R.12-03-014: Energy Division Workshop – SCE Stochastic System Need Analysis Project (SSNAP)

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California Public Utilities Commission

May 10, 2013

Remote Access

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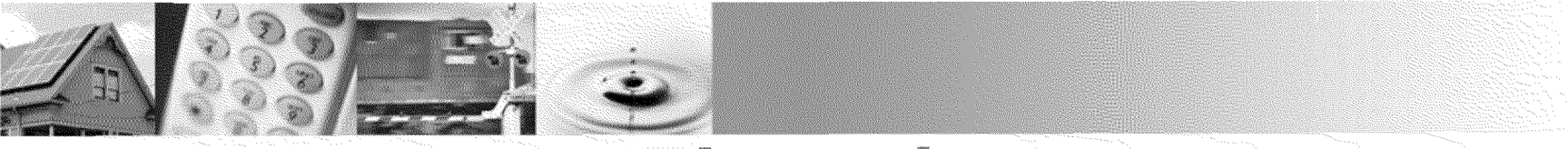


Agenda

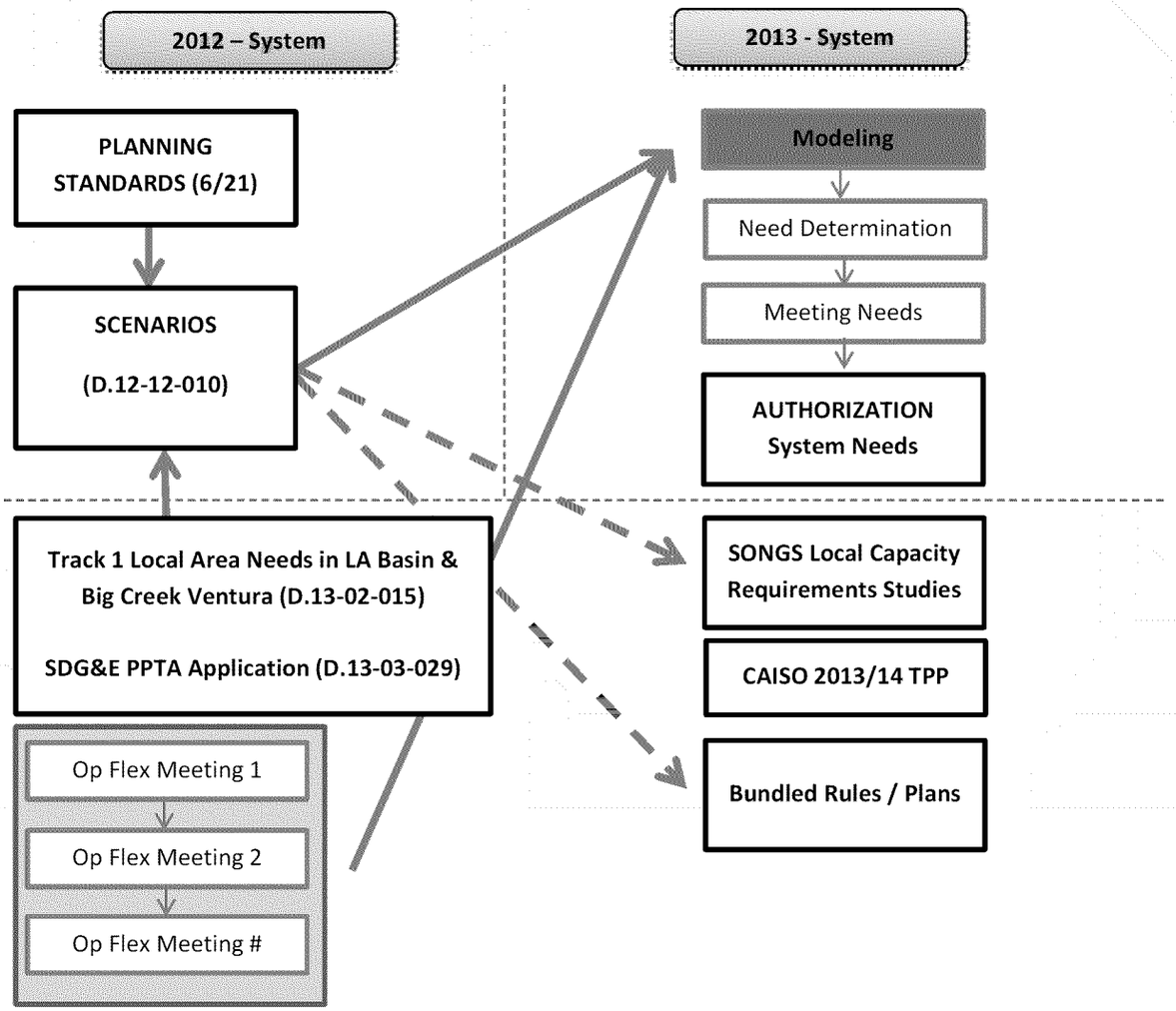
Time	Item
9:30 – 9:40	Introduction, Schedule
9:40 – 10:45	Project Overview and Stochastic Methodology
10:45 – 11:00	Break
11:00 – 11:50	Model Inputs and Results Metrics
11:50 – 12:00	Wrap Up/Next Steps

Note: ALJ Gamson will be holding an LTPP status conference after this workshop from 1-3pm in Hearing Room A.

Workshop Purpose

- Review Southern California Edison's stochastic operating flexibility study methodology
- Assess sample results
- Explain next steps for studies

Roadmap



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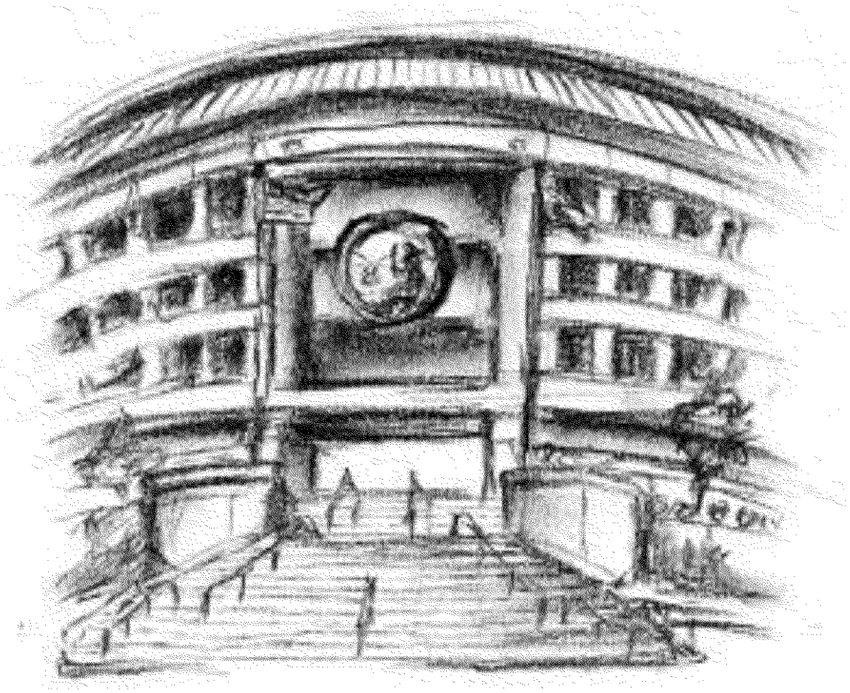

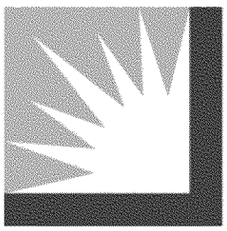

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Stochastic System Need Analysis Project (SSNAP)

May 10, 2013

SCE is performing a stochastic analysis of system need for the 2012 LTPP Track 2.

Background

1. 2012 Long-Term Procurement Plan (LTPP) Track 2 goal is to determine Renewable Integration Need
2. 2010 LTPP deterministic approach has limitations that make procurement decisions difficult
    1. Deterministic simulation does not capture or give probability to the range of future outcomes
    2. Hourly granularity limits understanding of intra-hour needs
    3. System Shortfall* cannot be directly translated into loss of load, frequency violations, curtailment, etc.

SCE's Stochastic System Need Analysis Project:

1. Forecast loss of load probability due to insufficient resource availability to meet load and reserves
2. Determine amount of, and driving factors behind, need for flexible and non-flexible capacity

* In 2010 LTPP, system shortfall was defined as not being able to meet net load following, regulation, or contingency reserves requirements

Objective of Today's Presentation

1. **Review the methodology of SCE's Stochastic System Need Analysis Project (SSNAP)**
2. **Discuss next steps and action items**

Agenda

1. Project Overview and Goals
2. Modeling and Analysis
3. Sample Results
4. Timeline and Next Steps

Project Overview

Analysis uses stochastic draws of key variables to predict the likelihood that the generation fleet cannot meet 5-min net load.

Methodology Overview

Objective

- Evaluate system resources' ability to meet system needs down to the 5-minute level

Design Principles

- Generate realistic uncertainty in key variables
- Maximize number of possible simulations within a reasonable timeframe
- Rely on publically available information

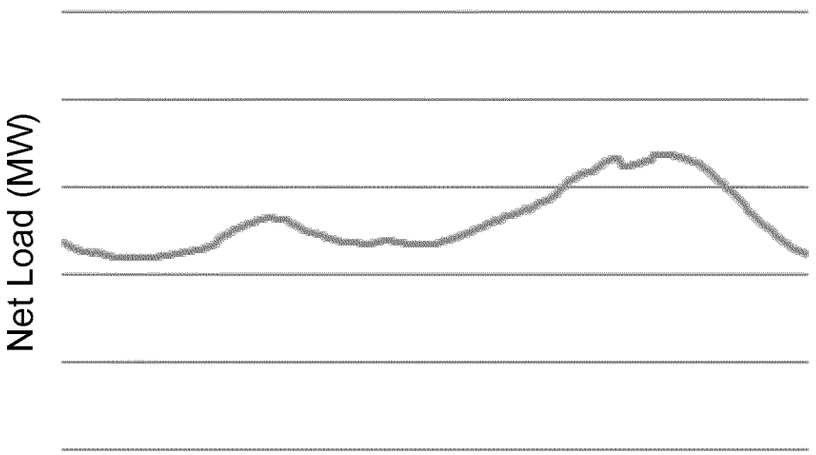
Key Features

- Stochastic method tests a range of net load (load minus wind and solar)
- 5-minute granularity to understand appropriate level of system need and fleet capability
- Calculate a loss of reserve probability and loss of load probability (LOLP)

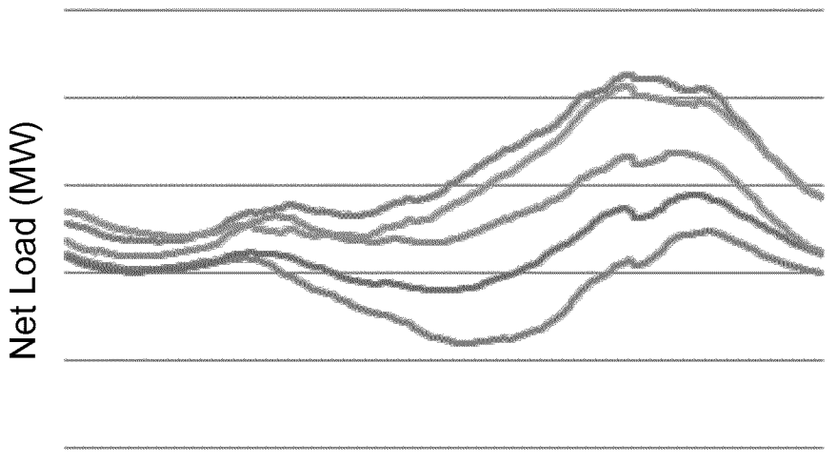
SSNAP will test a wide range of factors to determine the probability of outages in 2022.

Stochastic Analysis

Single Day Deterministic Net Load* Example



Single Day Stochastic Net Load* Example



- Stochastic analysis tests a range of factors that affect system need
- Results are combined to find the probability of an outage in 2022

*Net load, defined as load minus wind and solar production, is just one of the inputs stochastically varied

The largest change in modeling from the 2010 LTPP is the use of stochastic variables and the move to 5-minute granularity.

Summary of SSNAP Modeling Differences

Item	2012 LTPP Deterministic Modeling	SSNAP
Load Peak and Shape	1 Draw	Stochastic Analysis
Intermittent Generation	1 Draw	Stochastic Analysis
Maintenance and Forced Outages	1 Draw	Stochastic Analysis
Dispatch Granularity	1 HR	5 Minutes
Dispatch Horizon	8760 hours	One day for each season; but many samples
Economics	Yes	No*
Reserve Shortfall	Net Load Following / Regulation / Contingency	Regulation / Contingency
CA Detailed Modeling (Generation, Transmission, Constraints)	Yes	Yes
Reliability Measure	Reserve Shortfall	Loss of Load Probability

*Can be included in sample runs or in full analysis at the expense of run time

Modeling and Analysis

Modeling and Analysis Steps

1. External Inputs

- All deterministic assumptions for SSNAP will match the Base Case assumptions
- Load, wind, and solar stochastic assumptions will be based on the Base Case assumptions

2. PLEXOS Analysis

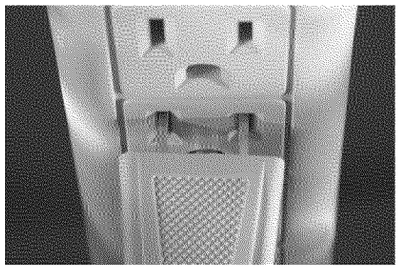
- Hourly Commitment
- 5-Minute Dispatch
- Maintenance and Forced Outages*

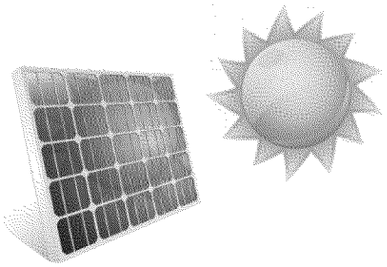
3. Results

- Loss of Load Probability
- MW Need (Magnitude and Type)
- Identifying factors that result in system need

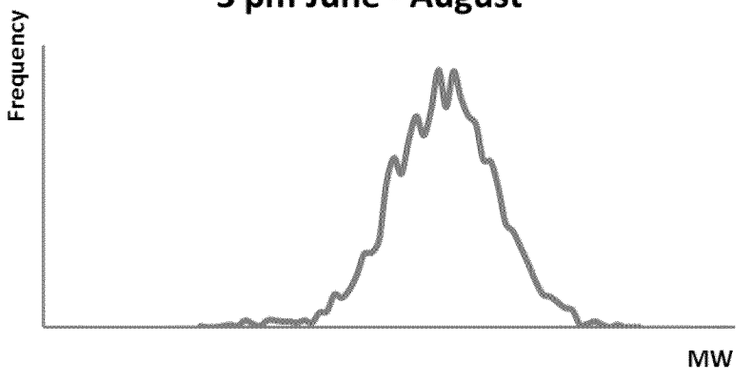
*Uses a combination of PLEXOS analysis and post-process analysis

Net load is created by stochastic draws of load, wind, & solar (Net Load = Load – Wind – Solar).





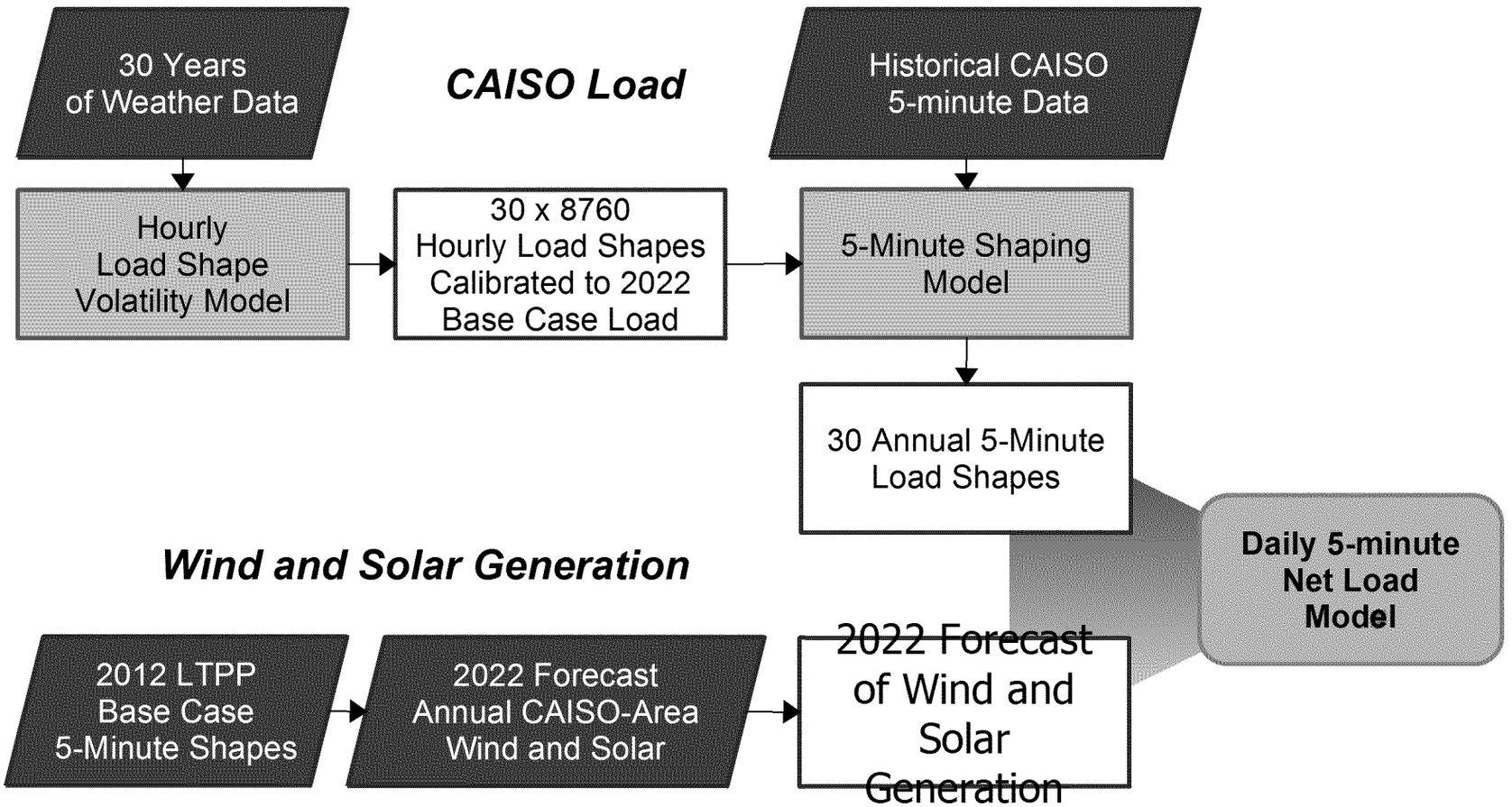
Perform stochastic draws from profiles



Process creates a very large number of cases; will sample the outcomes

Load volatility model and LTPP forecasts for wind and solar generation are used to create a 5-minute net load forecast.

Net Load Inputs



Load, wind and solar forecasts are randomized by month to create a population of possible daily net load shapes for each month.

Daily 5-Minute Net Load Model (Stochastic Net Load)*

CAISO Load	*Wind*	*Solar*
28 to 31 days per month per year (30 sample years)	28 to 31 days per month (1 sample year)	28 to 31 days per month (1 sample year)

10,154,670 Possible Daily Net Load Shapes
(658,560 to 893,730 Shapes per Month)

Representative Sample Selected for PLEXOS Modeling
(Approximately 500-1000 runs per season)

*Exploring methods to understand correlation between load, wind, and solar

A modified PLEXOS model will test system need on a 5-minute basis.

Model Development

1 Benchmark Reliability Results

- Use full PLEXOS database and scenario with known reliability levels (reserve shortfall)

2 Model Simplification

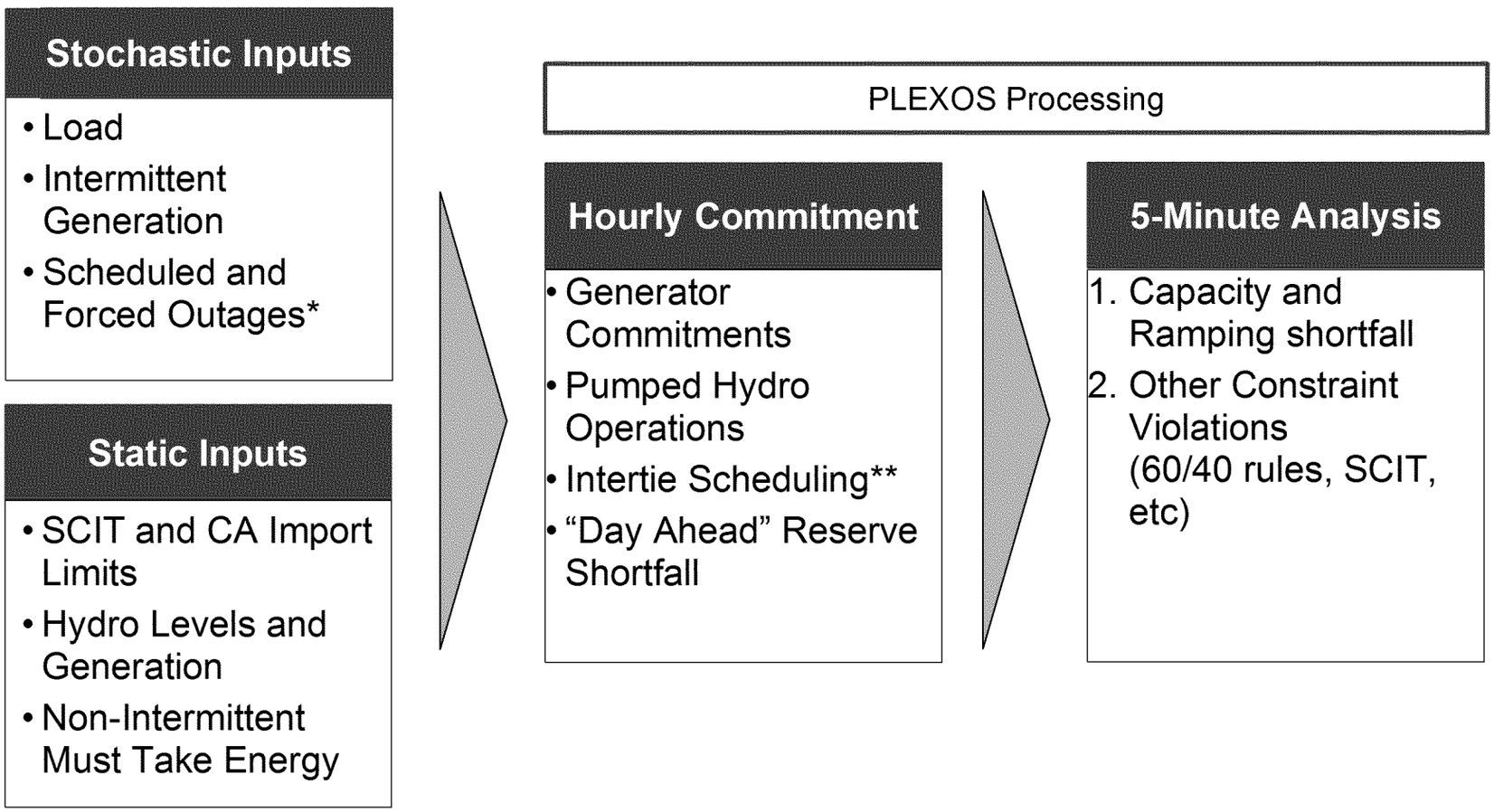
- Remove constraints and functionality without changing shortfall results. For example:
  - WECC Generation Fleet, Load, and Regions (Replaced with WECC Aggregation)
  - Prices (GHG, Fuel, etc.)
  - AB32 Modeling

3 Implement Stochastic Simulation

- Use a combination of hourly inputs and 5-min stochastic runs to determine likelihood of system reserve shortfall

Modeling utilizes a combination of stochastic and static inputs and analyzes them on an hourly and 5-minute granularity basis.

Modeling and Analysis Flow Chart



* Outages will be analyzed using a combination of stochastic draws and post-processing analysis

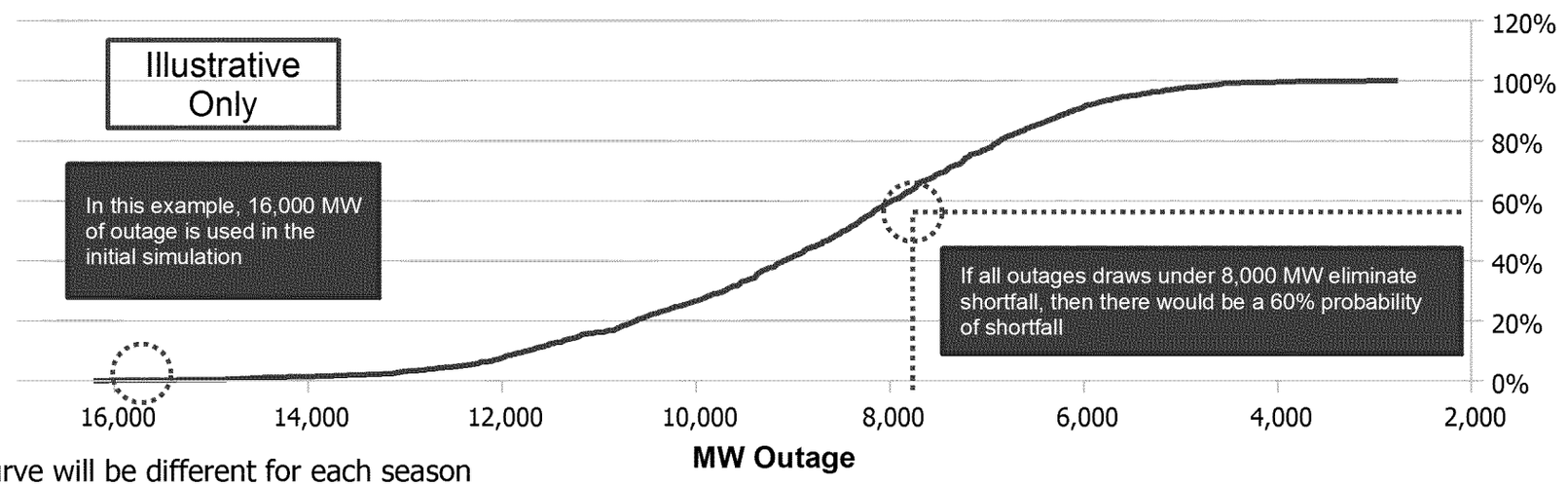
** 15-minute intertie scheduling and California export limitations will be analyzed

Outages are accounted for using modeling runs and post process analysis.

Maintenance and Forced Outage Analysis

1. Maintenance and Forced Outage draws are created using PLEXOS and CAISO outage factors
2. The highest outage draw is used in the initial simulation. Tests are performed to determine which outage draws would have resulted in the elimination of shortfall.
3. The total outage draws that result in shortfall will have their probability of occurrence applied to each net load draw

Total CA Outages (MW) Cumulative Probability Distribution Function **Spring** Example



*Curve will be different for each season

The expected number of shortage events and need MWs will be classified by shortfall types and time periods.

Result Metrics

Event	Expected Events Over 10 Years
Regulation Reserve Shortfall	
Stage 1 System Emergency (<6% Cont. Reserves)	
Stage 2 System Emergency (<5% Cont. Reserves)	
Stage 3 System Emergency (<3% Cont. Reserves)	

Determine how many MW are needed by the system to achieve 1 Event in 10 Years Reliability

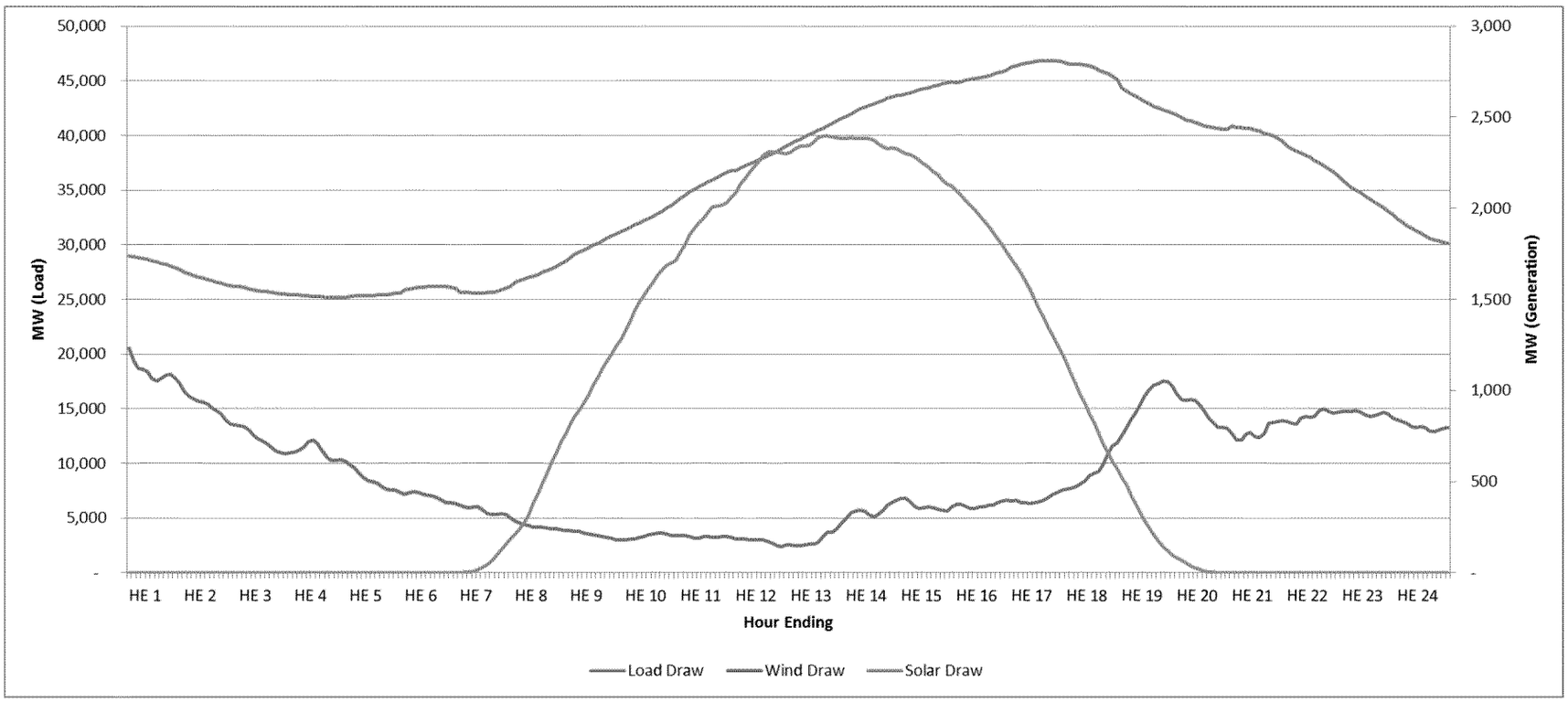
Project Deliverables

1. Expected Events for System Emergencies
2. MW (Type* and Magnitude) needed to reduce Stage 3 System Emergency Probability to 1 Event in 10 Years
3. Sensitivities on CA Exporting capabilities and 15-minute Intertie Scheduling
4. Analysis of factors that result in system emergencies (Net Peak, 3-Hour Ramp, etc.)

*For example, flexible vs inflexible capacity

Sample Results

Example Summer 2012 CAISO Load, Wind, and Solar Draw



Draw represents a high stress (high net peak) day, with a low probability of occurrence

Preliminary Summer 2012 Result Metrics

Work In Progress

Event	Expected Events Over 10 Years
Regulation Reserve Shortfall	Calculation in progress
Stage 1 System Emergency (<6% Cont. Reserves)	
Stage 2 System Emergency (<5% Cont. Reserves)	
Stage 3 System Emergency (<3% Cont. Reserves)	< 0.5

No additional MW are needed on the system since the expected events over 10 years less than 1*.

- Results are preliminary, model runs and analysis are still in progress
- Results are for Summer 2012 only, does not represent the full year

*Assuming other seasons do not have substantial need

Next Steps

Timeline and Next Steps

- Complete 2012 model backcasting
- SCE is currently building out the 2012 LTPP Track 2 Base Case
  1. All deterministic assumptions for SSNAP will match the Base Case assumptions
  2. All stochastic assumptions will be based on the Base Case assumptions
- Base Case Analysis will be completed by August 2013*

*Contingent on what is agreed to in the 5/10/2013 LTPP Status Conference

Thank You!
Questions / Comments:

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Appendix

Definitions

Term	Definition
Net Load Following Reserves	Reserves held in hourly modeling to account for intra-hour variability and forecast error
Regulation Reserves	Reserves held to account for intra-5 minute variability and forecast error
Contingency Reserves	Spinning and non-spinning reserves held for system contingency events
Loss of Load Probability	Probability a given day in a year will experience load shedding
Commitment	The process of deciding if a generator needs to be turned on in a given time-frame
Intertie Scheduling	The amount of flow scheduled over transmission lines in a given time-frame
SCIT Limit	Southern California Import Transmission Limit
60/40 Rule	The 60/40 import constraint ensures that total imports into the SCE area do not exceed 60% of the total load in the SCE area

For the final results, inputs will be sourced from the 2012 Track 2 LTPP Base Case and modified for stochastic analysis.

Other Inputs

Input	Source / Methodology
Regulation Reserve	• 1.5% Load (CAISO "Rule of Thumb")
Contingency Reserves	• 3% Load as Spinning • 3% Load as Non-Spinning
Hydro – Dispatchable	• Average Hydro Year by Season
Hydro – Run of River	• Typical Hydro Day by Season
CA Municipalities	• Deterministic
WECC	• WECC Aggregation*
Prices and Economics	• None**

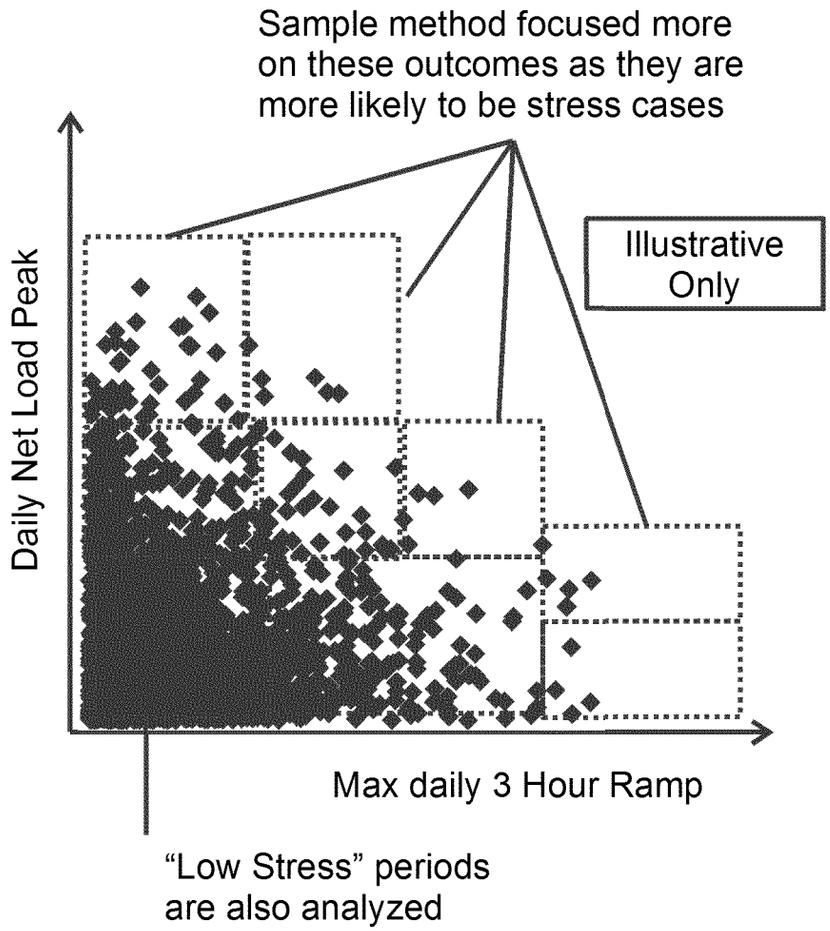
* The WECC (excluding AS capable imports) are replaced with an aggregated unit to improve run times. Import limitations are enforced to keep results feasible.

** Testing was done to verify that the removal of economic factors in the model would not change shortfall and need results

Data is grouped into similar net peaks and 3 hour ramp rates, and then a random sample is performed.

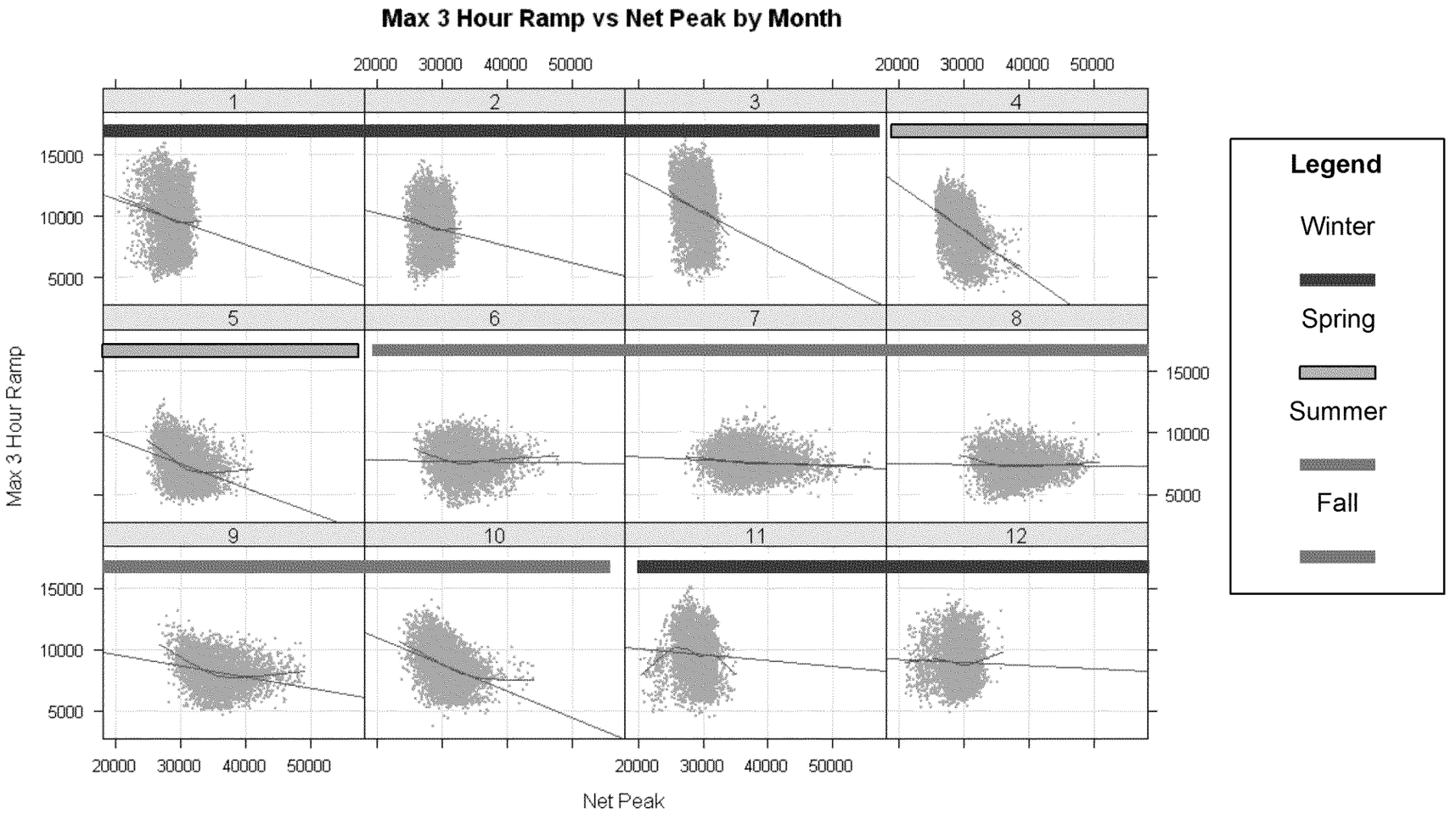
Stratified Sampling

1. Months grouped into 4 seasons
2. From step 1, place similar seasons into buckets based upon similar net load daily peak
3. From each bucket in step 2, place into another bucket based upon similar daily max 3 hour ramp
4. Sample a day from each bucket from step 3, and run simulation
5. Combine results to represent a full year



Months are grouped into seasons based on the similarities between their daily net load peak and 3 hour ramp.

1) Net Load Stratification (Work In Progress)



Split draws based on net load peak and max 3 hour ramp, allowing high stress periods to be tested in PLEXOS.

2) Net Peak Strata

Net Peak Strata (Percentile)					
< 50	50-90	90-95	95-97.5	97.5-99	>99

3) Max 3 Hour Ramp Strata

3 Hour Ramp Strata (Percentile)				
< 25	25-50	50-90	90-95	>95