Attachment A:

Guide to Production Cost Modeling in the Integrated Resource Plan Proceeding

Revised November 13, 2018

Contents

I. Introduction

This document describes guidelines for production cost modeling in the Commission's Integrated Resource Plan (IRP) rulemaking (currently R.16-02-007), including modeling scope, conventions, analytical steps, and output reporting. Within a two-year IRP planning cycle, production cost modeling is intended to first inform development and validation of Reference System Plan capacity expansion modeling and subsequently evaluate the Preferred System Plan based on the aggregation of individual LSE IRP filings. This document describes a potentially durable analytical framework that could be replicated in future IRP cycles. As such, its scope includes specifying the technical aspects of IRP production cost modeling but does not include specifying the procedural process for engaging with parties to the proceeding. Procedural process will vary from cycle to cycle and is more appropriately specified via rulings from the assigned administrative law judge (ALJ).

II. Role of Production Cost Modeling in IRP

The primary purposes of production cost modeling in the IRP proceeding are to evaluate the system reliability, operational performance, emissions, and operating cost of a given projection of future resource mix and load. First, capacity expansion modeling will be used to narrow the projections of future resource mix and load into a Reference System Plan. Then, production cost modeling will be used to evaluate the Reference System Plan prior to Commission adoption. After adoption, load serving entities (LSEs) develop individual IRPs consistent with Commission direction and the Reference System Plan. LSEs may employ their own production cost modeling to develop their plans. After the LSEs file their individual IRPs with the Commission, staff will aggregate the LSEs' portfolios into one or more system portfolios. Finally, staff will use production cost modeling to evaluate the aggregated system portfolios and recommend a Preferred System Plan for Commission consideration. Other parties to the proceeding may also conduct their own modeling of the aggregated system portfolios and make recommendations to the Commission.

To the extent possible, entities performing production cost modeling to inform the IRP proceeding should adhere to the guidelines specified in this document and be consistent with the baseline assumptions in the "Unified RA [Resource Adequacy]/IRP Inputs and Assumptions" document referenced later in this document. Use of common guidelines and assumptions will help facilitate comparisons between the modeling results of different parties.

In general, stakeholders will have regular opportunities to participate in or comment on the various modeling activities in the IRP proceeding. Informally, Commission staff will engage with stakeholders via the Modeling Advisory Group,[1] a forum conducive to collaborative work between multiple parties and staff. Formally, parties to the proceeding can provide comment or submit modeling results according to the guidance and schedule determined by rulings from the assigned ALJ.

III. Modeling Scope and Conventions

Commission staff will use the SERVM[2] production cost model to measure operational performance and verify satisfaction of the Planning Reserve Margin[3] (PRM) requirement. This is the same model as used in the Resource Adequacy proceeding to calculate Effective Load Carrying Capability (ELCC).[4] Because the staff modeling work in both proceedings shares the same model, the detailed inputs and assumptions are described in a common document, the Unified RA/IRP Inputs and Assumptions document.[5] This document is updated annually at a minimum, or more frequently according to the needs of proceeding modeling activities. While the Unified RA/IRP Inputs and Assumptions document describes in detail the SERVM model inputs, the remainder of this document describes the modeling scope and conventions specific to IRP and the analytical steps to be taken. IRP production cost modeling work shall use the following scope and conventions:

A. Study years: every four years through the end of the study period (for the 2017-2018 IRP cycle: 2022, 2026, and 2030).
B. SERVM will be run using hourly time-steps.
C. Hourly system load shapes will be built up from fundamental <u>consumption</u> load shapes.
D. Behind-the-meter photovoltaics (BTM PV), Additional Achievable Energy Efficiency (AAEE), Time-of-Use (TOU) rate impacts, and electric vehicle (EV) load will be explicitly modeled as fixed shape

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[1] 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.

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

[3] 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.

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

[5] The most recent version is posted here: http://www.cpuc.ca.gov/General.aspx?id=6442451972

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generation (with both positive and negative values), rather than embedded in the load shapes. Transmission and distribution loss effects will be accounted for.

E. Loss-of-load event definitions and counting conventions, and operating reserve targets[6] shall be consistent with those used in the Resource Adequacy proceeding's production cost modeling with SERVM for ELCC calculations and as described in the Unified RA/IRP Inputs and Assumptions document. 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. Loss-of-load hours (LOLH) shall count total hours of loss-of-load events whether consecutive or not.

F. Average portfolio ELCC values will be calculated on an annual basis only. This may differ from the methods used in the Resource Adequacy proceeding because of their requirement to produce monthly ELCC values for a monthly Resource Adequacy program.

G. The loss-of-load-expectation (LOLE) reliability target for calculating annual average portfolio ELCC values shall be 0.1 LOLE on an annual basis.

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:[7] Conventional thermal generators that have announced their retirement will be removed first. If LOLE remains below the target level, additional conventional thermal generation will be removed from California Independent System Operator (CAISO) areas in amounts proportional to service area load in each area. The oldest generation in each area will be removed first. No hydro generation or renewable generation will be removed.
   - Addition of generation to reduce LOLE events in underbuilt systems shall use the newest existing combustion turbine type generator as a proxy and will seek to distribute the added capacity to each service area proportionately. This is done because the LOLE results are meant to represent aggregate reliability across the CAISO. No calibration will be performed to areas outside the CAISO.

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[6] SERVM's operating reserve targets are currently defined 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%. If other parties elect to define operating reserve targets differently, it should be clearly documented and justified.

[7] 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.

  - 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 CAISO area wind and utility-scale solar including dynamically scheduled or dedicated import wind and solar generation, both existing and new, but exclude all BTM PV (i.e. BTM PV is left in the system and not part of the portfolio ELCC calculation). All CAISO wind and utility solar will be part of the ELCC calculation regardless of deliverability status.

J. The portfolio removed in an ELCC study (e.g. all wind and solar) is replaced with perfect capacity until the target LOLE is restored. 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.

K. An annual CAISO area reserve margin will be calculated for each study year. The Net Qualifying Capacity (NQC) List[8] is used as a reference for this calculation. The conventions in the following table apply:

Component	Counting convention
Peak demand	California Energy Commission (CEC) Integrated Energy Policy Report (IEPR) 1-in-2 year coincident annual peak sales forecast grossed up to system level
Existing non-wind, non-solar generation	Use current Net Qualifying Capacity values for August
New non-wind, non-solar generation	Use nameplate megawatts (MW)
New battery storage	Use nameplate MW. For batteries less than 4 hours duration at max output, derate by the ratio of duration hours / 4 hours.
Wind and solar (excluding BTM PV), existing and new, fully or partially deliverable	Multiply the annual average portfolio ELCC of all wind and solar, by the sum of the nameplate MW of only the fully or partially deliverable portion of wind and solar.
Energy-only resources	Do not count any resources assumed to be energy-only interconnection status. For example, to get wind and solar total NQC, subtract off the energy-only nameplate from the total nameplate of wind and solar before multiplying by the wind and solar average portfolio ELCC. Other resources besides wind and solar may also be designated as energy-only and these should also not be counted.
Unspecified or non-dedicated Imports	Use the CAISO maximum simultaneous import limit, adjusted downward for Existing Transmission Contracts

L. Reporting of operational performance should include: LOLE, LOLH, and EUE probabilistic reliability metrics[9], generation dispatch mix, emissions,[10] including estimating emissions from

[8] For the 2017-2018 IRP cycle, the March 15, 2018 version of the NQC List is used.

[9] LOLE (Loss of Load Expectation), LOLH (Loss of Load Hours), EUE (Expected Unserved Energy)

[10] The scope of GHG emissions reporting at the system level will be CAISO balancing area, California, and WECC-wide. CAISO area and California greenhouse gas (GHG) emissions accounting should align with California Air Resources Board, CEC, and CAISO production cost modeling practices to the extent possible. Air pollutant emissions will be reported in aggregate for plants located in disadvantaged community areas, the CAISO area, and California.

starts and stops, and NOx and PM2.5, RPS generation, curtailment patterns, production cost, and import/export flows.

IV. Reference System Plan Evaluation Steps

This section describes the steps that Commission staff will use to evaluate the Reference System Plan with production cost modeling. In the steps below, "study" or "studies" means production cost modeling runs. "As found" means the system under study is modeled with no additions or removals to the included generating units. "Calibrated LOLE" means the system under study had generating units added or removed to calibrate the LOLE reliability level to a desired target.

A. Conduct "As found" annual studies for study years (for the 2017-2018 IRP cycle: 2022, 2026, and 2030)
   1. Evaluate operational performance, including the metrics as described above
   2. Benchmark key metrics from SERVM (or other production cost model) with equivalent metrics from the capacity expansion model used to develop the system under study. (In the 2017-18 IRP cycle, this was the RESOLVE model's 2017 IEPR-updated 42 MMT core policy case.)
B. Conduct annual "Calibrated LOLE" studies for each study year
   1. Add or remove CAISO area generating units according to the convention described above until the LOLE reliability level is 0.1 LOLE on an annual basis.
   2. Report the generation added or removed in MW.
C. Conduct annual average portfolio ELCC studies for wind and utility solar for each study year
   1. Remove from the "Calibrated LOLE" system all CAISO area wind and utility solar (including dedicated import wind and solar generation, and including both deliverable and energy-only units).
   2. Incrementally add back perfect capacity until the annual LOLE reliability level returns to 0.1 LOLE.
   3. Calculate the average portfolio ELCC of wind and utility solar together as the ratio of perfect capacity added back to the nameplate wind and utility solar capacity that was removed.
   4. Report the annual average portfolio ELCC as a percent.
D. Calculate the CAISO system reserve margin and verify satisfaction of the PRM system reliability requirement in each study year
   1. Use the counting convention specified earlier in this document.
   2. Count all the generating units in the "As found" system, i.e. the reserve margin is being calculated for the "As found" system, not the "Calibrated LOLE" system.

Note that the production cost modeling exercises above do not include any marginal ELCC studies. Average ELCC studies are used to characterize the capacity value of a whole class or group of resources whereas marginal ELCC studies are used to characterize the capacity value of adding an increment of a given resource type. Until directed otherwise by the CPUC, any analyses conducted by LSEs or other interested parties that require the use of marginal ELCC values should use marginal ELCC estimates derived from the RESOLVE model. For reference, the values from the version of RESOLVE model used in the 2017-18 IRP cycle are shown in the table below. Note that RESOLVE groups BTM PV as part of the solar portfolio for which RESOLVE estimates marginal ELCC. This is in contrast to the average portfolio ELCC method used with the SERVM model described above, which does not include BTM PV in the ELCC calculation.

2017-18 IRP RESOLVE model marginal ELCC Values	**2018**	**2022**	**2026**	**2030**
Marginal Solar ELCC (including BTM PV as part of the solar portfolio)	13%	2%	2%	2%
Marginal Wind ELCC	29%	31%	30%	30%

V. Preferred System Plan Evaluation Steps

This section describes the steps that Commission staff will use to evaluate the Preferred System Plan with production cost modeling. The steps are similar to those taken to evaluate the Reference System Plan, but with additional steps to first aggregate individual LSE IRP data into one or more system portfolios to be studied.

A. Aggregate the individual LSE IRP data from their filings into one or more system portfolios to be studied with production cost modeling – generally this will be the sum of each LSE's Conforming or Preferred portfolios or a hybrid of the two. In the 2017-2018 IRP cycle, only Standard Plan filing data will be aggregated. This comprises about 97% of the total load represented by all IRP filers (i.e. about 3% of the total load is represented by the Alternative Plan filers).
    1. Validate consistency of reported generation unit and contract data
        a. Physical resource data is used to update the SERVM model dataset
            i. Verify new unit data does not exceed system potential or transmission capability
            ii. Reconcile reported existing unit data with SERVM existing units
            iii. Update data on whether a unit actually delivers to and is scheduled in CAISO
        b. Contract data is used to assess individual LSE and total system contract positions
            i. Verify contracts do not conflict/overlap or exceed the available physical resources
        c. Tabulate and summarize physical resource and contract data
            i. System-wide, by LSE type, by resource type, by year
    2. Validate individual loads add back up to system load

a. Using load or load-modifying resource data reported in the Standard New Resource Data Template and the Clean Net Short (CNS) Tool[11]
   i. Reconcile load shifts between LSEs
   ii. Verify no missing or extra load – individual load should add up to IEPR system load
   iii. Verify individual ESP loads (including load from Alternative Plan filers) sum up to IEPR direct access load

3. Staff posts the aggregated system portfolio(s) to serve as the common input for any party using production cost modeling to conduct their own evaluation. Data deemed confidential will be protected through the aggregation process or other means.

B. Conduct "As found" annual studies for every four years during study period. In the 2017-2018 IRP cycle, only year 2030 will be studied.
   1. Evaluate operational performance, including the metrics as described above
   2. Compare with results of the "As found" studies that were done to evaluate the Reference System Plan.

C. Conduct annual "Calibrated LOLE" studies for each study year
   1. Add or remove CAISO area generating units according to the convention described above until the LOLE reliability level is 0.1 LOLE on an annual basis.
   2. Report the generation added or removed in MW. In the 2017-2018 IRP cycle, the analysis stops here. No ELCC values will be calculated.

D. Conduct annual average portfolio ELCC studies for wind and utility solar for each study year
   1. Remove from the "Calibrated LOLE" system all CAISO area wind and utility solar (including dynamically scheduled or dedicated import wind and solar generation, and including both deliverable and energy-only units).
   2. Incrementally add back perfect capacity until the annual LOLE reliability level returns to 0.1 LOLE.
   3. Calculate the average portfolio ELCC of wind and utility solar together as the ratio of perfect capacity added back to the nameplate wind and utility solar capacity that was removed.
   4. Report the annual average portfolio ELCC as a percent.

E. Calculate the CAISO system reserve margin and verify satisfaction of the PRM system reliability requirement in each study year
   1. Use the counting convention specified earlier in this document.
   2. Count all the generating units in the "As found" system, i.e. the reserve margin is being calculated for the "As found" system, not the "Calibrated LOLE" system.

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11 http://cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/GHG%20Calculator%20for%20IRP%20v1.4.5.xlsx

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