

FILED
9-19-17
10:17 AM

Attachment D

Attachment D: Summary of Sensitivity Analyses Conducted by Staff in Response to Party Comments

This table summarizes the sensitivity analyses conducted by Commission staff in response to party comments on Question #9 of the “Administrative Law Judge’s Ruling Seeking Comment on Staff Proposal on Process For Integrated Resource Planning,” issued on May 16, 2017.¹ Question #9 reads: “Modeling Assumptions. Do you have any specific changes to recommend to the modeling assumptions detailed in Chapter 4 and Appendix B of the Staff Proposal and the associated spreadsheet Scenario Tool? What are they and why? Indicate a publicly-available source of your recommended assumptions.”

<u>Item</u>	<u>Issue</u>	<u>Parties</u>	<u>Action</u>	<u>Summary of Sensitivity Analysis</u>
1	Allow more granular incremental MW/duration pumped hydro?	Brookfield	Test sensitivity of duration	Commission staff tested a sensitivity in which the minimum duration of new pumped storage was relaxed from 12 to 6 hours. This change has no impact on the portfolio in the Default & 42 MMT scenarios (since no pumped storage was selected in these scenarios). In the 30 MMT scenario, this change results in the selection of a small amount of additional pumped storage capacity, displacing a small amount of battery storage from the portfolio. Because of the major uncertainties in future battery costs and pumped storage availability--and the fact that RESOLVE runs will not be used directly to prescribe procurement of batteries or pumped storage--this impact on the portfolio is not significant enough to incorporate into the full scenario analysis. <i>Case Name: ##mmt_Ref_6h_ps_20170831</i>

¹ Available at: <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442453458>.

<u>Item</u>	<u>Issue</u>	<u>Parties</u>	<u>Action</u>	<u>Summary of Sensitivity Analysis</u>
2	Change the model to account for longer lifetime, >10y horizon, lifecycle cost/benefits of candidates	Brookfield	No action. RESOLVE models the financing lifetime of pumped storage as 25y. Financing over more years beyond 25 has a tiny impact. Lifecycle cost/benefits broadly considered by virtue of last modeled year getting more weight.	
3	Change the default 5000 MW net export limit to 2000 MW (CAISO) Proposes a set of principles to set the limit (CalWEA) No limit is needed (Gridliance) Account for the expanding EIM (ORA) The limit should be 0 MW or negative (TransCanyon)	CAISO, CalWEA, Gridliance, ORA, SCE, TransCanyon	Keep default of 5000 MW. Test sensitivities with lower/higher limits. RPS driven cases may be sensitive to the limit, GHG driven cases may be less so.	Staff tested two sensitivities on the net export limit: 2,000 MW and 8,000 MW. Staff observes that in general, a lower export limit tended to push the portfolio towards a more diverse result, though the effect was usually small. A lower export limit also increases the cost of each of the portfolios. However, because the overall composition of the portfolios do not change dramatically--and because this limit is highly uncertain and cannot be determined with substantial precision--staff does not recommend revisiting this assumption at this time. <i>Case Names: ##mmt_Ref_high_exports_20170831, ##mmt_Ref_low_exports_20170831</i>

<u>Item</u>	<u>Issue</u>	<u>Parties</u>	<u>Action</u>	<u>Summary of Sensitivity Analysis</u>
4	<p>Revise assumptions for Li-Ion battery resources to be in line with industry as follows: (a) Energy Capital costs are too high, suggest \$230-\$400 \$/kWh in 2016 (b) Power Capital costs are too low, suggest \$540-\$1000 \$/kW (c) All-in costs (Energy and Power Capital costs combined) decline with Compound Annual Growth Rates -5% to -11% between 2017-2030 (d) All-in costs appear high, especially in later years (e) Model lifetime of battery cells as >10 years for durations >4 hours and <10 years for durations <4 hours.</p>	PG&E	<p>See p.28 of PG&E Opening Comments for citations. Check if PG&E's proposed cost numbers are within the upper/lower bounds of the Lazard's cost curves that RESOLVE used. Test sensitivities.</p>	<p>Staff tested a sensitivity using the battery storage prices for lithium-ion storage devices recommended by PG&E. The results show little impact on the optimal portfolios in the Default and 42 MMT scenarios, which still select modest amounts of energy storage. In the 30 MMT scenario, the lower battery costs trigger a shift in the portfolio away from pumped storage and towards battery storage, as low cost batteries provide a substitute for the services provided by pumped storage. The low cost of batteries in this case results in no pumped storage being selected. Staff sees this as a strong reminder of the impact of uncertainty in planning, but does not propose to revisit the assumptions on storage currently as this work is not being used directly to determine an appropriate split between competing storage technologies.</p> <p><i>Case Names: [Specific case results not included in public release because not materially different from the low storage cost cases (##mmt_Ref_low_storagecost_20170630).]</i></p>

Item	Issue	Parties	Action	Summary of Sensitivity Analysis
5	<p>"Environmental screens" or scaling factors artificially limit potential renewable capacity available for RESOLVE to select and give too rough an approximation. Suggested alternative modeling mechanisms include: (1) Configure the model to recognize the relationship between saturation and development costs. (2) Allow model to solve for least cost/best fit resource portfolio without arbitrary scaling factors, then qualitatively refine results to avoid excessive concentration. (3) If scaling factors are used, run various scenarios using different scaling factors and adjust as needed. (Gridliance)</p> <p>Incorporate RFO bids and other recent market-based pricing information into each successive IRP cycle. Open to a RESOLVE sensitivity utilizing more restrictive land-use screens, but only legally prohibited lands should be screened in the base scenarios. Baseline resources should include all contracted resources and those in current commission policy, including CCA/ESP/muni RPS contracts and mandated program volumes. RPS resources with expiring contracts should be available for re-contracting in RESOLVE. (PG&E)</p>	Gridliance, PG&E	<p>No action. Refining land-use screening will be in scope in subsequent IRP cycles.</p> <p style="text-align: center;">5</p>	N/A

Item	Issue	Parties	Action	Summary of Sensitivity Analysis
6	<p>Categorize Nevada CREZ areas (in VEA), NV_WE and NV_SW, as "In-State Resources". The current assumptions improperly treat all resources geographically outside California as "Out-of State Resources" subjecting them to costs they would not incur since they are on the CAISO grid or directly interconnected.</p>	<p>GridLiance West, VEA</p>	<p>Test sensitivity to determine if this adjustment is material enough to rerun all cases.</p>	<p>Staff tested a sensitivity in which NV wind, solar, and geothermal resources were treated as connecting directly to the CAISO footprint (i.e. treated as in-state resources). This adjustment adds a new source of resource diversity (wind and geothermal) showing some benefit under the 30 MMT scenario, in which both of these resources are selected, displacing solar and energy storage. Staff incorporated this update into the model used to produce the proposed Reference System plan. Staff also reminds parties that RESOLVE is not being used to identify specific locations for procurement, and that its coarse geographic granularity on renewable cost and quality do not lend the model to use in this purpose.</p>
7	<p>Assuming no renewables can be sited in most CREZ areas outside California on existing transmission are biased oversimplifications. Where California-external CREZs are shown to have zero ability to support additional renewables on existing transmission, there may still be room for smaller resources. The presumed "first year available" for out-of-state renewables should be refined to recognize that they could be interconnected before 2026. Many projects are already in CAISO's queue and likely to interconnect with existing transmission or require only short-lead-time upgrades.</p>	<p>GridLiance West, VEA</p>	<p>Test sensitivity to determine if material enough to rerun all cases.</p>	<p>See above.</p>

Item	Issue	Parties	Action	Summary of Sensitivity Analysis
8	Update costs so that interconnecting geothermal resources is the same cost as interconnecting wind and solar resources in southern Nevada.	GridLiance West, VEA	No Action. Resolved through changes to treatment of VEA in general.	Interconnection costs were developed by Black & Veatch based on geospatial data on resource potential and the proximity of those resources to the existing high-voltage transmission network. Staff does not recommend ad hoc adjustments to these interconnection costs, as the differences between resources are intended to reflect actual resource-specific differences in cost.
9	Assumptions don't include assumed values for available transfer capability between CREZ areas, CAISO, or the LSEs, so will likely include unnecessary network upgrades, increasing presumed costs for outside California resources, especially for those on VEA 230 kV transmission system.	GridLiance West	No Action. Resolved through changes to treatment of VEA in general.	N/A
10	Change capacity-factor assumption for Nevada wind to 37% from 28% based on recent study by ICF Resources.	GridLiance West	No action. RESOLVE uses sources of approximately the same vintage for CF assumptions and given expected <i>de minimis</i> impact, decline to make a one-off change.	N/A

<u>Item</u>	<u>Issue</u>	<u>Parties</u>	<u>Action</u>	<u>Summary of Sensitivity Analysis</u>
11	Correct cost and performance assumptions in Table 20 of RESOLVE Documentation Draft so Implied LCOE for Greater Imperial Geothermal is based on (1) Capacity Factor of 88%, (2) Capital Cost of \$5,063/kW, and (3) annual Operating Cost of \$200/kW-yr.	Imperial County	No action. Previously clarified misinterpretation with Tim Duane, representing IID.	N/A
12	"Out-of-State" renewable resource cost and performance assumptions (Table 21) are lower than what the market is currently providing. Public testimony on 3/21/17 identified NCF of 52% and installed cost of \$1,581/kW for a wind farm in New Mexico.	Pattern Energy Group	No action. RESOLVE uses sources of approximately the same vintage for these assumptions and given expected <i>de minimis</i> impact, decline to make a one-off change.	
13	Assumption that OOS wind with new transmission won't be available until 2026 isn't supported by data from RETI 2.0 (2015-17). The TWE Project has resolved a majority of the risks associated with large multi-state transmission projects and it is reasonable to assume it will be online in 2021 to begin providing California access to Wyoming wind resources eligible for full Production Tax Credit.	TransWest Express	Test sensitivities that assume the best possible future to realize OOS Wind.	Staff tested a "best-case" sensitivity for OOS wind, in which the resource is developed by 2018 and is able to claim the full value of the PTC. As in the other resource studies, 3,000 MW is forced into the portfolio (i.e. not selected optimally). The results indicate a small incremental cost relative to the Reference Case in the Default scenario but savings to ratepayers in the 42 MMT and 30 MMT scenarios, increasing with more stringent carbon goals. Staff finds this sensitivity useful to include alongside others exploring the benefits of OOS wind to illustrate the importance of timing on the investments made by the state. <i>Case Name: ##mmt_Ref_early_ooswind_20170831</i>

Item	Issue	Parties	Action	Summary of Sensitivity Analysis
14	Update modeling assumptions for federal Production Tax Credit to reflect that wind projects in service before end of 2020 qualify for either full Production Tax Credit or phased-down amount depending on the year they met requirement to "begin construction." Include assumption in RESOLVE that full Production Tax Credit will be applied to Wyoming's (and possibly other states') wind resources through 2022.	TransWest Express	Test sensitivities that assume the best possible future to realize OOS Wind.	See above.
15	Use 50-year amortization period for pumped storage rather than 25-year because too short and doesn't reflect historic operations.	National Grid	No action. RESOLVE models the financing lifetime of pumped storage as 25y. Financing over more years beyond 25 has a tiny impact.	
16	A 37-day distribution based on a single hydro year (low, average, or high) with added sensitivities to reflect other hydro years may be more reasonable for optimal portfolio development than capturing hydro year variability by incorporating a range of hydro year inputs.	ORA	Disagree. The Model should be trying to build a future fleet that satisfies all hydro conditions, not just all low hydro or all high hydro.	

Item	Issue	Parties	Action	Summary of Sensitivity Analysis
17	Small amount of EV could be included as a load modifier to represent minimum baseline of customer adoption, but remainder of EV load should be modeled as a separate and distinct candidate resource. Assign proper costs including EV capital costs, avoided fuel costs, charging infrastructure costs, and program administrator costs. Regarding benefits, in order to not discourage LSEs from exploring EV, develop and model a GHG offset mechanism that reduces LSE's increased GHG emissions accountability. Also recommends using compound average growth rate for post-2027 growth rate setting for all EV levels, not linear default.	PG&E	Staff proposed to continue work on modeling EV potential in the next IRP cycle.	
18	Clarify: (1) assumed load due to light, medium, and heavy duty vehicles in Scenario Tool, which charge differently, (2) breakdown by technology and GWh for EVs included from CARB's Proposed Scoping Plan, (3) sources used to develop EV efficiency and vehicle miles traveled.	PG&E	Staff to provide clarifying details.	The EV load included in RESOLVE is intended to represent light-duty vehicles. Electrification of medium- and heavy-duty vehicles is not currently modeled in RESOLVE.

<u>Item</u>	<u>Issue</u>	<u>Parties</u>	<u>Action</u>	<u>Summary of Sensitivity Analysis</u>
19	Cost estimates for "conventional" and "advanced" DR provided in Section 4.4 of Appendix B are hypothetical and may not represent true cost for these technologies.	PG&E	No action. Staff believes these costs are highly uncertain and the current assumptions are reasonable.	
20	DR conventional category is a straight-line of Table 16 in Section 3.5. Load impact values should be updated to actual values by year.	PG&E	No action. Staff believes the extra refinement of this assumption will have a <i>de minimis</i> impact on results.	
21	Recommends that long-lead-time, capital intensive projects be modeled as candidate resources. Suggest at least one scenario should be run to allow a true least-cost, unconstrained case. Explain rationale for forcing in resources and how you will prevent the outcome of resource-specific carve-outs.	PG&E, SCE, TransCanyon	Develop sensitivities to remove constraints on candidate selection.	Staff modeled a sensitivity in which unlimited quantities of WY & NM wind were allowed to compete with in-state resources in the optimal portfolio. This resulted in the selection of a modest amount of new OOS wind in the 42 MMT scenario (600 MW), displacing some in-state solar; in the 30 MMT scenario, a total of 5 GW of OOS wind is selected, displacing in-state solar (primarily), wind, and geothermal. The cost savings of this OOS wind resource are significant in the 30 MMT scenario. <i>Case Name: ##mmt_Ref_unconstrained_ooswind_20170831</i>

(End of Attachment D)