2014 Long Term Procurement Plan R.13-12-010

Phase 1B Workshop on Draft Staff Proposal on Modeling Methodology

California Public Utilities Commission

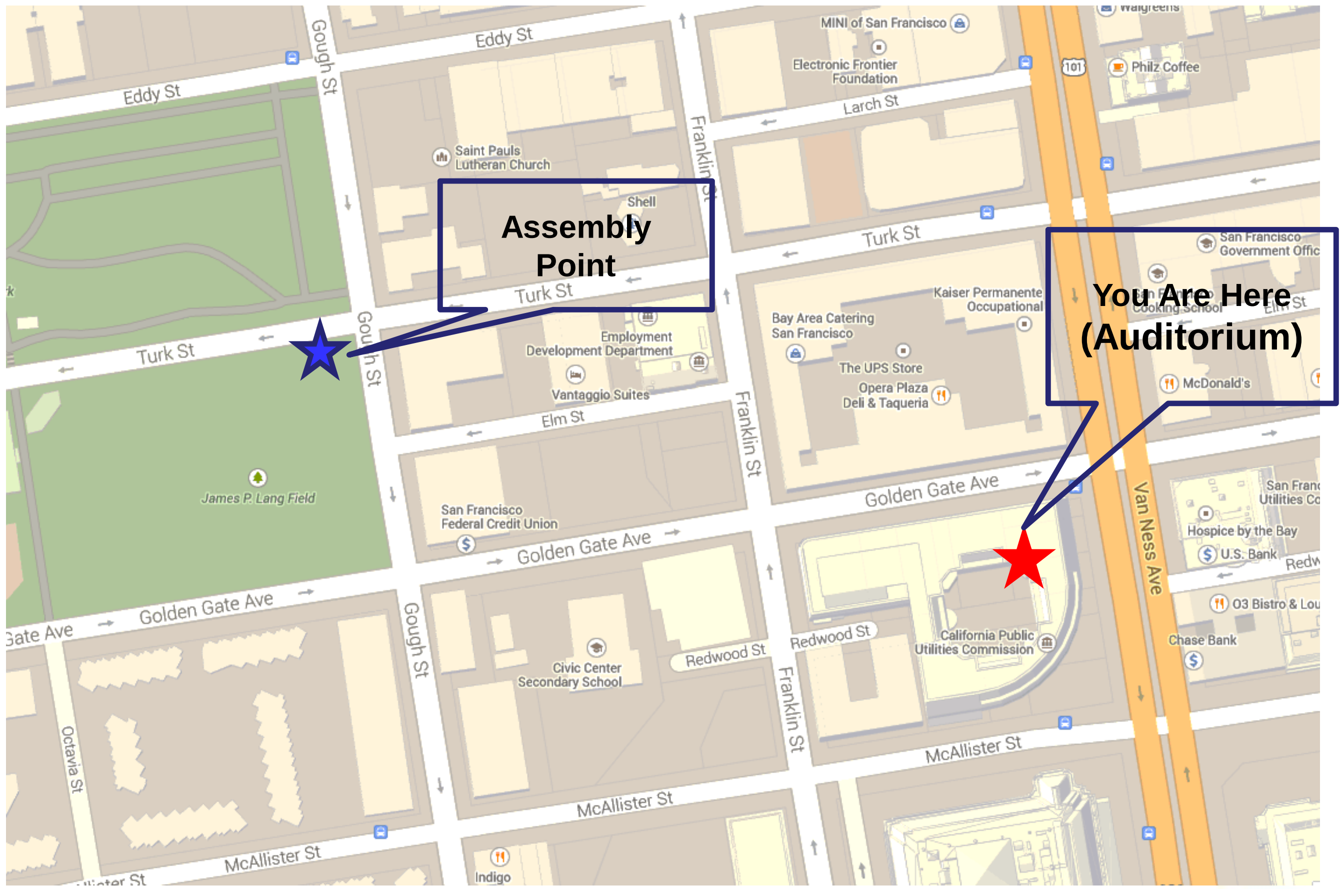
Auditorium

August 4, 2015, 10:00 am - 3:30 pm

Evacuation Procedure

In the event of an emergency evacuation, please calmly proceed out the nearest exit.

★ Our assembly point is Jefferson Square Park on Turk and Gough Streets.



Workshop Communications

In person attendees, please:

- Queue up at the microphones to ask questions
- Announce your name and organization before speaking

Remote attendees, please:

Call in: 866-830-2902   Passcode: 2453758

- Upon entry to the call, place yourself on mute (*6 to mute/unmute)
- We will take questions during the course of the workshop. During those times, remain on mute unless you are actively asking a question. Please mute yourself when done speaking.
- Announce your name and organization before speaking.
- For technical difficulties and questions that cannot be conveyed over the phone, contact Justin Hagler during the workshop at justin.hagler@cpuc.ca.gov

Key Milestones

Phase 1A/1B ALJ Ruling	March 25, 2015
Phase 1B Technical Working Group Calls and Informal Comments	April 14, 2015 to June 30, 2015
CAISO No Curtailment / Wellhead 2019 studies served	May 8, 2015
Phase 1B Draft Staff Proposal sent to Service List	July 27, 2015
Phase 1B Draft Staff Proposal Workshop	August 4, 2015
Ruling issuing Staff Proposal for formal comments	August
Comments on Staff Proposal due	August
Reply comments on Staff Proposal due	August
Ruling or Decision adopting revised Staff Proposal	October

Workshop Purpose

The purpose of this workshop is to provide a forum in which LTPP staff can present its draft proposal regarding revisions to the LTPP modeling efforts that were discussed in a series of technical discussions held from April through June of 2015. The draft staff proposal covers three topics:

1) developing common definitions, metrics and standards
2) identifying standard outputs
3) validating stochastic and deterministic models and making technical improvements

In addition to providing input during the workshop, parties will have an opportunity to submit formal written comments and reply comments after the workshop. A Ruling soon after the workshop will formally issue the staff proposal and set comment deadlines. The purpose of party comments is to inform a Ruling or Decision adopting any of the content in the staff proposal.

Agenda

Time	Speaker	Topic
10:00 – 10:15	Patrick Young	Introduction
10:15 – 11:15	Carlos Velasquez	WG 1 proposal
11:15 – Noon	Patrick Young	WG 2 proposal
Lunch Break		
1:00 – 3:00	Keith White	WG 3 proposal

Working Group 1
Definitions, Metrics & Standards

- Support the application of the modeling validation techniques covered in Sections 5 & 6 of the draft Staff Proposal emailed to parties on July 27, 2015.
- Enable parties to use a consistent set of definitions, metrics, and standards when comparing modeling results.

Stochastic: Day, Event, Metrics, Standard

Metric	Event definition A (conservative)	Event definition B (less conservative)	Day definition	Standard	Implied PRM / Capacity Needed To Meet Standard?	Cost
Loss of Load Expectation (LOLE)	• supply is less than load + CAISO reserves [1]	• supply is less than load + 3% reserves [2]	1 day is any day where one or more events occurred	1-day-in-10 years	?	?
Loss of Load Hours (LOLH-1)	• supply is less than load + CAISO reserves [1]	• supply is less than load + 3% reserves [2]	1 hour	1-hour-in-10 years	?	?
Loss of load Hours (LOLH-24)	• supply is less than load + CAISO reserves [1]	• supply is less than load + 3% reserves [2]	24 hours	24-hours-in-10 years	?	?
Normalized Expected Unserved Energy (EUE) [3]	• supply is less than load + CAISO reserves [1]	• supply is less than load + 3% reserves [2]	NA	0.001	?	?
Over-generation	• loss of regulation-down • or dump energy [4]	• dump energy [4]	NA	NA	NA	?

[1] CAISO reserves includes: loss of contingency reserve greater than 50% of the required 6% (spin and non-spin), loss of regulation-up, or unserved energy

[2] 3% reserves: as specified by CAISO Stage 3 Emergency definition

[3] Normalized EUE represents percent of system load expected to be unserved in a year

[4] Modeling convention to record situations where model cannot balance system under excess generation conditions

Deterministic: Event, Metric, Standard

Metric	Event definition A (*conservative*)	Event definition B (*less conservative*)	Standard	Implied PRM / Capacity Needed To Meet Standard?	Cost
Loss of Load	• loss of load following-up greater than 50% of its requirement, • loss of contingency (operating) reserve, • loss of regulation-up, • or unserved energy	• Supply is less than load • plus 3% reserves	1 hour in 1 year	?	?
Over-generation	• loss of load following-down greater than 50% of its requirement, • loss of regulation-down, • or dump energy	• dump energy	NA	NA	?

CAISO's Deterministic Event Definition: Too Conservative?

- What amount of operating reserves does this deterministic event definition amount to?:
  - loss of load **following-up** greater than 50% of its requirement (*1.8%*?)
  - loss of contingency (**operating) reserve** (*6.0%*?)
  - loss of **regulation-u**p (*1.0%*?)
  - or **unserved energy**

Does a Lack of Flexible Capacity Equal a Loss of Load Event?

TURN suggested we define the consequences of not having enough flexibility in the system because it "may not necessarily be a loss of load (as would obviously happen when capacity is insufficient). It is conceivable that a lack of a particular type of flexibility could lead to a loss of load on a "one-to-one" basis, that is, that load will be curtailed on a "MWh-for-MWh" basis for every MW or MWh of flexibility not available. But it also possible that curtailments of load merely become more likely when flexible capacity is insufficient, and further that such likelihood could be quite small. Defining criteria for flexibility needs thus requires a more careful examination of the type of flexibility desired and the consequences of its absence."

Working Group 1 BACKUP SLIDES

Should Increases To Operating Reserves Be Triggered Only By Additional MW of Intermittent Resources?

- Union of Concerned Scientist's comment:

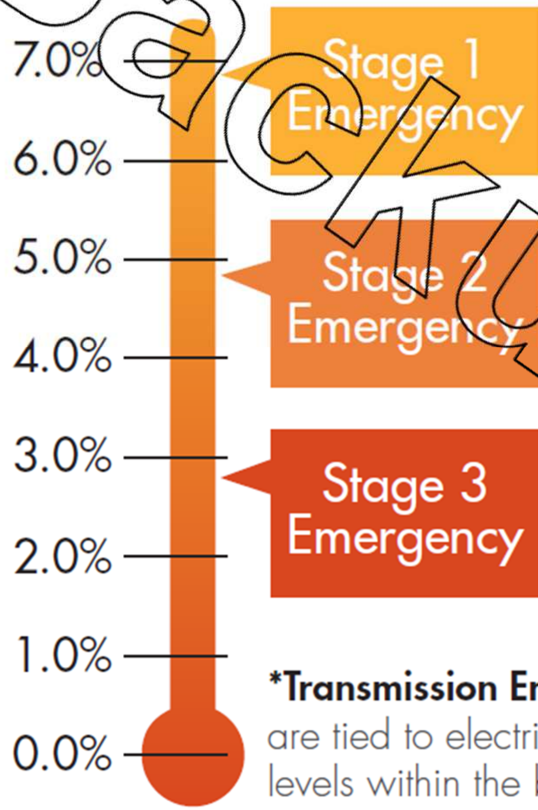
  "*any increment to the operating reserves that are used to define a loss of load event should address only the need for that type of reserve that is triggered by the additional MW of intermittent resources*." (Draft proposal p.8)

How To Measure Reliability v. Cost Trade-Off?

- "The reliability cost trade-off can be considered only when the minimum reliability is observed" (page 13 Staff Proposal)
- **P.U. Code Section 380(d):** "Each load-serving entity shall, at a minimum, meet the most recent **minimum planning reserve and reliability criteria approved** by the Board of Directors of the Western Systems Coordinating Council or the **Western Electricity Coordinating Council."**
- **CAISO operating procedures (6/16/15):** "The CAISO issues an Emergency Stage 3 when the Spinning Reserve portion of the Operating Reserve depletes, or is anticipated to deplete below the WECC Operating Reserve requirement and cannot be restored. The WECC Operating Reserve requirement states that Spinning Reserve shall be no less than 50% of the total Operating Reserve requirements."

CAISO's Emergency Notifications

Backup slide



Operating reserves fall below 7%
Stronger request for conservation

Operating reserves less than 5%
Requires ISO intervention in the market

Operating reserves less than 3%
Issue notice of potential load interruptions to utilities‡

Transmission Emergencies** — Many emergencies are tied to electric supply and operating reserve levels within the balancing area. However, ***some emergencies are declared as a result of transmission line overloads, losses, or limitations.

‡ Affected areas are at the discretion of the utilities

CAISO Proposal

Backup Slide

Modeling Method	Definition of "Loss of Load" Incident	Counting Method	Standard	Notes
Stochastic	• Capacity shortfall situation: loss of contingency (operating) reserve, loss of regulation-up, or unserved energy • Over-generation situation: loss of regulation-down or dump energy	Cumulative hours (not necessarily continuous) of incidents in each year each iteration	7 hours-in-10 years	Report cumulative volume (MWh) of "loss of load" – is system sufficient is there is no more than 7 hours in 10 years of a capacity shortfall?
Deterministic	• Capacity shortfall situation: loss of load following-up greater than 50 percent of its requirement, loss of contingency (operating) reserve, loss of regulation-up, or unserved energy • Over-generation situation: loss of load following-down greater than 50 percent of its requirement, loss of regulation-down, or dump energy	Cumulative hours (not necessarily continuous) of incidents in a year	1 hour-in-1 year	

TURN Proposal

Planning Issue	Reliability Metric	Result	Modeling Method
Peak	Firm load interrupted not more than “1-day-in-10-years” due to lack of resources	Planning Reserve Margin of “X” percent above 1-in-2 peak load established to meet peak metric	Stochastic calculation using LOLP algorithm of existing model (e.g., PLEXOS, SERVM) or other purchased or custom model
Flexibility	Criterion comparable to “1-day-in-10-years” metric to be developed for lack of flexible resources	Flexibility Range of “Y” percent (of (100 + X) percent) established to meet flexibility metric	Stochastic calculation using enhancement to LOLP algorithm in one of above models
Over-Generation	Over-generation is economic issue, so no reliability metric applicable	LTPP will assess least cost means for managing over-generation and meeting other planning goals, such as reducing GHGs	Deterministic production cost modeling (e.g., PLEXOS)

PG&E Proposal

Dimension	PG&E
Peak Capacity	Similar to CAISO and TURN. Stochastic modeling framework to assess needs against an established reliability standard.[2]
Flexibility	Same stochastic modeling framework as above to assess flexibility needs via a two-step process.
	Step one, reliability assessment, captures loss of load events due to flexibility deficiencies and counts them, along with peak deficiencies, towards the 1 day in 10 years reliability standard
	Step two, economic assessment, reveals the net value (mitigates the costs and risks) of additional system flexibility, capturing all of the possible benefits of flexibility (e.g., reducing the cost of curtailments, helping the state meet its policy goals, reducing the cost of inefficient dispatch of resources)[3]
Pros	Holistic approach that assesses a system's overall flexibility needs from both reliability and economics (and policy) perspectives; designed to reveal the need (or value) of system flexibility
Cons	A new approach (i.e., to assess flexibility needs explicitly in a reliability analysis, supplemented by an economics analysis) that requires demonstration and further understanding

Working Group 2: Standard Outputs

- Existing 2014 LTPP technical studies were difficult to validate and compare to each other:
  - Varying definitions (WG 1)
  - Varying (and complex) methodologies (WG 3)
  - Varying assumptions (more detailed guidelines for 2016 LTPP Assumptions & Scenarios)
  - Varying reported outputs (WG 2)

- Goal for WG 2: identify standard (common) outputs that any model should report to improve the ability to compare, interpret, and validate different models and their results

Working Group 2: Standard Outputs

Topic areas:

- Whether deterministic, stochastic, or a combination of both modeling techniques should be used
- GHG emissions reporting
- Iteration-specific results to report

Whether deterministic, stochastic, or a combination of both should be used

- Deterministic
  - Familiar and easier to understand, generally well vetted
  - Can model system operations of entire WECC in detail
  - Fixed set of assumptions
  - Reports one outcome with no probability

- Stochastic
  - Complex and not well vetted, hesitant to rely on results
  - Computational intensity necessitates reduction in detail
  - Can model wide range of conditions
  - Reports probability of average and extreme conditions

Whether deterministic, stochastic, or a combination of both should be used

Staff Recommendation:

- Continue to use and improve both model types, relying on deterministic models in near-term and incorporating the use of stochastic models as they mature
- Deterministic preferred for assessing over-generation, production costs, emissions
- Stochastic preferred for assessing capacity (flexible and generic) needs
- Working Group 3 staff proposal recommends specific ways to improve and apply both deterministic and stochastic modeling techniques to assess system performance and inform Commission decisions

GHG emissions reporting

GHG emissions reduction is a primary state goal – different models should consistently model and report emissions – so we can assess whether we are achieving reduction goals under a range of alternative futures

- Deterministic models inherently report emissions
- Stochastic models may not easily report emissions
- Less important to assess short-term statistical variation of emissions in a stochastic model; better to assess long-term variation through range of deterministic sensitivities

Staff Recommendation:

- Report WECC-wide emissions (as well as California-specific)
- Stochastic models should report emissions to the extent possible
- Rely on deterministic models as primary tool to assess emissions – use sensitivity analysis to consider long-term uncertainties

Accounting for bioenergy unit emissions

Green Power Institute recommended specifying accounting methods for emissions from bioenergy resources (biogas and biomass)

- California ARB policy states that energy production from bioenergy resources are carbon neutral or better – because the bio-waste would release the same or more GHG than if it were burned for energy production
- Therefore, bioenergy units should be modeled with an emissions factor of zero

Staff recommendation:

- For purposes of accounting for GHG emissions of a planning scenario under study, assign a GHG emissions factor of zero to qualified bioenergy units unless there is a change in ARB policy

Iteration-specific results reporting

- Deterministic models are a single detailed production cost simulation of a study year and can be considered a single, detailed “iteration”.
- Stochastic models are based on running many “iterations” to capture the statistical behavior of key parameters. The model post-processes outputs from all iterations to report aggregated results.
- Having key inputs and outputs from each iteration, or iteration-specific results, prior to any post-processing can facilitate a clearer understanding of the impact of underlying variables on model results and aid model validation and transparency.
- Constraints in computing resources however, limit how many iteration-specific results can feasibly be saved. It may also unfeasible to sift through data from thousands of iterations.

Iteration-specific results reporting

Staff recommendation:

- Limit collection of iteration-specific results to key data
- Limit temporal granularity where possible, e.g. report emissions monthly, but report reserve shortfalls hourly
- Support the recommendations of Working Group 3 on use of iteration-specific results for “deep-dive” or other validation efforts

Deterministic results to report hourly

Load	Regional gen. requirement shadow price
Up reserve requirements (LF_up, Reg_up, spin, non-spin)	Storage charge/discharge state and magnitude
Ancillary services available, by resource type	Hydro and nuclear generation
Energy generation, by resource type	Net imports
Load and/or reserve shortfall magnitude, by type	CAISO CCGT generation and emissions
Import limits	CAISO CT generation and emissions
Demand response dispatched	CAISO CHP generation and emissions
Outages	CAISO other emissions
Curtailment magnitude, by type	GHG emissions in rest of WECC
Down reserve requirements (LF_dn, Reg_dn)	Production costs
Energy price for SCE, SDG&E, PG&E Bay, and PG&E Valley	CO2 permit costs
Shadow price for each reserve product	

Stochastic results to report hourly

Load	
Up reserve requirements (LF_up, Reg_up, spin, non-spin)	
Ancillary services available, by resource type	
Energy generation, by resource type	
Load and/or reserve shortfall magnitude, by type	
Outages	

Working Group 3: Validation and Refinement of Modeling Methodologies

- **Pursued two overarching questions:**

  1. What modeling methodologies are ***fundamentally appropriate*** (we have sufficient confidence in them) for informing what kinds of Commission decisions…….and what modifications to their design or application would be desirable for these purposes?

  2. What modeling methodologies are worth pursuing but have ***not yet fundamentally achieved sufficient confidence***, and what is needed to achieve such confidence?

Overview of CPUC Staff Recommendations for Key Identified Modeling Issues

- **Deterministic modeling** – *Appropriate for a range of issues. However, for capacity need issues a greater range of conditions must be examined, and stochastic methods may ultimately be preferred.*

- **Stochastic modeling –** *Greater understanding and confidence are needed regarding modeling of diverse, unprecedented combinations of load/wind/solar (L/W/S) conditions…conditions not historically documented.*

- **Modeling flexible reserves commitment requirements** – *Better understanding of methods and their modeling consequences is needed.*

- **Modeling regional generation requirements** – *This is a modeling input requiring justification and possibly refinement.*

- **Modeling storage and hydro** – *not a major barrier to confidence, but should be examined in the course of future studies (**not discussed today**)*

Deterministic Methodologies: Summary of Working Group 3 Views

- **There is sufficient confidence in deterministic production simulation models used for addressing over-generation, production cost, GHG and integration adder issues.**
- **These models can also be used to help understand *capacity need* issues, although stochastic methods may be preferred if/when achieving sufficient confidence.**
- **Particularly when used for capacity (generic and flexible) issues, deterministic methodologies must cover a *wider* range of plausible conditions that could produce capacity or flexibility stress.**
  - *P<u>robabilistic</u> reliability criteria (e.g., "no more than x events in y years") imply a need to weight deterministic cases.*

Deterministic Methodologies: CPUC Staff Recommendations - 1

- For 2016 LTPP planning cases, at least the base case should have *multiple subcases,* each having different 8760-hour profiles of load+wind+solar ("L/W/S") conditions.
- Each subcase's profiles would be based on load, wind and solar conditions documented to have historically co-occured, hour by hour, in a particular year.
- The historical data sources for these profiles would be CAISO load data and both wind and solar profiles developed by NREL for about 40,000 different locations westwide (years 2007-2013 for wind, at least that many years for solar).
- Areas outside of CAISO (or California) might be modeled using only a single set of deterministic L/W/S profiles.

Deterministic Methodologies: CPUC Staff Recommendations - 2

- **This multi-subcase approach meets three desirable criteria:**
  - **It covers an expanded range of L/W/S conditions, compared to using a single set of L/W/S profiles per deterministic case.**
  - **It produces L/W/S conditions (profiles) that are credible since they have co-occurrrred in the past, based on public data.** <1>
  - **It is more transparent than stochastic methods used to produce an expanded L/W/S range.**
- **This is also a useful intermediate step towards building confidence in stochastic methodologies**
- **During this process, PV profiles should be assessed for consistency with the likely mix of designs deployed.**

<1> I.e., for any L/W/S subcase the load, wind and solar values for hour 15 of March 23 would all be based on load, wind and solar conditions that co-occurred in hour 15 of March 23 for one particular historical year.

Deterministic Methodologies: CPUC Staff Recommendations - 3

- **Building multiple L/W/S profiles for a case is more laborious than building a single profile, but less laborious than using the same L/W/S data to develop stochastic profiles.**
- **Historical wind/solar (meteorological) conditions converted to MW output (e.g., via NREL's Solar Advisor Model) would be scaled by the *MW of wind/solar in the particular planning case.***
- **Adjusting *load* data from multiple historical years to produce multiple load profiles that are nevertheless *consistent* with a given case's adopted load forecast is less straightforward.**
  - **However, it should entail no more, and likely less challenge than developing <u>*stochastic*</u> load profiles as part of an expanded range of L/W/S conditions that never actually co-occurred historically.**

Stochastic Methodologies: Summary of Working Group 3 Views

- Stochastic methodologies are promising, but there is insufficient confidence in the construction and modeling of stochastic L/W/S profiles that exceed historical experience.
- Validation of such profiles should
  - utilize trusted historical and other data sources,
  - assess L/W/S correlations both overall and for particular circumstances (e.g., high-load summer days), and
  - pay particular attention to bounds and extremes of probability distributions.
- Also, validation should include "deep dives" to examine specific conditions modeled to co-occur during capacity shortfall and overgeneration events.

Stochastic Methodologies: CPUC Staff Recommendations - 1

- ❑ **L/W/S profiles constructed for stochastic modeling should be compared with "benchmarking" profiles that are based on historically co-occuring L/W/S conditions, i.e., *the above recommended deterministic "subcase" profiles*.**

- ❑ **The extent to which stochastic L/W/S levels or ramps exceed those for benchmarking profiles should be assessed for credibility and explanation.**

- ❑ **L/W/S *correlations* and *extreme values* (magnitudes x probabilities) should be compared for historical L/W/S data and benchmarking profiles - - versus stochastic profiles.**
  - ➢ **Overall (e.g. for July, for March, etc.), and also**
  - ➢ **for particular conditions (such as high-load days/hours in July).**

Stochastic Methodologies: CPUC Staff Recommendations - 2

- **Validation of stochastic L/W/S profiles should also utilize "*deep dives*" that extract and inspect detailed modeling inputs and results for *specific hours or days* in which significant shortfall or overgeneration events are modeled.**
- **This would extract L/W/S values and also other key data such as forced outages, imports, resource utilization.**
- **To assess: What combinations of conditions cause events, are these combinations credible or do they go far beyond the benchmarking profiles?**
- **Deep dives must be pragmatically designed considering value versus effort. Feasiblity of a two-pass approach re-simulating key periods will need to be evaluated.**

Flexible Reserves Commitment: Summary of Working Group 3 Views

- **There was widespread interest in clarification, justification and consequences - - of the ways that hourly flexible reserves commitment requirements are modeled.**
- **This is *not* generally seen as important a need as (1) greater diversity of L/W/S conditions in deterministic studies or (2) credibility of stochastically modeled L/W/S conditions.**
- **Concern about flexible reserves commitment requirements was lower if shortfall "events" are not automatically triggered by failure to meet those requirements. But…..**
  - **We still need to understand how events *<u>are</u>* triggered, with what probability, and…**
  - **there is concern regarding how reserve requirements impact modeled overgeneration, production costs and GHG.**

Flexible Reserves Commitment: CPUC Staff Recommendations - 1

- **Recommend a 7-part approach to improving understanding and confidence regarding deterministic *and* stochastic modeling of flexible reserves commitment requirements.**
- **This would require very little in terms of modeling runs not already being conducted for other purposes.**
- **Parts 1-4 involve improved *<u>explanation of the computational logic and rationale</u>* for setting commitment requirements and calculating shortfall events. This should be provided in an efficient, structured manner *early* in the LTPP study process (vs. ad hoc via subsequent data requests).**
- **Parts 5-7 involve using *<u>modeling inputs and results</u>*, and other data, to assess reserve commitments.**

Flexible Reserves Commitment: CPUC Staff Recommendations - 2

- **Parts 1-4**

1. **Fully define each flexible reserve (e.g., MW ramp over *how many* minutes? Does it have to already be on line?)**
2. **Describe what variabilities and uncertainties (using what data sources) each kind of reserve is calculated to offset, such as hour ahead forecast error, 5-min. and 1-min. within-hour variations, etc.**
3. **Provide numerical examples to support #2, from specific modeling hours.**
4. **Clearly explain computational logic and rationale by which a model calculates *achieved operating reserves amount and probability* for an hour. How does this address intra-hour intervals?**

Flexible Reserves Commitment: CPUC Staff Recommendations - 3

- **Parts 5-7**

  5. **Compare amounts required for each flexible reserve type across different models (for similar L/W/S conditions).**

  6. **Run one or more sensitivities in which a modeling case having significant shortfall (and possibly overgeneration) is re-run with the same inputs except that flexible reserve commitment requirements are signficantly increased and/or decreased.**

  7. **Compare flexible reserve requirements in a modeled planning case vs. under current CAISO operating practices:**

     - **Calculate reserves under *current practices*, but assuming higher wind/solar levels from the planning case**

     - **Recalculate *planning case reserve commitments* assuming current (lower) wind/solar levels**

Regional Generation Requirements: Summary of Working Group 3 Views

- **The basis for modeling regional minimum generation (hourly energy dispatch)<1> requirements should be fully assessed, making changes if necessary. This clearly affects overgen, operating costs, and GHG.**

- **Assessment should consider the *different* types of reliabilty services (primary frequency response, inertia, etc) for which the generic regional requirements are a proxy, as well as…**
  - **Whether "regions" (having requirements) should be defined differently**
  - **Whether other kinds of resources (including load and storage) should be eligible to provide certain services**
  - **Whether only one or two of the services are most limiting (affecting required regional generation) in particular regions**

<1> of eligible types of resources within each defined region in the CAISO footprint

Regional Generation Requirements: CPUC Staff Recommendations - 1

- **CPUC staff recommend pursuing the issues identifed under "Working Group views" above**
- **This can be done via a task force effort including the energy agencies with CAISO and transmission owners, and perhaps others - - in parallel with (separately from) the overall LTPP**
- **This effort should include examination of whether...**
  - **it is feasible or desirable to model (via production simulation) regional requirements for <u>multiple</u> kinds of reliability services;**
  - **only *one kind* of service may be most limiting (serving as a proxy for overall reliablity services need) in any region;**
  - **a certain amount of reliability services need can be met by resources *not dispatched for energy*.**