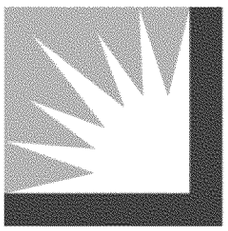

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Stochastic System Need Analysis Project (SSNAP)

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 understand system flexibility 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)

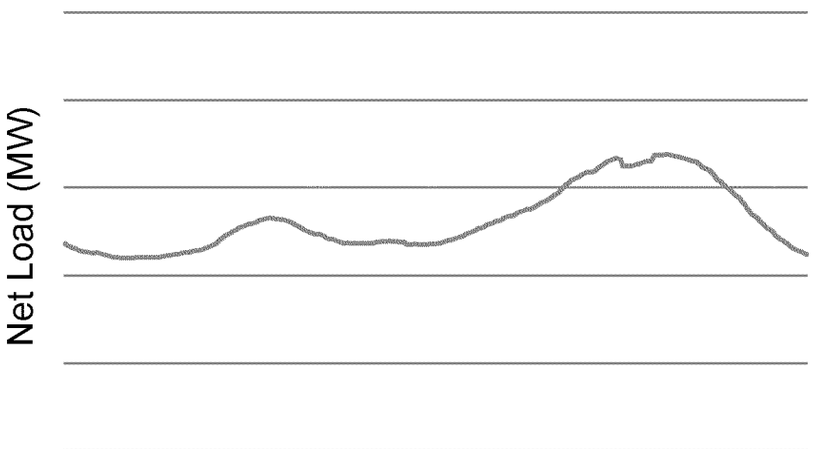
5-minute granularity to understand appropriate level of system need and fleet capability

Calculate a loss of reserve probability and loss of load probability (LOLP)

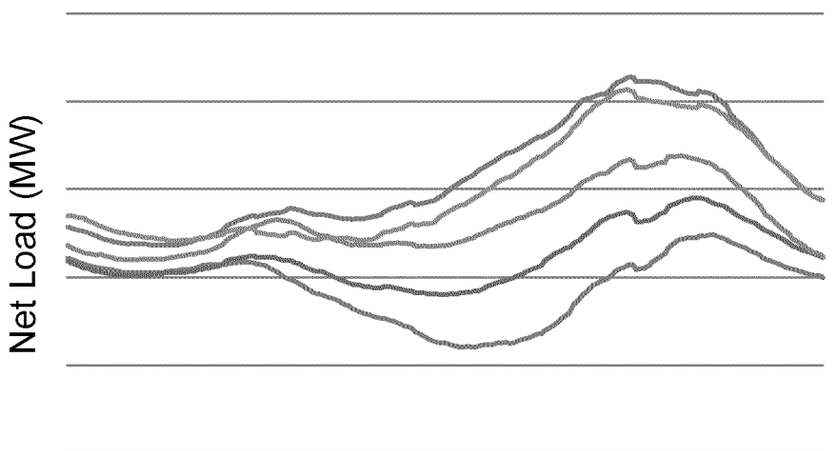
SSNAP will test a wide range of factors to determine the probability of outages in 2022

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
Loss of Load or Reserve Probability	No	Yes

*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 and Reserve Probability

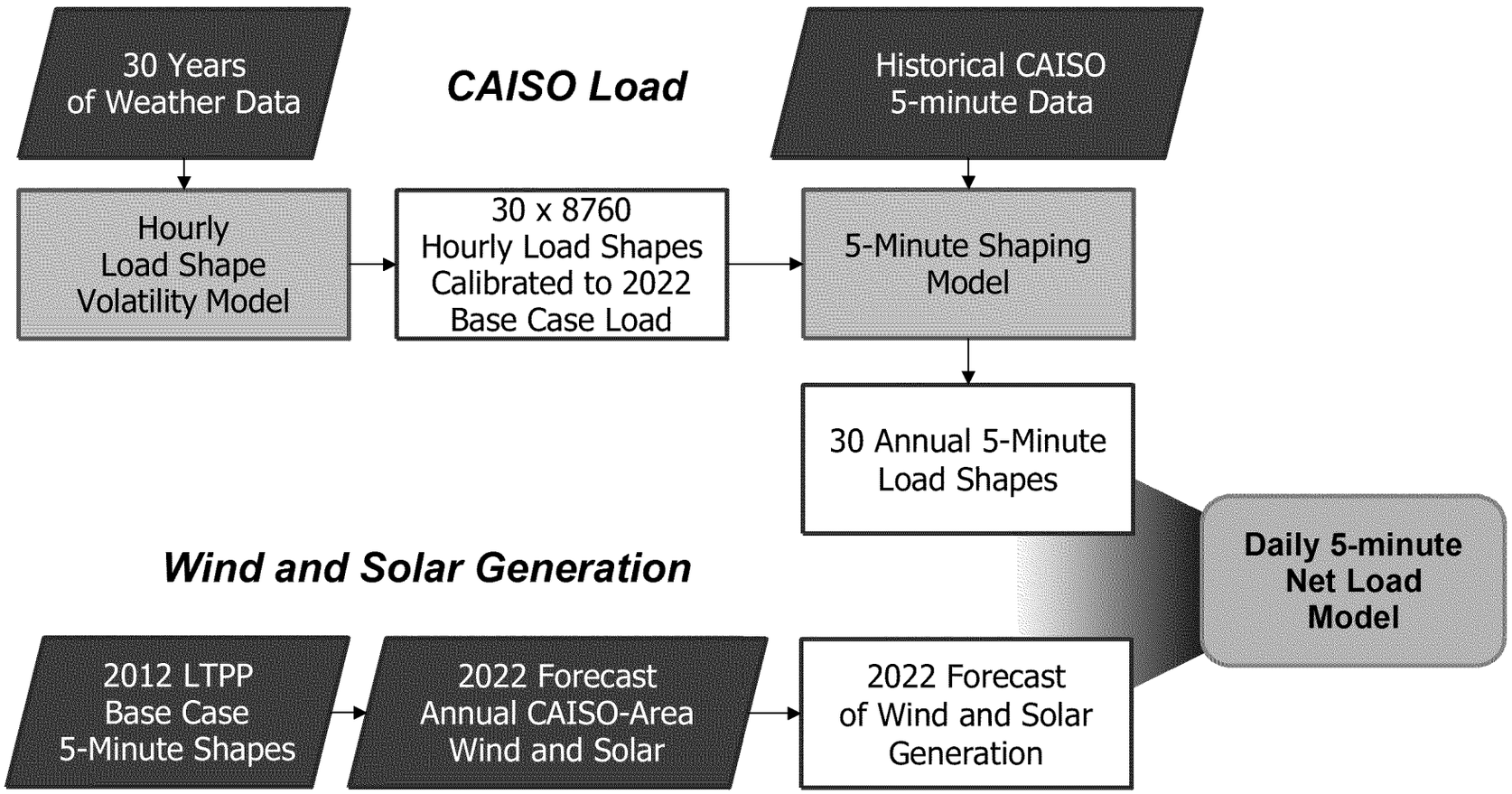
MW Need (Magnitude and Type)

Identifying factors that result in system need

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

In-house 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*
29 to 31 days per month per year (30 sample years)	29 to 31 days per month (1 sample year)	29 to 31 days per month (1 sample year)

10,154,670 Possible Daily Net Load Shapes

(658,560 to 893,730 Shapes per Month)

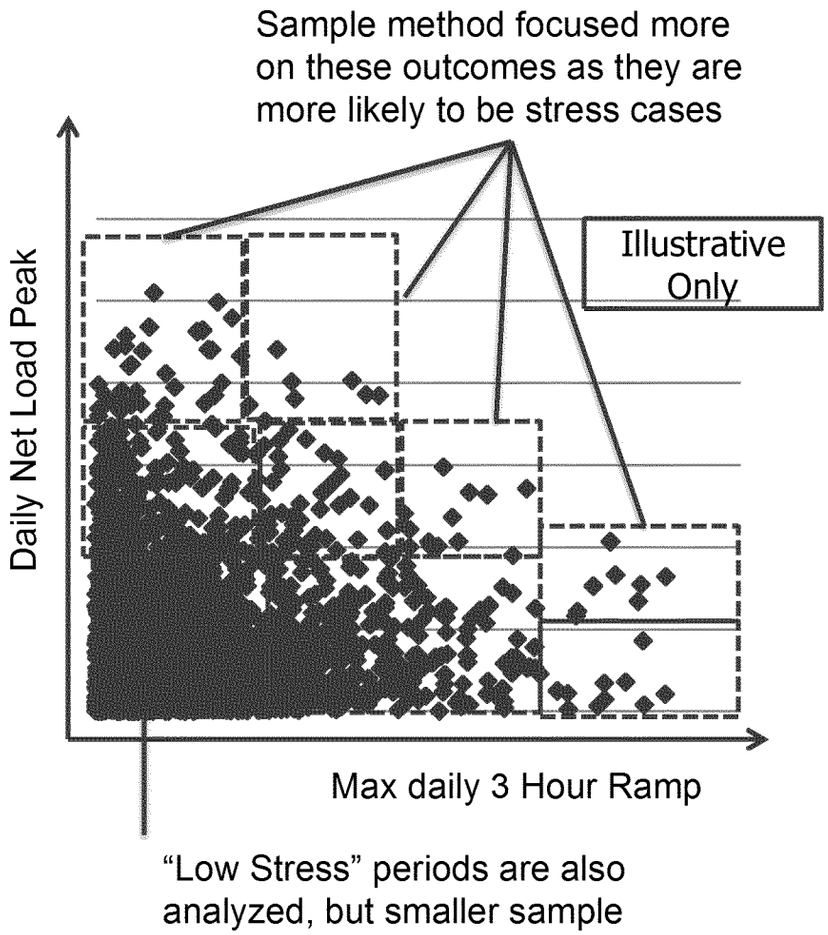
Split Load, Wind, and Solar profiles by Region
(PG&E Valley, PG&E Bay, SCE, SDG&E)
Static Split based on CEC Demand Forecast and Annual RPS Generation Split

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

Cannot model all 10 million possibilities, need to perform a stratified sample to represent the data

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



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:

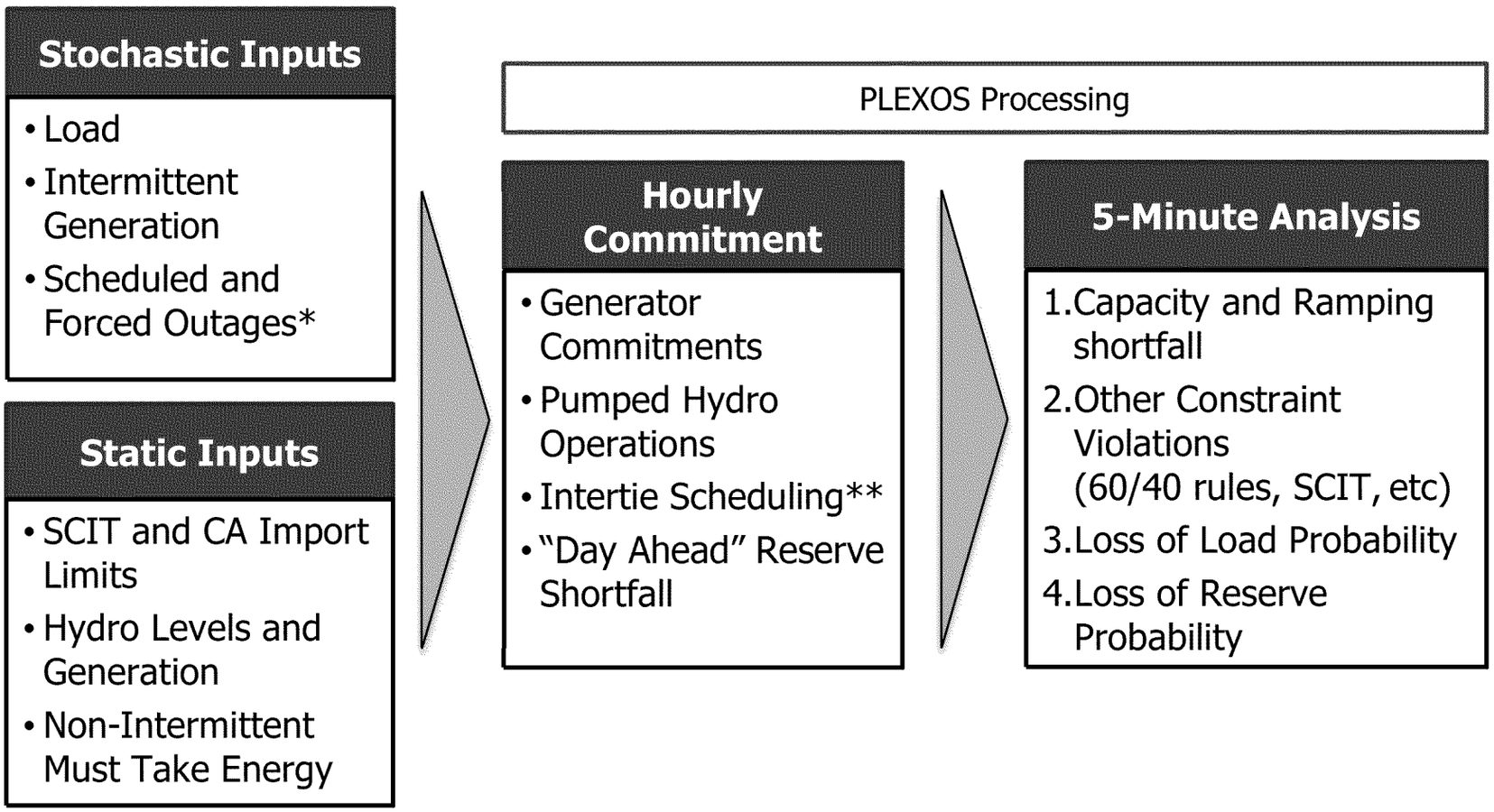
- WECC Generation Fleet, Load, and Regions (Replaced with WECC Aggregation)
- Prices (GHG, Fuel, etc.)
- AB32 Modeling

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

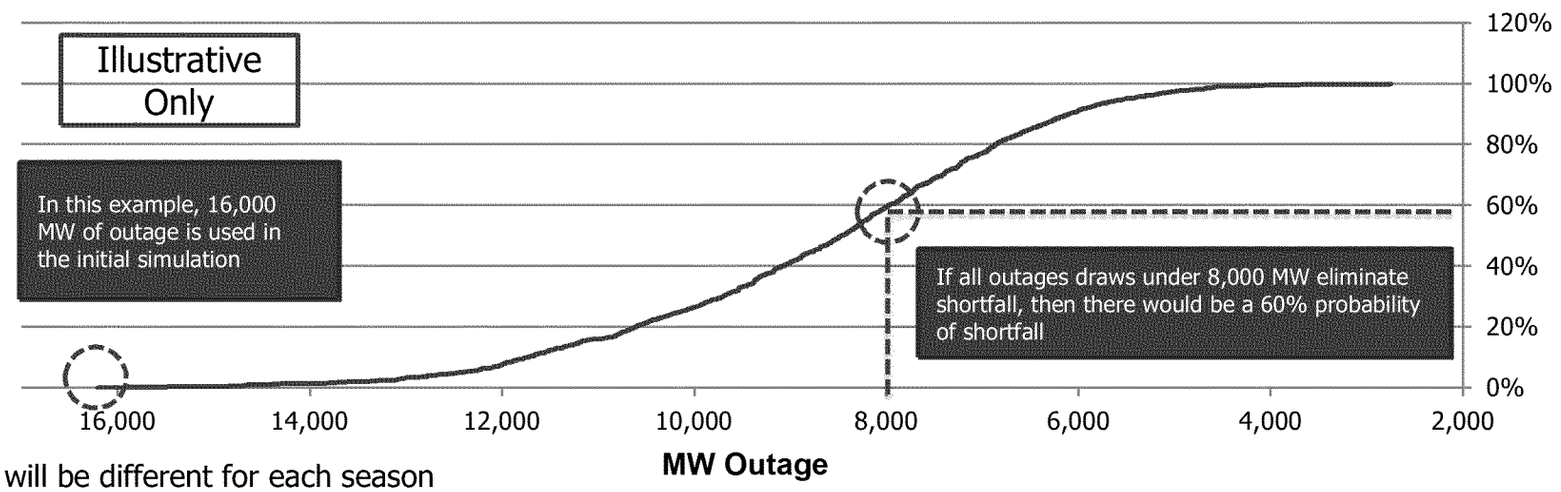
**15-minute intertie scheduling and California export limitations will be analyzed

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

Shortage Event	Expected Shortfall Events Over 10 Years (ESE)	MW Needed to Reduce ESE
Operational Reserves		
Contingency Reserves		
Energy		

Project Deliverables

1. Expected Shortfall Events for different System Needs
2. MW (Type* and Magnitude) needed to reduce expected shortfall events to a range of reliability levels
3. Sensitivities on CA Exporting capabilities and 15-minute Intertie Scheduling
4. Analysis of factors that result in system need (Net Peak, 3-Hour Ramp, etc.)

*For example, flexible vs inflexible capacity

Sample Results

Work in progress

To be provided at workshop

Next Steps

Timeline and Next Steps

- 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*

- Other cases (SONGS Out, Replicate TPP, High DG/DSM) if there is need to complete and time permits

*To match CAISO proposed timeline for LTPP Track 2 Analysis Completion

Thank You!
Questions / Comments:

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Appendix

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