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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.	Rulemaking 16-02-007

ADMINISTRATIVE LAW JUDGE'S RULING SEEKING COMMENT ON PROPOSED REFERENCE SYSTEM PORTFOLIO AND RELATED POLICY ACTIONS

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Summary

This ruling and its attachments constitute the proposed Reference System Portfolio (RSP) recommendation for use in the development of the individual integrated resources plans scheduled to be filed by individual load-serving entities (LSE) on May 1, 2020.

The proposed RSP contains a recommendation for the greenhouse gas (GHG) emissions target of 46 million metric tons (MMT) for 2030 for the electric sector that is set by the California Air Resources Board (CARB), as well as for the LSEs representing the portion of the electric sector under the Commission's authority. This 46 MMT target is equivalent to the 42 MMT target already adopted by the Commission in Decision (D.) 18-02-018, adjusting for an accounting methodology difference between CARB and the Commission with respect to emissions from combined heat and power facilities; the emissions associated with the two cases are the same, but the new case was renamed to 46 MMT avoid further confusion with CARB's targets.

In addition, the proposed RSP contains the representative resources recommended to be procured by the LSEs within the California Independent System Operator (CAISO) portion of the California electricity grid. The RSP, once adopted, will also form the recommended portfolio to be forwarded to the CAISO for use as the base case in its annual Transmission Planning Process (TPP). Finally, several potential near-term LSE and/or Commission actions are included in this ruling for input from parties.

Comments from parties on all of the above items are invited to be filed and served by no later than November 27, 2019. Parties who have conducted their own independent modeling may also provide the results of that analysis in their

comments due on this same day. In addition, reply comments may be filed no later than December 13, 2019.

1. Background

D.18-02-018 adopted a two-year cycle for the Commission's integrated resource planning (IRP) process. In the first year, a RSP, with an associated plan, is developed by Commission staff, to be used as a guide for the IRP planning of individual LSEs and for use in the CAISO's TPP. The plan consists of the portfolio, the GHG planning target, a GHG planning price for use in valuing resources, and any near-term policy actions associated with achieving the portfolio. In the second year, individual LSEs are filed, aggregated, evaluated, and used to form a recommended Preferred System Portfolio (PSP), which represents the portfolio to be used for the following CAISO TPP, along with actions to achieve the portfolio.

Commission staff have been conducting analysis and modeling for the RSP recommendation for the 2019-2020 IRP cycle beginning in late 2018 and for most of 2019.

The process kicked off with an Administrative Law Judge (ALJ) ruling issued November 29, 2018 seeking comments on the inputs and assumptions for use in the development of the 2019-2020 RSP. A webinar on these materials was conducted on December 7, 2018. Parties filed comments in response to the November 29, 2018 inputs and assumptions ruling on January 4, 2019, with reply comments filed on January 15, 2019.

Another ALJ ruling was issued on February 11, 2019 seeking comment on proposed scenarios for the 2019-2020 RSP. An associated webinar was conducted on February 28, 2019. Comments in response to the February 11, 2019

scenarios ruling were filed on March 5, 2019, with reply comments filed on March 15, 2019.

A webinar on the progress of the modeling and analysis to support RSP development was conducted on June 17, 2019. Finally, on October 8, 2019, Commission staff presented a full-day workshop with preliminary results of the RSP analysis, including modeling calibration to ensure that the portfolios developed were realistic and reliable, as well as a methodology for busbar mapping of the portfolio for transmission planning purposes.

2. Modeling and Analysis

This section generally describes the modeling analysis conducted, including the scenarios and sensitivities, models and assumptions, and common metrics. Section 2.2 provides questions for parties to respond to.

2.1. Analysis Conducted

2.1.1. Models and Assumptions

To conduct the analysis to support the development of the new RSP, like in the past RSP development, Commission staff used RESOLVE, a capacity expansion model designed to inform long-term planning questions around renewables integration. RESOLVE co-optimizes investment and dispatch for a selected set of days of a multi-year horizon, in order to identify least-cost portfolios for meeting specified GHG targets.

The RESOLVE optimization performed for the 2019-2020 IRP cycle covers the CAISO balancing area, including publicly-owned utility (POU) load within the CAISO. The model also optimizes dispatch at a coarse granularity, but not investment, outside of the CAISO.

Several RESOLVE model revisions and updates were made since the last RSP development in the 2017-2018 IRP cycle. First, the demand forecast input is

now from the California Energy Commission's (CEC) 2018 Integrated Energy Policy Report (IEPR) Update, adopted in February 2019. Another important update was the addition of functionality to model economic retirement or retention of existing thermal generation resources. In the prior cycle, all thermal generation in the RSP was initially assumed to be retained through the planning horizon of 2030, an assumption that most parties did not favor, while the final adopted PSP assumed a 40-year age-based retirement. In this new RSP analysis, RESOLVE could choose to retain dispatchable thermal generation based on its economics, with the exception of planned retirements, including those for once-through-cooling (OTC) units to comply with California policy. In addition, thermal generation needed in local capacity areas was also assumed to be retained.

Additional assumptions were also developed to account for the increasing penetration of storage on the electric system. Similar to the addition of solar photovoltaic resources, as the penetration of battery storage on the system increases, the proportional capacity value of each increment of storage capacity decreases. The RESOLVE model was updated to account for this factor.

Behind-the-meter storage was also added in RESOLVE as a candidate resource for this cycle. The candidate wind resource supply curve was also updated and validated. Load following and regulation reserve requirements were refreshed to incorporate updated load projections and variable renewable resource buildout.

Several updates from CAISO data were also added. Electrical zone boundaries were updated to match CAISO assumptions and candidate wind, solar, and geothermal resources were mapped to the new boundaries. RESOLVE was also modified to represent the multiple concurrent (or nested) limitations

identified by the CAISO to deliver energy from renewable resource zones to load centers.

Finally, RESOLVE was configured to run additional modeling years, including 2020, 2021, 2023, and 2024; capability was also added to consider timeframes out to 2045.

The RESOLVE model used to develop the RSP results is available on the Commission's web site at: https://www.cpuc.ca.gov/General.aspx?id=6442459770.

Commission staff also used the Strategic Energy Risk Valuation Model (SERVM),[1] which is a probabilistic system-reliability planning and production cost model. SERVM is designed to inform security-constrained planning, meaning the primary objective is to reduce risk of insufficient generation to an acceptable level. SERVM was configured to assess a given portfolio in a target study year, under a range of scenarios of future weather, economic output, and unit performance. SERVM performs hourly economic unit commitment and dispatch, and contains a zonal representation of the transmission system.

Since the previous version of SERVM used to develop the prior RSP, several assumption updates were made for this cycle. Weather-based hourly profiles were updated to cover weather years 1998-2017, including scheduled hydroelectric, electric demand, and wind and solar generation profiles. Operating parameters for individual resources were updated based on the January 2019 CAISO MasterFile information and the Western Electricity Coordinating Council (WECC) 2028 Anchor Data Set Phase 2, version 1.2.

[1] Commercially licensed through Astrape Consulting: http://www.astrape.com/servm/

Commission staff incorporated an approximation of ambient temperature capacity derating for gas plants based on the Summer Net Qualifying Capacity (NQC) for these units. The ability for storage to provide spinning and load following reserves, in addition to regulation and frequency response, was also added. Forced and scheduled outage statistics were updated.

Finally, Commission staff developed scaling factors in SERVM to ensure that annual energy from behind-the-meter solar installations modeled in SERVM would match with the annual energy from installations projected in the CEC's IEPR.

The two models were used to develop an optimal portfolio of new resources to add to the existing fleet in the CAISO area to plan for: achievement of long-term GHG reduction targets, maintaining reliability, keeping costs reasonable, and accounting for uncertainty and expected energy market conditions. The role of the RESOLVE model is to select portfolios of new resources that are expected to meet policy goals, in particular the GHG emissions constraint for the electric sector, at least cost, and while ensuring reliability. The role of SERVM is to validate the reliability, operability, and emissions of resources portfolios generated by RESOLVE.

After the Commission approved the PSP in D.19-04-040, completing the first cycle of IRP, Commission staff spent several months calibrating RESOLVE and SERVM. During the calibration process, staff sought to ensure that both models were representing assumptions such as fuel cost, candidate resources, grid topography, and other inputs so that the models simulate the California electric system in a comparable way.

The models were calibrated iteratively, by developing portfolios in RESOLVE, feeding the portfolios into SERVM, and then validating the key

operational results, including GHG emissions, curtailment results, and dispatch patterns. If results differed between models, changes were made to one or both until key outputs were consistent, and those changes were documented and presented in several webinars for other parties performing their own reliability modeling. More details of the calibration process can be found the calibration slide deck presented at the October 8, 2019 workshop.[2] A calibrated RESOLVE model was then used to explore a wider range of sensitivities and scenarios.

The modeling assumptions used for RESOLVE and SERVM were developed simultaneously for this RSP analysis, and the same assumptions were used in both models to the extent possible. Attachment C to this ruling contains the full description of all inputs and assumptions used for RESOLVE, while the key inputs in SERVM are available on the Commission's web site.[3]

The first core input is the CEC's 2018 IEPR Update Forecast. This represents the demand forecast utilized in the models. Uncertainty in future electricity demand is also considered, by modeling updated weather scenarios, as well as different high and lower load scenarios. The IEPR forecast annual projections of electricity consumption and demand modifiers were used to scale hourly shapes in RESOLVE and SERVM.

Common baseline resource data was also used for both models; baseline resources are included in a RESOLVE run as a fixed assumption rather than being selected by the model as part of an optimal solution. The baseline resources capture: existing resources, net of planned retirements; new resources that are sufficiently likely to be constructed, usually because they are LSE-owned

[2] Available at: https://www.cpuc.ca.gov/General.aspx?id=6442459770

[3] Available at: https://www.cpuc.ca.gov/General.aspx?id=6442461894

or contracted and have already been approved by the appropriate oversight body (*e.g.*, the Commission or a local governing board); and projected demand-side programs that already have approved budgets under current policy, such as energy efficiency programs or net energy metering. In external zones outside of the CAISO, where the RESOLVE model does not optimize the portfolios, baseline resources are derived from the WECC Anchor Data Set. The baseline developed includes information collected through Spring of 2019, and is updated since the adoption of the 2017-2018 IRP cycle PSP in D.19-04-040.

See the following link for the complete list of baseline assumptions: https://www.cpuc.ca.gov/General.aspx?id=6442461894.

In RESOLVE, "candidate" resources are then selected by the model to develop the optimal portfolio within the constraints of each scenario. Candidate resources were developed using publicly-available data on cost, potential, and operations. These assumptions have been updated since the previous IRP cycle, including changes to the costs of most resource types, the supply of different types of resources in the CAISO and other relevant interconnection queues, and updated resource potential. Some types of resources were also constrained by the length of time it would likely take to develop those resources and bring them online. But otherwise, the candidate resource data does not contain any assumptions about the feasibility of building resources at any particular magnitude in the future. Both supply and demand-side resources are included as candidate resources.

Finally, one of the key assumptions that tends to drive the resource selection results is the amount of resource adequacy capacity available from imported electricity. In 2017-2018 RSP development, resource adequacy capacity available from imports was assumed to be at the maximum import capability

level (approximately 11 gigawatts (GW)). In the 2019-2020 RSP development, different levels of resource adequacy capacity available from imports were modeled, with the default value set at 5 GW. The maximum import capability remained at about the 11 GW level.

2.1.2. Scenarios and Sensitivities Modeled

As with the previous RSP, adopted in D.18-02-018, Commission staff began this RSP analysis by looking at scenarios for the electricity sector that would meet the State's goal of reducing statewide GHG emissions 40 percent below 1990 levels by the year 2030. In 2018, CARB, in coordination with this Commission and the CEC, established a GHG planning target range for the electric sector for 30-53 MMT by 2030, as required by Senate Bill (SB) 350 (DeLeón, 2015).

D.18-02-018 adopted an electric sector GHG target of 42 MMT by 2030 as part of the 2017-2018 RSP. For a point of reference, the 2017 GHG emissions from the electric sector were approximately 62 MMT.[4]

For the current RSP development for the 2019-2020 IRP cycle, Commission staff began with the 42 MMT limit established in D.18-02-018. This case formed the "default" case, though it has been renamed to be the 46 MMT Default Scenario, because of an accounting difference between CARB and the Commission in the last cycle, related to the accounting treatment of behind-the-meter combined heat and power (CHP) emissions. While CARB treated these CHP emissions as electric sector emissions in its PATHWAYS economy-wide modeling to inform the 2017 Scoping Plan Update, in the

[4] The CARB GHG Inventory can be found at the following link: https://ww3.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_sum_2000-17.pdf

2017-2018 RSP the Commission treated them as industrial sector emissions. For the current RSP development, Commission staff have conformed the accounting treatment to that of CARB. Thus, the 42 MMT case adopted in D.18-02-018 has now been renamed the 46 MMT Default Scenario, though the resulting GHG emissions do not vary between the two cases.

Commission staff also modeled two other major GHG target scenarios: 38 MMT and 30 MMT. The 30 MMT case represents the low end of the CARB established range, while the 38 MMT case represents the midpoint between the two other cases. It should also be noted that these MMT targets represent the total electric sector in California; the emissions associated with the CAISO balancing authority are modeled as a portion of the total, approximately 81 percent currently, and expected to remain so through 2030.

After presentation of the preliminary results of these cases at the workshop on October 8, 2019, Commission staff made a number of minor improvements and corrections to the RESOLVE model. They included a complete implementation of the multiple concurrent (or nested) limitations identified by the CAISO to deliver energy from renewable resource zones to load centers as described earlier, limiting annual demand response buildout to a realistic level in the near term, and other small adjustments. These minor changes to RESOLVE mean that the results for the three major GHG target scenarios (46 MMT, 38 MMT, and 30 MMT, respectively) presented in this ruling are slightly different from what was presented at the October 8, 2019 workshop.

To focus in on some of the nearer-term potential for reliability challenges, Commission staff also reran the three major GHG target scenarios to produce outputs for every year from 2020 to 2024, plus 2026 and 2030, as previously presented.

Since the workshop, Commission staff also modeled an additional scenario designed to capture a combined set of assumptions that more closely approximates expected reality of electricity sector conditions. This new case, which is referred to as the 46 MMT Alternate Scenario, is a variation of the 46 MMT Default Scenario with two changes: 1) an assumption that approximately half of the OTC units scheduled to retire at the end of 2020 are instead extended for three years (*i.e.*, through the end of 2023); and 2) some limitations on the annual buildout of solar capacity in the early years, to reflect what is likely a more feasible buildout scenario based on historical experience.

For the current RSP development, Commission staff also performed analysis to explore how the 2045 goals for the electric sector, as expressed in SB 100 (DeLeón, 2018), could affect the outlook for the electricity sector GHG emissions and resource planning in the 2030 timeframe. This analysis was primarily informational and directional, intended to inform Commission decision-making regarding the appropriate 2030 GHG planning target, the RSP, and the associated least-regrets investments needed in the early part of the next decade.

In addition, a number of sensitivity cases were run, to test the impact of changes in assumptions for certain individual variables. These included the following sensitivity cases: no new out-of-state transmission, low-cost out-of-state transmission, high-cost out-of-state transmission, offshore wind, high solar photovoltaic cost, extension of the solar investment tax credit, high battery cost, paired battery cost, low resource adequacy imports, high resource adequacy imports, 2045 end year, a high-load sensitivity, full OTC extension, partial OTC extension, and early shed demand response availability. The 2045 studies included sensitivities for high electrification, high electrification with

new out-of-state transmission, high electrification with offshore wind available, high hydrogen, and high biofuels.

Commission staff also ran one other set of analysis to support development of avoided costs for use in estimating the cost-effectiveness of distributed energy resources. This analysis is presented in Appendix B of Attachment A to this ruling. A staff proposal is expected in the integrated distributed energy resource rulemaking to propose several updates to the Avoided Cost Calculator, used to forecast marginal avoided costs for cost-effectiveness analysis. One of the main changes likely to be proposed is to use values generated in RESOLVE modeling in this proceeding as inputs to the Avoided Cost Calculator. Attachment A, Appendix B, contains more details on this analysis.

2.1.3. Common Metrics

When analyzing the various scenarios and sensitivities, Commission staff used a common set of metrics to compare results. These metrics included the selected candidate resources, the amount of thermal generation capacity not retained, costs (including a metric for incremental total resource costs, revenue requirements, and an average rate), and total GHG emissions.

2.2. Questions for Parties

This section provides a standard set of questions related to Section 2.1, for parties to respond to in filing comments on this ruling.

1. Please provide any comments on the use of the RESOLVE model;
2. Provide any comments on the use of SERVM;
3. Provide any comments on baseline assumptions;
4. Provide any comments on any other assumptions;
5. Provide any comments on the scenarios and sensitivities modeled; and
6. Provide any comments on the common metrics compared across cases.

3. Scenario Results

This section summarizes the major results of the scenarios modeled by Commission staff. A set of questions for parties related to results is also provided.

3.1. Results

Attachment A to this ruling provides the detailed results of the major scenarios studied, including the 46 MMT Default Scenario, the 38 MMT, and the 30 MMT scenarios. The 46 MMT Alternate Scenario is also presented and the details of this scenario are discussed later in this ruling. Attachment B to this ruling contains further details of the reliability and production cost modeling conducted in SERVM to analyze the various scenarios and portfolios.

Table 1 below summarizes the resource buildout results from RESOLVE for the various scenarios. The 2017-2018 PSP is also presented for purposes of comparison.

Table 1. Cumulative Incremental Resource Buildout in Key Scenarios (in megawatts (MW))

Scenario	Wind	Solar	Battery Storage	Pumped Storage	Geo-thermal	Shed Demand Response	Year
2017-2018 PSP	1,145	5,852	-	-	-	-	2022
	1,145	5,852	187	-	-	-	2026
	2,246	5,916	2,104	-	1,700	-	2030
46 MMT Default	34	-	2,960	-	-	222	2021
	1,950	-	2,960	-	-	222	2022
	1,950	11,807	2,960	-	-	222	2023
	2,372	11,807	3,878	-	-	222	2024
	2,372	11,807	5,796	-	-	222	2026
	2,837	11,807	11,376	-	-	222	2030
46 MMT Alternate	34	2,006	624	-	-	222	2021
	1,950	4,006	624	-	-	222	2022
	1,950	6,006	1,336	-	-	222	2023

Scenario	Wind	Solar	Battery Storage	Pumped Storage	Geo-thermal	Shed Demand Response	Year
	2,550	6,006	3,759	-	-	222	2024
	2,550	6,006	5,193	-	-	222	2026
	2,837	11,774	11,384	-	-	222	2030
38 MMT	34	-	3,095	-	-	88	2021
	1,950	-	3,095	-	-	88	2022
	1,950	13,682	3,095	-	-	88	2023
	2,550	13,682	3,885	-	-	88	2024
	2,550	13,682	6,112	-	-	88	2026
	4,337	17,224	15,789	-	-	88	2030
30 MMT	34	-	3,095	-	-	88	2021
	2,392	-	3,095	-	-	88	2022
	2,392	14,873	3,095	-	-	88	2023
	2,992	14,873	3,757	-	-	88	2024
	6,453	14,873	6,525	85	-	88	2026
	8,279	20,826	19,084	85	-	88	2030

Commission staff focused in on the GHG emissions results under the different scenarios, also analyzing the results of the 46 MMT cases in SERVM. Table 2 below presents the results for the CAISO area only (the approximately 81 percent of the statewide electric sector emissions attributable to LSEs within the CAISO system).

Table 2. GHG Emissions Results in the CAISO Area (in MMT)

Planning Year	**46 MMT Default**	**46 MMT Alternate**	**38 MMT**	**30 MMT**
RESOLVE Results				
2022	41.6	39.6	41.5	41.2
2026	40.3	42.9	39.0	34.3
2030	37.9	37.9	31.1	24.3
SERVM Results				
2022	Not simulated	39.8	Not simulated	
2026		44.5		

Planning Year	46 MMT Default	46 MMT Alternate	38 MMT	30 MMT
2030	39.0	38.9		

In terms of reliability assessment with SERVM, the preliminary results presented at the October 8, 2019 workshop indicated that these updated portfolios would be sufficiently reliable when modeled in SERVM. Commission staff considered sufficiently reliable to mean a loss of load expectation (LOLE) of less than or equal to 0.1, which translates approximately to one day in ten years where the electric system would have to shed firm load due to insufficient generating capacity to service load and hold critical operating reserves.

However, when Commission staff were preparing variations on assumptions to analyze the 46 MMT Default and Alternate Scenarios, they discovered an issue when comparing results from the RESOLVE and SERVM models. While both models include a simultaneous import constraint for the CAISO area at the maximum import capability (MIC) level (approximately 11 GW), RESOLVE contains an additional constraint of 5 GW as the default assumption for imports that can be counted towards resource adequacy and meeting the planning reserve margin (PRM) requirement of 15 percent. SERVM, by contrast, did not have any similar additional constraint on imports. Thus, in assessing whether the electric system was sufficiently reliable, SERVM was relying on a larger set of potential imports than RESOLVE.

To further constrain SERVM to approximate RESOLVE's assumption that only 5 GW of imports can count towards resource adequacy, Commission staff have now added in SERVM a second CAISO simultaneous import limit of 5 GW that applies for all hours where gross electric demand is higher than the 95th percentile. This approximates the stressed hours of the year that the resource adequacy program is intended to cover.

When this additional SERVM constraint was added, the LOLE results exceeded 0.1 for 2022, 2026, or 2030 in the 46 MMT Default scenario. Table 3 below presents the LOLE results for this scenario.

Table 3. LOLE Results with Additional SERVM Import Constraint Added

Planning Year	46 MMT Default
2022	0.220
2026	0.108
2030	0.166

Knowing that the 46 MMT Alternate Scenario would be a likely option for the RSP since it includes realistic assumptions about near-term buildouts, Commission staff focused its limited modeling resources on a more detailed study of this scenario using SERVM. Observing that the 46 MMT Default Scenario and the 46 MMT Alternate Scenario are similar in buildout and level of existing gas unit economic retention, staff predicted that SERVM simultations of the 46 MMT Scenario as-is from RESOLVE would also yield LOLE results that exceeded 0.1.

To ensure SERVM simulations that would demonstrate a 0.1 LOLE or better level of reliability for the 46 MMT Alternate Scenario, Commission staff estimated that 2,000 MW of generic effective capacity would need to be added to the portfolio. The 2,000 MW was added for the study years of 2026 and 2030, meaning it would be online by 2026. No extra capacity was added in 2022, since the 46 MMT Alternate Scenario included a partial extension of existing OTC units that should provide sufficient effective capacity in 2022. In this context, generic effective capacity can be understood to represent NQC for resource adequacy purposes, without regard to the type of resource providing the capacity. Such capacity could come from a number of potential sources: firm imports, batteries paired with solar, geothermal, demand response, or more

economic retention of existing natural gas generation. The issue of the appropriate source of the capacity is discussed further in Section 6 of this ruling. But for reliability modeling purposes, when 2,000 MW of generic effective capacity was added to SERVM manually, the LOLE results given in Table 4 below are produced.

Table 4. LOLE Results with Additional SERVM Import Constraint Added Plus Addition of 2,000 MW of Generic Effective Capacity

Planning Year	46 MMT Alternate
2022	0.070
2026	0.056
2030	0.016

Further details of the analysis conducted and its results can be found in Attachment B to this ruling. These results suggest that the two-part modeling approach being conducted by Commission staff for IRP analysis purposes is working appropriately, and highlights the importance of reliability checks in SERVM. While the portfolio to meet a 46 MMT GHG target produced by RESOLVE looks viable, the reliability analysis produced by SERVM suggests that additional capacity would be needed to produce a functional electric system for the CAISO.

3.2. Questions for Parties

7. Provide any comments on the results from the major scenarios or sensitivities analyzed by Commission staff to develop the RSP recommendation.
8. Comment on the modifications to SERVM made by Commission staff to approximate RESOLVE's PRM constraint, which limits the amount of imports that can count towards resource adequacy. Were the changes appropriate? Why or why not?
9. Comment on the manual addition of 2,000 MW of "generic effective capacity" in order to produce a portfolio with an LOLE result of less

than 0.1. Would you recommend a different way of depicting the reliability gap in the portfolio? If so, describe in detail.

4. Electric Sector GHG Target

This section addresses the recommended GHG target scenario for the Commission to use as the basis for the recommended RSP, along with questions for parties on this topic.

4.1. Recommendation

As the basis for the RSP, this ruling recommends using the 46 MMT Alternate Scenario, with the alternative assumptions for OTC retirement and solar buildout and the addition of 2,000 MW of generic effective capacity beginning in 2026. Commission staff developed the 46 MMT Alternate Scenario in order to represent a likely implementation pathway as LSEs conduct procurement and the system continues to have reliability needs. The primary assumption changes in the 46 MMT Alternate Scenario are related to OTC unit retirements and the pace of solar buildout.

As of the publication of this ruling, it is not possible to know precisely whether some of the OTC units will have their compliance deadlines extended, but it seems reasonable to assume that at least some of the OTCs with deadlines at the end of 2020 will be able to operate for a few years longer to assist with system reliability in the short term. In addition, Commission staff have compared the progress of solar buildout during the past decade with the 46 MMT Default Scenario options and assessed that the assumptions for the 46 MMT Alternate Scenario are more in line with historical progress of solar development, even during the height of the buildout to support renewables portfolio standard (RPS) requirements in the past decade.

More fundamentally, the 46 MMT Alternate Scenario is consistent with past IRP policy. It is similar to the scenario adopted in D.18-02-018 and keeps the

electric sector on the trajectory to meet its 2030 GHG goals, even considering the impending retirement of the Diablo Canyon nuclear plant in 2024 and 2025.

Analysis is ongoing by CARB and others with respect to the progress toward the 2030 goals in other sectors of the economy, but it is reasonable to assume that at least some GHG emissions reductions progress in other sectors such as transportation and buildings may result in electrification of those energy uses. Thus, the electricity load in the state is likely to grow at the same time the emissions trajectory in the electric sector is continuing to go down.

Thus, the 46 MMT Alternate Scenario represents a realistic but still aggressive goal for the electricity sector, given the substantial buildout of renewables required in the portfolio. This is especially true in light of the numerous new LSEs whose procurement choices will contribute to this goal.

4.2. Questions for Parties

10. Do you support the 46 MMT Alternate Scenario as the basis for the GHG emissions goal for 2030 to be affirmed by the Commission? Why or why not? If you propose a different scenario, explain your rationale.

5. Electric Resource Portfolio

This section discusses the electric resource portfolio associated with the recommended 46 MMT Alternate Scenario, as described in the last section. Questions for parties are also included here, related to the portfolio choice.

5.1. Portfolio Description

The portfolio resulting from the 46 MMT Alternate Scenario, with the alternative assumptions for OTC retirements and solar buildout, results in a portfolio buildout by 2030 that is heavily weighted toward solar and battery storage, plus some wind resources and a small amount of shed demand response.

In particular, the battery capacity selected for this portfolio is approximately 11 GW, which is roughly ten times the installed capacity of batteries nationally in 2018. The utility-scale solar capacity required also represents almost a doubling of solar capacity compared to current in-state solar in California. Such a large buildout of these resources is unprecedented at this magnitude, and the practical challenges associated with it in reality cannot be effectively estimated using only a model.

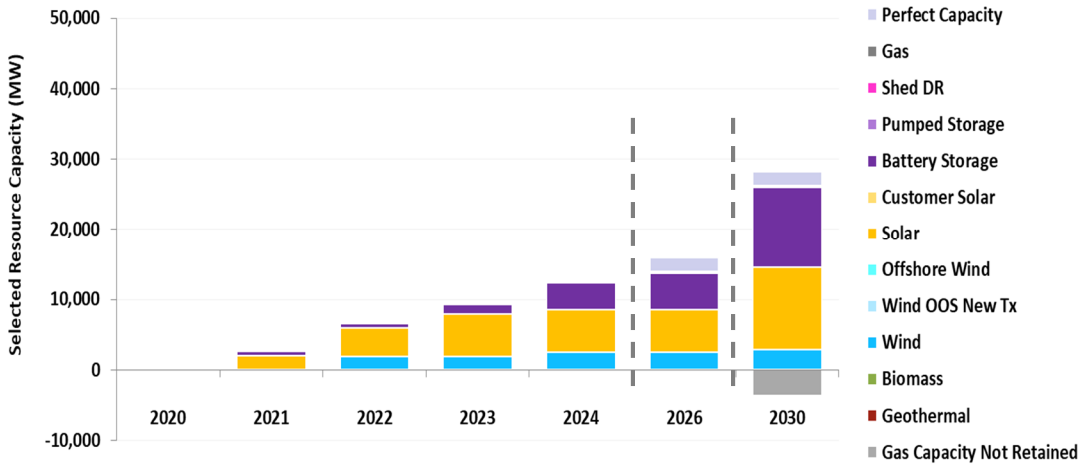
In addition, this portfolio chosen by RESOLVE chooses not to economically retain approximately 3.7 GW of the existing thermal generation. This is exclusive of the portfolio's fixed assumption that about half of the existing remaining OTC plant capacity currently scheduled to retire at the end of 2020 will be extended through 2023.

Further, the baseline portion of the portfolio includes existing wind, geothermal, and biomass, a portion of which likely needs to be repowered to stay online through 2030. For example, Commission staff estimate that 1.5 to 2.5 GW of wind currently operating in the CAISO system will be 25 years or older by 2030. Some portion of this will likely be competitive with new resources, and even if not, it is all assumed in RESOLVE to be contributing to the GHG reduction and reliability needs through 2030.

Finally, the 46 MMT Alternate Scenario contains the generic 2,000 MW of effective capacity added in SERVM by Commission staff (and not originally selected in RESOLVE) to make the portfolio sufficiently reliable (resulting in an LOLE of less than 0.1).

Figure 1 below shows the incremental resources necessary to achieve the 46 MMT Alternate Scenario by 2030. Additional results, including total resource buildout, are included in Attachment A.

Figure 1. Selected Resource Capacity (MW) in the 46 MMT Alternate Scenario



5.2. Questions for Parties

11. Are you concerned about the risk of overreliance on solar as part of the recommended portfolio? Why or why not?
12. Are you concerned about the risk of overreliance on battery storage as part of the recommended portfolio? Why or why not?
13. Is the retention of most or all of the current thermal generation fleet reasonable and realistic? Why or why not?
14. Do you have additional comments about the portfolio associated with the 46 MMT Alternate Scenario?

6. Commission or LSE Actions in Response to Portfolio Recommendation

This section addresses actions that the Commission can ask LSEs to take to respond to the recommended portfolio. Questions for parties are also included.

6.1. Possible Actions

The heavy emphasis on solar and battery storage in the selected portfolio may be of concern for several reasons. First, there is the development risk associated with such a large buildout of these two types of resources. Second, there is cost risk if the assumptions utilized in the RESOLVE model to select this portfolio prove to be inaccurate. Third, there is the declining capacity value of

both types of resources with so much greater penetration, at levels never before seen in any electric system anywhere. Fourth, there is operational risk associated with so much battery storage deployment, because even the current installations in California are not being utilized in the manner that they would need to be in 2030 with a system so heavily built out with solar capacity. And fifth, there is risk associated with the lack of diversification among the selected new resources, or putting all of California's eggs in a few baskets. Put simply, it is unknown whether there will be enough reliable energy resources to charge the large amount of storage so that it can discharge when needed to provide reliability services.

In addition to these risks, in order to make a reliable portfolio beginning in 2026, Commission staff needed to add 2,000 MW of generic effective capacity as described in Section 3 above. This capacity will need to be defined more precisely and procured by LSEs at some point in the near future, so that it is online by at least 2026. Basic questions include:

- What types of resources should provide the additional 2,000 MW of needed effective capacity?
- Given that the reliability need is for effective capacity, and not necessarily energy, should the resources be required to be exclusively zero-emission resources?
- Who should procure the additional required capacity?

For all of these portfolio diversity and additional capacity requirement reasons, there is the possibility that the Commission should recommend or require the development of a different portfolio of resources, or additional resources, beyond the portfolio identified by RESOLVE as the optimal one. RESOLVE is simply a model that produces results based on its assumptions. It does not have a way to assess or quantify the portfolio diversity risks and

benefits identified above. It is difficult to create a model with an objective function that incorporates these complex risks. While it is not quantified or necessarily quantifiable, there is certainly some value in resource diversity in resource planning, to manage risk.

There is also the coming retirement of the Diablo Canyon nuclear plant units in 2024 and 2025, that is likely to lead to the need for additional capacity resources in the same timeframe, and may actually cause the capacity shortfall identified by Commission staff in the modeling. Based on the experience and pending actions associated with the large amount of OTC capacity scheduled to retire at the end of 2020 and the tightening of the resource adequacy market in California, the Commission may need to take additional actions now to ensure replacement capacity for Diablo Canyon.

All of the above considerations, taken together, may point to the need to consider the other types of resources not represented in the optimal portfolio analyzed in RESOLVE, but available for development, are at least two types of resources analyzed in the 2017-2018 IRP cycle, and which appeared in the 36 MMT scenarios analyzed then. These resources are geothermal and pumped storage resources, as well as additional wind from untapped sources. In the case of geothermal, it is likely to provide better capacity replacement for the Diablo Canyon plant than many of the other options available. In the case of out-of-state wind, it is worth noting that this resource was not selected by RESOLVE in this current RSP development, most likely due to reduced solar and battery costs since the last round of analysis.

It already seems likely that LSEs soliciting for additional procurement in the next decade will conduct overall renewables solicitations and not specific solicitations for solar or battery storage or wind. However, it seems unlikely that

geothermal or pumped storage resources will compete favorably in such solicitations if compared only based on price, since that is essentially the analysis that the RESOLVE model provides.

This leads to the question of whether the Commission or LSEs should undertake specific actions that could lead to the development of different types of resources specifically, for their risk diversification value, additional capacity value, or for some other reason. For example, early in the RPS process, the Commission specifically took steps leading to the development of the Tehachapi Renewable Transmission Project, in order to access primarily wind potential in that area. A similar geographically-concentrated potential for geothermal resources exists in the Imperial Valley, and certain areas of Northern California. A similar type of effort may be necessary if development of offshore wind resource potential is to be undertaken.

For pumped storage resources, the barriers are more associated with their large and capital-intensive nature, likely requiring more than one buyer/off-taker in order to facilitate development of a project.

All of these issues, including the need for repowering of existing resources, are already included in the scope of the procurement track of this proceeding, as articulated in D.19-04-040. The question here is whether the Commission should prioritize taking any specific actions now associated with these or other resources.

6.2. Questions for Parties

15. Should the Commission take steps to begin development of transmission and/or generation from geothermal resource areas? If so, what steps? If not, why not?
16. Should the Commission take steps to support the development of at least one pumped storage facility in California? If so, what steps? If not, why not?

17. Are there other actions the Commission should take specifically with respect to replacement capacity for the Diablo Canyon nuclear plant? Describe in detail.
18. Are there other actions the Commission should take with respect to development of any other types of capacity or resources such as offshore or out-of-state wind? Describe in detail.

7. CAISO TPP Recommendations

This section describes the recommended portfolios to be transferred to the CAISO for purposes of its 2020-21 TPP, which will kick off in early 2020. A recommended reliability and policy-driven base case, as well as two sensitivity cases, are described below. Questions for parties are also presented.

7.1. Recommendations

7.1.1. Reliability Base Case and Policy-Driven Base Case

For purposes of both the reliability base case and the policy-driven base case for the CAISO TPP, similar to the past two years (in D.18-02-018 and D.19-04-040), this ruling recommends that the same case be used for both purposes. The reliability and policy-driven base cases are used by the CAISO to identify transmission upgrades needed that, once identified, will proceed directly to the planning stage and be brought to the CAISO board for consideration. The base case recommended for this purpose is the 46 MMT Alternate Scenario, as described in Sections 4 and 5 of this ruling.

7.1.2. Sensitivity Cases

Policy-driven sensitivity cases are those studied by the CAISO, but that do not necessarily lead directly to transmission project development. In the 2019-2020 TPP cycle, the Commission asked the CAISO to study two different 36 MMT cases with different in-state and out-of-state generation portfolios, in

order to assess the implications for in-state transmission under those different scenarios. Results of that analysis are pending.

For this next TPP cycle, Commission staff are similarly suggesting at least two cases that can be used to develop additional transmission cost and congestion information.

In general, the CAISO provides annually to Commission staff the transmission capability limits and upgrade cost estimates used as a direct input into RESOLVE for the IRP analyses. The CAISO is unable to provide transmission upgrade cost estimates for transmission zones that have not already required study in the TPP or the generation interconnection study processes under more aggressive GHG targets.

Currently, if a transmission zone does not have dispatchable resources, the CAISO assumes a 20 percent exceedance level of curtailment of new resources would be possible during summer peak load conditions, based on the current on-peak deliverability methodology, but does not provide an energy-only (EO) capability number. A zero EO limit is assumed for those areas in RESOLVE. Commission staff propose to collaborate with the CAISO staff during the 2020-2021 TPP cycle to incorporate less stringent EO limits than estimated in the past. These updated EO limits would be developed under the assumption that an increased amount of curtailment would be permitted in various transmission zones. These relaxed limits would allow RESOLVE to place more generation resources in transmission zones which have not been extensively studied, and in turn the CAISO would be able to better assess congestion in these areas, as well as transmission projects that could economically address the congestion. Commission 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 congestion findings could flow into RESOLVE in the future to inform selection and location of new generation and transmission buildout.

To conduct this analysis, Commission staff recommends that multiple sensitivity portfolios may need to be transmitted to the CAISO to produce information on congestion and transmission upgrade costs necessary to improve the co-optimization of generation and transmission in future RESOLVE runs. Below are two sensitivity approaches proposed by Commission staff.

Policy-Driven Sensitivity 1:

- The CAISO provides LEVEL 1 updated EO transmission capability estimates
  - LEVEL 1 is defined as: As an update to the previously-provided EO transmission capability estimates
    - Provide 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)
    - Increase 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.
    - Increase the EO transmission capability estimates for zones with "minor upgrades" (scope of work limited to inside an existing substation) by the same amount as the incremental capability provided by the upgrades.
- New EO limits incorporated into RESOLVE allow the model to build new generation in more transmission zones. The selected resources are mapped to substations and the portfolio with busbar mapping is transmitted to the CAISO.

- The CAISO studies congestion impacts of additional new generation in more transmission zones.

Policy-Driven Sensitivity 2:

- The CAISO provides LEVEL 2 updated EO transmission capability estimates.
  - In addition to LEVEL 1 estimates, LEVEL 2 will increase 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.
- New EO limits incorporated into RESOLVE allow 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 transmission to the CAISO.
- The CAISO's assessment of this portfolio provides additional information on congestion in the transmission zones with further relaxed EO transmission capability limits.

The above proposed policy-driven sensitivity portfolios would allow for the comparison of congestion impacts in each area, leading to better understanding of the costs and benefits of building new transmission. In addition, it is expected that these sensitivities would produce updated transmission upgrade cost information if the CAISO found the need for new transmission under these information-only sensitivities.

7.1.3. Busbar Mapping

On October 22, 2019, Commission staff informally shared with the service list of this proceeding a proposal for the methodology on mapping electric resources to busbars for use in the CAISO TPP analysis. Several parties provided informal comments to staff and the service list by October 29, 2019, as requested.

Commission staff had originally intended to provide the actual mapping of the proposed RSP for formal comment in this ruling.

However, the mapping process being conducted by CEC and Commission staff is not yet complete. In addition, because the Commission has not yet adopted a specific RSP, it is potentially inefficient and duplicative to have more than one portfolio mapped to busbars.

To provide a more efficient process, while also allowing formal input from parties on the mapping process, this ruling proposes to have the busbar mapping process proceed on a parallel path with the adoption of the RSP.

To facilitate this, a separate ruling will be issued in the near future with details of the busbar mapping, and seeking party comments on the methodology and the results. Depending on timing, the actual mapping results will either be adopted in the decision adopting the RSP, or will be delegated to the assigned Commissioner and/or ALJ to finalize the mapping after the RSP is adopted.

Either way, this would represent an improvement over past cycle process. In the last cycle, busbar mapping was conducted informally by Commission and CEC staff after-the-fact, once the RSP or PSP was already adopted by the Commission. It should be noted that numerous parties at the October 8, 2019 workshop on preliminary results expressed support for increased opportunities for formal input on this topic. It is also important for LSEs to participate in and understand the busbar mapping process, because of limits on transmission and resource availability in specific geographic areas that may affect procurement plans and choices.

7.2. Questions for Parties

19. Comment on the recommendation to use the 46 MMT Alternate Scenario as the reliability and policy-driven base cases for the next CAISO TPP;

20. Comment on the recommendations for policy-driven sensitivities around curtailment in particular transmission zones and the associated impact on EO or full deliverability for renewables; and
21. Comment on the suggested process for seeking formal input on busbar mapping of the proposed RSP.

8. Proposed Aggregation Process for the 2020 PSP

This section describes a proposed process to be used to aggregate individual IRP filings from all LSEs separately, to form the basis for the PSP in 2020.

8.1. Aggregation Process

In the 2017-2018 IRP cycle, Commission staff aggregated the LSEs' conforming portfolios together using a methodology described at the October 31, 2018 workshop.[5] Ultimately, the PSP adopted in D.19-04-040 was not based on this aggregation. Lessons learned from the aggregation process included:

- Where the summation of LSEs' planned resources exceeded relevant limits such as the resource potential estimated for a particular resource zone, Commission staff did not have pre-established and stakeholder-vetted criteria for determining if reallocation of resources was needed, and if so, on what basis it should be performed;
- Manual reallocation of resources is time-consuming and introduces the possibility of errors. For example, arithmetic errors can arise when taking a MW amount that is identified to exceed a resource potential limit and splitting it across multiple neighboring resource zones; and
- Reallocation of resources, even if done with the intention of optimizing at the system level, may inadvertently depart

[5] This methodology is included in slides 25-30 of the following powerpoint presentation: https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/IRP_workshop_2018-10-31_slides.pdf

> from the planning intentions of the individual LSEs in important ways and detract from the value of the development of the individual IRPs in the first place.

For these reasons, Commission staff are suggesting a refined approach to aggregating individual IRP resource choices in 2020. Establishing criteria ahead of time should hopefully have the following benefits:

- Ensuring that the process is streamlined, objective, and transparent;
- Clarifying for LSEs how information in their portfolios and broader plan filings will be used to inform the development of the 2020 PSP, thereby focusing efforts on development of the critical information;
- Reducing Commission staff's manual reallocation of MW values in LSE plans to better fit at the system level, reducing potential for errors; and
- Identifying for stakeholders what will happen in the event that LSE portfolios, in aggregate, differ from the RSP adopted by the Commission.

To try to bring about these benefits, the following aggregation criteria are proposed to be used when Commission staff develops the aggregate portfolio to recommend as the PSP in 2020.

If an LSE has more than one conforming portfolio, Commission staff should use the LSE's preferred portfolio for aggregation.

For any LSE required to file an IRP in 2020 but which does not appear in the 2018 IEPR Update forecast (*e.g.*, a newly emergent CCA), Commission staff will engage with the LSE and the affected investor-owned utility to identify a clear load migration date, to determine which years from each LSE's conforming portfolio to use in aggregation.

POUs within the CAISO balancing area report their activities and planning to the CEC, yet the Commission's RSP includes baseline and selected candidate

resources associated with serving CAISO load for POUs within the CAISO. Thus, an aggregation of LSE portfolios must include some representation of POU portfolios in order to have a complete picture of resources serving load within the CAISO. For aggregation, Commission staff propose to use the POUs' baseline resources and an approximation of their share of selected candidate resources from the RSP. Staff may also refer to the POUs' IRPs, if practical and more instructive.

For resources not yet procured (*i.e.*, planned by LSEs) that are coming online in the medium term, Commission staff should leave resource choices as is in LSE plans, if technically feasible. Where resource choices are indicated by LSEs to be non-specific, Commission staff should optimize the selection of these resources, using RESOLVE directly if possible, or at least mirroring the criteria it uses.

The aggregate of planned resources should not exceed resource potential in each zone.

Commission staff should also ensure that identification of need for new transmission is substantiated by LSEs as needed over any other lower-cost or lower-risk alternatives. LSEs may trigger an upgrade not identified in the RSP if the LSEs communicate that they are actively planning for the upgrades, and can justify the cost, timeline, and risks.

Absent justification by LSEs for any new transmission necessary to interconnect their planned resources with FCDS, staff may either convert resources to EO and/or shift to zones with available transmission capacity. There will be a preference for keeping FCDS for resource types that have higher capacity value (*e.g.*, geothermal and wind).

Commission staff will reallocate planned resources to zones while retaining the resource characteristics according to LSE individual plans as much as possible, in descending order of priority:

- Resource technology/type;
- EO or FCDS;
- Geographic proximity; and
- Performance and cost-effectiveness.

The explanation within LSE plans on resource choices should be considered where the LSE's Action Plan associated with the resource meets the filing requirements.

The portfolio should be reliable, with Commission staff assessing the portfolio as follows:

- Using the new 2019 IEPR load forecast, expected to be adopted in early 2020;
- Assuming thermal fleet retirements consistent with the RSP, updated with any changes publicly announced by generators and contracts with existing generators indicated in LSE plans;
- Comparing LSE plans to any system and local capacity requirements adopted by the Commission; and
- Where Commission staff determines that additional resources may be necessary for renewables integration, selection of these resources should be optimized by using RESOLVE or at least mirroring its criteria.

To further illustrate the general criteria description given above, this ruling presents a theoretical situation below, followed by a description of the steps that Commission staff would take in aggregation the portfolios and developing the PSP. The theoretical scenario is the following: Initial aggregation of LSE portfolios identifies 600 MW of FCDS wind in Carrizo in 2022, which is 413 MW

in excess of the FCDS capability of the existing transmission system, and 313 MW in excess of the potential estimate for that zone under the default environmental screen. LSE plans do not attempt to justify the need for new transmission in this zone.

To address this situation, Commission staff would follow the aggregation criteria by taking the following steps:

- Observe that all of the 600 MW is planned by LSEs to come online in the medium term and represents specific Carrizo zone selection, rather than selection of more generic CAISO wind resources;
- Identify nearby zones, their existing FCDS capability and resource potential: Kern_Greater_Carrizo (597 MW and 60 MW, respectively), and Tehachapi (3,677 MW and 275 MW, respectively). Staff would note that Westlands and Central_Valley_Los_Banos have no capacity for new resources, due to their resource potential and FCDS capability;
- Check that Kern_Greater_Carrizo Wind and Tehachapi Wind have generation profiles and levelized fixed costs that are reasonably similar to Carrizo Wind. If so, Staff would reallocate up to 60 MW and 275 MW to each of these zones, to the extend that LSEs have not already planned new resources there that have equivalent or higher capacity value than wind. Lower capacity value resources (*e.g.,* solar) could be converted to EO or reallocated to other zones, unless justified by LSEs as requiring FCDS;
- If Kern_Greater_Carrizo Wind and Tehachapi Wind do not have similar or better generation profiles and levelized fixed costs compared to Carrizo Wind, staff would seek to reallocate to resource zones that may not be geographically proximal (refer to next step);
- For MW that remain to be allocated, staff would generally follow the zone allocation of the RSP, while looking for

direction and rationale in LSE plans, including reporting against planning standards; Specifically, staff would look for LSE planning concerning zone and FCDS preferences (*i.e.*, commercial interest), updated assumptions to those used to form the RSP, and the need for transmission upgrades; and

- Staff will document assumptions and make them available for stakeholder review.

8.2. Questions for Parties

22. For a particular resource type and zone, where the aggregated resources in LSE plans exceed the resource potential, this suggests that some portion of the selected resources are non-viable from an economic, environmental, or land use perspective. What level of exceedance over resource potential is acceptable, if any, before staff should reallocate resources when aggregating resource choices to form a PSP?
23. What showings should LSEs be required to make to demonstrate that deviations, if any, between the aggregation of LSE portfolios and the RSP are appropriate and necessary to better adhere to the IRP statutory requirements?
24. What criteria should Commission staff use to determine whether transmission upgrade needs identified by LSEs in their IRPs are appropriate to be reflected in the PSP and the TPP reliability base case adopted by the Commission?
25. Provide any other comments on the Commission staff-proposed aggregation approach, including any process suggestions for how LSEs can more effectively participate or give input to the planning process.

IT IS RULED that:

1. The modeling results and all attachments to this ruling are hereby entered into the formal record of this proceeding.

2. Interested parties may file and serve comments in response to this ruling by no later than November 27, 2019. Parties should respond to the numbered questions throughout this ruling with reference to specific question numbers.

Comments on any and all other aspects of the ruling or its attachments may follow.

3. Parties who have conducted independent modeling analysis as input to the Reference System Portfolio may also file and serve those results with their comments due November 27, 2019.

4. Interested parties may file and serve reply comments by no later than December 13, 2019.

Dated November 6, 2019, at San Francisco, California.

/s/ JULIE A. FITCH
Julie A. Fitch
Administrative Law Judge