ATTACHMENT B

Guide to Production Cost Modeling in the Integrated Resource Plan Proceeding

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I. Introduction

This document describes guidelines for production cost modeling in the Commission's Integrated Resource Plan (IRP) rulemaking (R.16-02-007), as well as a process for calibrating and vetting production cost modeling using the Reference System Plan and subsequently applying the calibrated and vetted production cost modeling to evaluate the Preferred System Plan being considered in IRP. This document describes a potentially durable modeling process that could be replicated in future IRP cycles, as well as some workarounds to make the process fit within the schedule of this first IRP cycle.

Production cost modeling may be employed by LSEs to inform development of their respective IRP filings (LSE Plans). LSEs should adhere to the production cost modeling guidelines specified in this document[1] to the extent possible and be consistent with the baseline assumptions in the "Unified RA/IRP Inputs and Assumptions" staff deliverable as described later in this document.

Production cost modeling will also be conducted by Commission staff to evaluate the Preferred System Plan. Parties to the IRP proceeding may wish to also conduct their own modeling to evaluate the Preferred System Plan. Production cost modeling for the purpose of evaluating the Preferred System Plan must undergo the calibrating and vetting process described in this document. The goal of calibrating and vetting is to ensure modeling conducted by different parties produces comparable results and that differences are understood. The Reference System Plan will be used as the basis for calibrating and vetting modeling. Completing the calibration and vetting work up front using the Reference System Plan enables subsequent modeling on the Preferred System Plan to focus more on evaluating the Preferred System Plan, rather than validating models or characterizing differences between models.

II. Production Cost Modeling Calibration and Vetting

This section describes a process for calibrating and vetting production cost modeling in preparation for relying on such modeling to evaluate the Preferred System Plan. The process will be led by Commission

[1] The calibration and vetting process described in this document may ultimately result in revisions to the production cost modeling guidelines. Nevertheless, LSEs who will use production cost modeling to develop their respective LSE Plans should use the guidelines in this document since the work to develop an LSE Plan occurs in parallel to the calibration and vetting process. Any guideline revisions at the completion of the calibration and vetting process would apply to the subsequent evaluation of the Preferred System Plan, which is the aggregation of LSE Plans.

staff via the Modeling Advisory Group,[2] a forum conducive to collaborative work between multiple parties and staff. The process will include an opportunity for parties to formally comment on the modeling work on the IRP proceeding record, and conclude with the Commission providing revised guidance to standardize modeling across multiple parties in preparation for modeling to evaluate the Preferred System Plan. The following table summarizes the timeline of this process.

Item	Date	Activity or Milestone
(1)	December 2017 – February 2018	Staff calibrate RESOLVE and SERVM model input data with Reference System Plan and 2017 IEPR demand forecast
(2)	Mid-February 2018	Staff posts SERVM model input data and documentation
(3)	February – April 2018	Staff hosts monthly Modeling Advisory Group meetings
(4)	February – May 2018	Staff and modeling parties conduct modeling based on (2)
(5)	Early May 2018	Staff and modeling parties share results and revise as needed
(6)	Mid May 2018	Parties formally comment
(7)	June 2018	Commission, via ALJ ruling, provides revised guidance, if needed

Commission staff will use the SERVM[3] production cost model to measure operational performance and verify satisfaction of the Planning Reserve Margin[4] (PRM) requirement. This is the same model as used in the Resource Adequacy proceeding to calculate Effective Load Carrying Capability (ELCC).[5] Other parties who wish to evaluate the Preferred System Plan with their own production cost modeling should participate in the Modeling Advisory Group calibration and vetting process introduced above. Parties

[2] Modeling Advisory Group (MAG) notices are emailed to the proceeding service list – there is no separate list. Previous meetings and materials are posted here: http://www.cpuc.ca.gov/General.aspx?id=6442453968.

[3] Strategic Energy Risk Valuation Model – developed by and commercially licensed through Astrape Consulting.

[4] Refers to the system Resource Adequacy requirement based on each LSE's peak demand forecast plus a 15% planning reserve margin. See: http://www.cpuc.ca.gov/General.aspx?id=6307.

[5] The Resource Adequacy proceeding adopted ELCC values in D.17-06-027. The record of this proceeding includes proposals providing relevant background information on modeling and ELCC studies.

may use a production cost modeling tool of their choosing, but are expected to use the guidance within this document, use the input data and documentation posted by staff in early February 2018, provide modeling results in early-April 2018, and collaborate with staff and other parties to align modeling to the extent possible. The items listed in the table above are described below in further detail.

(1) Staff calibrate RESOLVE and SERVM model input data with Reference System Plan and 2017 IEPR demand forecast

The purpose of this step is to develop a production cost modeling input dataset consistent with both the 2017 IEPR demand forecast and the RESOLVE model's 42 MMT core policy case (which is the chosen Reference System Plan portfolio). Commission staff will develop this dataset as follows:

a. Update the RESOLVE model with the 2017 IEPR demand forecast and associated load modifier components and rerun the 42 MMT core policy case.
b. Build a SERVM model input dataset from this 2017 IEPR-updated 42 MMT core policy case.

Having a 2017 IEPR updated production cost modeling dataset facilitates subsequent evaluation of and consistency with the Preferred System Plan which would have been aggregated from individual LSE Plans that also used the 2017 IEPR. Rerunning the RESOLVE model's 42 MMT core policy case with 2017 IEPR data allows RESOLVE operational results to be comparable to production cost models built with 2017 IEPR data and eliminates a need to do any production cost modeling with 2016 IEPR data.[6] The updated RESOLVE 42 MMT core policy case built with the 2017 IEPR is intended solely for the exercise of calibrating and vetting production cost models and does not replace the Commission adopted Reference System Plan and portfolio.

(2) Staff posts SERVM model input data and documentation

This will be a key deliverable from Commission staff to parties. It will illustrate a translation of RESOLVE model aggregate data into SERVM model unit-level data. It will include baseline unit-level detail for most of the Western Interconnect. If using production cost modeling for individual LSE Plan development, the LSE's modeling should be consistent with the baseline assumptions provided in this deliverable. If using production cost modeling to evaluate the Preferred System Plan, parties must use this deliverable as input for its modeling within the Modeling Advisory Group calibration and vetting process. The deliverable will contain two components:

a. 2018 Unified RA/IRP Inputs and Assumptions document – description of zonal and unit level input data for the SERVM model as used in the Resource Adequacy proceeding (study year 2019) and the IRP proceeding (study years 2022, 2026, and 2030). This

[6] The original RESOLVE 42 MMT core policy case was built with the 2016 IEPR demand forecast.

document will also include incremental modeling guidance necessary for network reliability models (e.g. "power flow" modeling).

b. Data workbooks – SERVM model input data in a generic spreadsheet format such that it can be imported into any production cost model, and other assumptions relevant to network reliability modeling such as resource locations by transmission busbar.

This deliverable is intended to replace the function of the traditional "Assumptions and Scenarios" document that has been annually created to inform the Commission's Long Term Procurement Plan proceeding and the CAISO's Transmission Planning Process (TPP).

(3) Staff hosts monthly Modeling Advisory Group meetings

Commission staff expects to hold monthly (or as needed) Modeling Advisory Group meetings to facilitate the calibration and vetting process. The meeting format may be webinar, teleconference, or in-person. Staff and parties should provide updates on modeling progress and discuss any modeling issues that arise.

(4) Staff and modeling parties conduct modeling based on (2)

Commission staff and parties develop and run their respective production cost models and report progress and issues in Modeling Advisory Group meetings. Further details on specific production cost modeling steps and modeling conventions are provided in the following sections of this document.

(5) Staff and modeling parties share results and revise as needed

Commission staff and parties share their respective production cost model results and collaboratively assess differences. Additional runs may be necessary to better align results. In terms of metrics for comparison between models, staff and other parties should follow the guidelines in the ALJ Ruling Directing Production Cost Modeling Requirements[7] issued in this proceeding on September 23, 2016, unless superseded by a specific guideline called out in this document or a recommendation agreed upon in the Modeling Advisory Group.

(6) Parties formally comment

The Commission will provide an opportunity for parties to formally comment on the production cost modeling calibration and vetting results on the IRP proceeding record.

(7) Commission provides revised guidance

The Commission will provide revised guidance in the form of an Administrative Law Judge ruling, considering the recommendations of the Modeling Advisory Group and party comments, to standardize production cost modeling across multiple parties to the greatest extent possible. Parties will be expected to follow this guidance when they conduct their own production cost modeling or related analysis to evaluate the Preferred System Plan.

[7] http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442451199.

III. Modeling Scope and Conventions

The following describes the scope and conventions that Commission staff and parties are expected to use for both the production cost modeling calibration and vetting process and the subsequent evaluation of the Preferred System Plan. As indicated above, at the end of the calibration and vetting process the Commission may revise this guidance. Also as indicated above, LSEs using production cost modeling to inform their individual LSE Plan development should adhere to the modeling guidelines specified here to the extent possible.

A. Study years: 2022, 2026, and 2030.
B. SERVM will be run using hourly time-steps.
C. Hourly system load shapes will be built up from fundamental consumption load shapes and shapes for various load modifiers such as AAEE, TOU rates, and EV charging patterns. Transmission and distribution loss effects will be accounted for.
D. BTM PV will be explicitly modeled as generation, rather than embedded in the load forecast. Transmission and distribution loss effects will be accounted for.
E. Loss-of-load event definitions and counting conventions, and operating reserve targets[8] shall be consistent with those used in the Resource Adequacy proceeding's production cost modeling with SERVM for ELCC calculations. Multiple loss-of-load events occurring within one day shall count as one event for purposes of counting events towards a reliability target. The loss-of-load event occurs when regulation up/down (1.5% of hourly forecast load) or spinning reserves (3.0% of hourly forecast load) cannot be maintained.
F. Average portfolio ELCC values will be calculated for each month of the study year, consistent with the monthly Resource Adequacy program.
G. The loss-of-load-expectation (LOLE) reliability target range for calculating monthly average portfolio ELCC values shall be the range 0.02 to 0.03 LOLE for each month, same as was used in the Resource Adequacy proceeding's production cost modeling with SERVM.[9]
H. For ELCC calculations, the calibration of the system under study to the LOLE reliability target range may involve removing or adding generation.
    - Removal of generation to surface LOLE events in overbuilt systems shall be according to the following order:[10] Conventional thermal generators that have announced their

[8] As a percent of hourly forecast load, regulation up/down is 1.5% each, load following up is 2.5%, load following down is 1.5%, spinning reserves is 3.0%, non-spinning reserves is 3.0%.

[9] Specifically, the monthly LOLE target was created by first taking the industry standard 0.1 LOLE annual target and assuming that most of those events map to the four peak months of June through September, or one third of the year. Assuming a similar target reliability for the rest of the year would mean that total LOLE over the entire year should have a target of 0.1x3=0.3. Thus, monthly LOLE studies would have a monthly target LOLE of 0.3/12=0.025, i.e. a target range of 0.02 to 0.03.

retirement will be removed first. If LOLE remains below the target level, additional conventional thermal generation will be removed from CAISO areas ranked by age of the facility. The oldest one will be removed first, continuing in order of age. No hydro generation or renewable generation will be removed.

- Addition of generation to reduce LOLE events in underbuilt systems shall use perfect capacity as additions. Perfect capacity is a modeling proxy for generation with no operating constraints, e.g. always available, starts instantly, infinite ramp rate, no minimum operating level.
- Although the calibration step alters the system under study, this is a typical way of performing ELCC calculations and is not expected to significantly affect the ELCC measurement.

I. Average portfolio ELCC calculations will include all wind and utility-scale solar, both existing and new, but exclude all BTM PV. The calculation will treat all of these resources as if they were fully deliverable.

J. Reserve margin calculations will be performed for each month of a study year, relying on the average portfolio ELCC calculations as stated above. The conventions in the following table apply:

Component	Counting convention
Peak demand	IEPR 1-in-2 monthly peak consumption forecast adjusted for load-modifier impacts including BTM PV impact
Existing non-wind, non-solar	Use current monthly Net Qualifying Capacity values
New non-wind, non-solar	Use same conventions as the RESOLVE model
Wind and solar (excluding BTM PV), existing and new	Monthly average portfolio ELCC of these resources combined. Discount this value by the ratio of fully-deliverable capacity to total capacity.

K. Reporting of operational performance will include at least: LOLE probabilistic reliability level, emissions,[11] including estimating emissions from starts and stops, and NOx and PM2.5, RPS generation, curtailment patterns, production cost, import/export flows, and frequency of load following reserve shortages.

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[10] Note that the order specified here is simply a modeling convention picking one systematic way to remove capacity for the sole purpose of calibrating a system to a target reliability level in order to perform ELCC calculations. The choice and order of removing units does not imply the units are likely to retire or should retire.

[11] The scope of emissions reporting at the system level will be CAISO balancing area, California, and WECC-wide. CAISO area and California GHG emissions accounting should align with Energy Commission and CAISO production cost modeling practices to the extent possible.

IV. Modeling Steps

The following describes the steps that Commission staff will use for the production cost modeling calibration and vetting process. In the steps below, "study" or "studies" means production cost modeling runs. Parties participating in the calibration and vetting process with their own production cost model are expected to perform the "as found" study, but are not expected to perform any ELCC or reserve margin calculations. For the purposes of calibrating and vetting different production cost modeling efforts, comparing results from "as found" studies should be sufficient. Staff will be performing the ELCC and reserve margin calculation steps to exercise its own modeling process in preparation for evaluating the Preferred System Plan.

A. Conduct "as found" annual studies for years 2022, 2026, and 2030
    1. Evaluate operational performance, including the metrics as described above
    2. Quantify in MW the amount of effective capacity that should be added or removed to achieve an annual 0.1 LOLE target
    3. Benchmark key metrics from SERVM (or other production cost model) with equivalent metrics from the RESOLVE model's 2017 IEPR-updated 42 MMT core policy case
B. Calculate monthly average portfolio ELCC values for wind and utility solar
    1. For each month, calibrate the portfolio under study to the range of 0.02 to 0.03 LOLE for each month. Report the quantity of generation added or removed in MW.
    2. Calculate the monthly average portfolio ELCC of wind and utility solar together
C. Calculate the monthly reserve margin and verify satisfaction of the PRM system reliability requirement in each month of the study year (relying on the ELCC values in step B.)

Note that the production cost modeling exercises above do not include any marginal ELCC calculations. For this IRP cycle, the Commission directs LSEs to use marginal ELCCs derived from the RESOLVE model's Reference System Plan case and provided for reference in the table below. The Commission will consider providing production cost modeling-based marginal ELCCs in the subsequent IRP cycle.

ELCC Values	**2018**	**2022**	**2026**	**2030**
Marginal Solar ELCC (including BTM PV)	13%	2%	2%	2%
Marginal Wind ELCC	29%	31%	30%	30%

V. Preferred System Plan Production Cost Modeling

This section describes production cost modeling steps that Commission staff will take to evaluate the Preferred System Plan. Staff will use the SERVM production cost model to measure operational performance and verify satisfaction of the PRM requirement in each month of the study year, consistent with the current Resource Adequacy program. Staff will follow any new guidelines that resulted from

the calibration and vetting process described above. Parties wishing to conduct their own production cost modeling to evaluate the Preferred System Plan are expected to do the same.

VI. Modeling Steps

A. Aggregate the individual LSE Plans into the Preferred System Plan SERVM dataset
    1. The aggregation process must ensure that no resources are double-counted or under-counted, and that the aggregate of new resources selected by LSEs does not exceed the available resource potential. This step may require staff to make additional data requests to LSEs to resolve any issues.
    2. Staff posts the SERVM model input data representing the Preferred System Plan. This is also a key deliverable from staff to parties and serves as the common input for any party using production cost modeling to conduct their own evaluation of the Preferred System Plan, similar to the function and form of the SERVM model input data that was provided by staff at the beginning of the calibration and vetting process described above.
B. Conduct "as found" annual studies for years 2022, 2026, and 2030
    1. Evaluate operational performance, including the metrics as described above
    2. Quantify in MW the amount of effective capacity that should be added or removed to achieve an annual 0.1 LOLE target
    3. Compare with results of the "as found" studies based on the RESOLVE model's 2017 IEPR-updated 42 MMT core policy case used in the calibration and vetting process
C. Calculate monthly average portfolio ELCC values for wind and utility solar
    1. For each month, calibrate the portfolio under study to the range of 0.02 to 0.03 LOLE for each month. Report the quantity of generation added or removed in MW.
    2. Calculate the monthly average portfolio ELCC of wind and utility solar together
D. Calculate the monthly reserve margin and verify satisfaction of the PRM system reliability requirement in each month of the study year (relying on the ELCC values in step C.)

(End of Attachment B)