$ 2,156**		**9,600**	**13,260**
- Eldorado/Mtn Pass (230 kV)	250		1,400				$ 76		2,400	4,040
- Southern NV (GLW-VEA)	700		1,400				$ 150		700	2,170
- Greater Imperial*	1,200		1,400				$ 2,334		3,100	3,100
- Riverside East & Palm Springs	2,950		1,500				$ 2,156		5,500	6,050

* Subject to mitigation of the S-line constraint.
** Estimate EODS capability numbers are inclusive of the FCDS estimates. So the incremental EODS capability = Estimated EODS capability - Estimated FCDS capability
*** The Relaxed EO capability estimates are provided solely in response to the CPUC's request for transmission input that would help exploe a sensitivity portfolio with a higher EO resource buildout.

NOTE:
(i) The transmission areas indented in the table are subsets of the overarching transmission areas listed immediately above the indented areas.
(ii) The transmission capability estimates rely on the latest generation interconnection studies as one of the inputs. Estimated available transmission has been reduced by the amount of renewable resources that have come online by December 31, 2018 assuming that all these resources have a contract with an entity within CAISO BA.
(ii) The estimated capability added due to major upgrades and corresponding costs are ballpark numbers and are conceptual in nature.

2. New EO limits were incorporated into RESOLVE allowing the model to build additional new generation in certain transmission zones. The selected resources are mapped to substations and the portfolio with busbar mapping is transmitted to the CAISO.

Expected outcomes from TPP:

- The CAISO's assessment of this portfolio provides additional information on congestion and curtailment in the transmission zones with further relaxed EO transmission capability limits.
- Allows for comparison of congestion impacts in each area, leading to better understanding of the costs and benefits of building new transmission. Depending on the results, the CAISO may test upgrade options to mitigate renewable curtailment in certain zones in order to provide the upgrade information into IRP

Busbar Mapping for 2020 IRP Portfolios and Future Cycles

As recognized in the Staff Proposal, there is likely to be the need to further develop the methodology for mapping future IRP portfolios in 2020 and beyond, in order to plan for deep decarbonization of the electric sector and the associated need to co-optimize economic, land use, transmission, and interconnection issues. Staff appreciates the initial suggestions from stakeholders in response to the questions posed in the Staff Proposal and identifies the following items as priorities for consideration in the draft workplan for 2020 busbar mapping. It may not be possible to implement all of these for busbar mapping of 2020 IRP portfolio but staff acknowledge the need to explore these with stakeholders:

- Continued updates to the land use screens, possibly including incorporation of updated GIS data protocol (recommended by Public Advocates Office) as well as updates to numeric scoring methodology (recommended by TNC) and updates to land use datasets including for out-of-state resources (recommended by GLW, Defenders, and TNC)
- Interface between LSEs' plans, including for new transmission, and consideration of what substations are available for allocation
- Review of minimization of intra-zonal congestion as a guiding principle, in light of the proposed Policy-driven Sensitivity 2 designed to examine this issue
- Observation of permitting status of projects, in addition to their interconnection queue status
- Review of "standard radius" assumption for gen-ties, considering latest industry trends, by resource-type
- Development of a unified resource identification protocol for consistent use across planning and procurement processes
- Continued improvements to storage mapping methods

CPUC staff will notify stakeholders later in 2020 regarding the process for participating in the formation of the workplan for busbar mapping of IRP portfolios that are due to be generated in late-2020.

9. Appendices

A. Methodology for 2019 IRP Resource-to-Busbar Mapping
Will be available at IRP 2019-2020 webpage:
https://www.cpuc.ca.gov/General.aspx?id=6442459770

B. CEC Busbar Mapping Results for Base Case Generation Resources
Data Basin link to Excel File:
https://caenergy.databasin.org/galleries/eab0ce3a5be447ce928a310e80c65c8d#expand=208848

C. Busbar Mapping Dashboard workbook
Will be available at IRP 2019-2020 webpage:
https://www.cpuc.ca.gov/General.aspx?id=6442459770

D. 2019 IRP Baseline (for non-storage resources)
Excel file Gen_List_standalone .xlsx will be made available at Unified RA and IRP Modeling Datasets 2019 webpage:
https://www.cpuc.ca.gov/General.aspx?id=6442461894

E. IRP Procurement Decision Baseline (for storage resources)
Refer "Baseline list of resources as required by D.19-11-016", Baseline_List_Combined tab, available at: https://www.cpuc.ca.gov/General.aspx?id=6442463413

F. Baseline Reconciliation workbook
Will be available at IRP 2019-2020 webpage:
https://www.cpuc.ca.gov/General.aspx?id=6442459770

G. Solar Cost Sensitivity Modeling slides
Will be available at IRP 2019-2020 webpage:
https://www.cpuc.ca.gov/General.aspx?id=6442459770

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