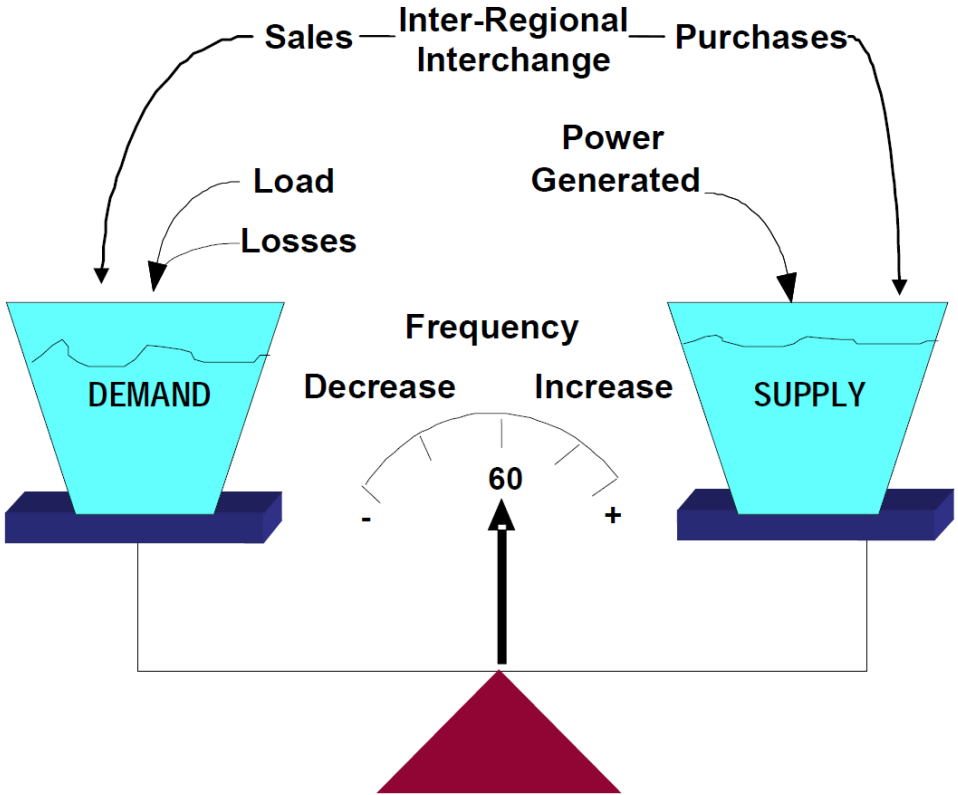
Southern Company

Introduction to Balancing Considerations

2017 UVIG Fall Technical Workshop
Tutorial – Essential Reliability Services –
Resources, Requirements and Next Steps

Rodney O'Bryant
October 10, 2017

Generation/Demand Balance



Balancing Challenges

- Load is always changing
  - Predicting load is like predicting the weather
- Generation can come off line unexpectedly
- Requires planning ahead:
  - How much load? (Load Forecasting)
  - What resources are available? (Unit Commitment)
  - Reserve Management

Load and Resource Balance (Ramping/Load Following Capability)

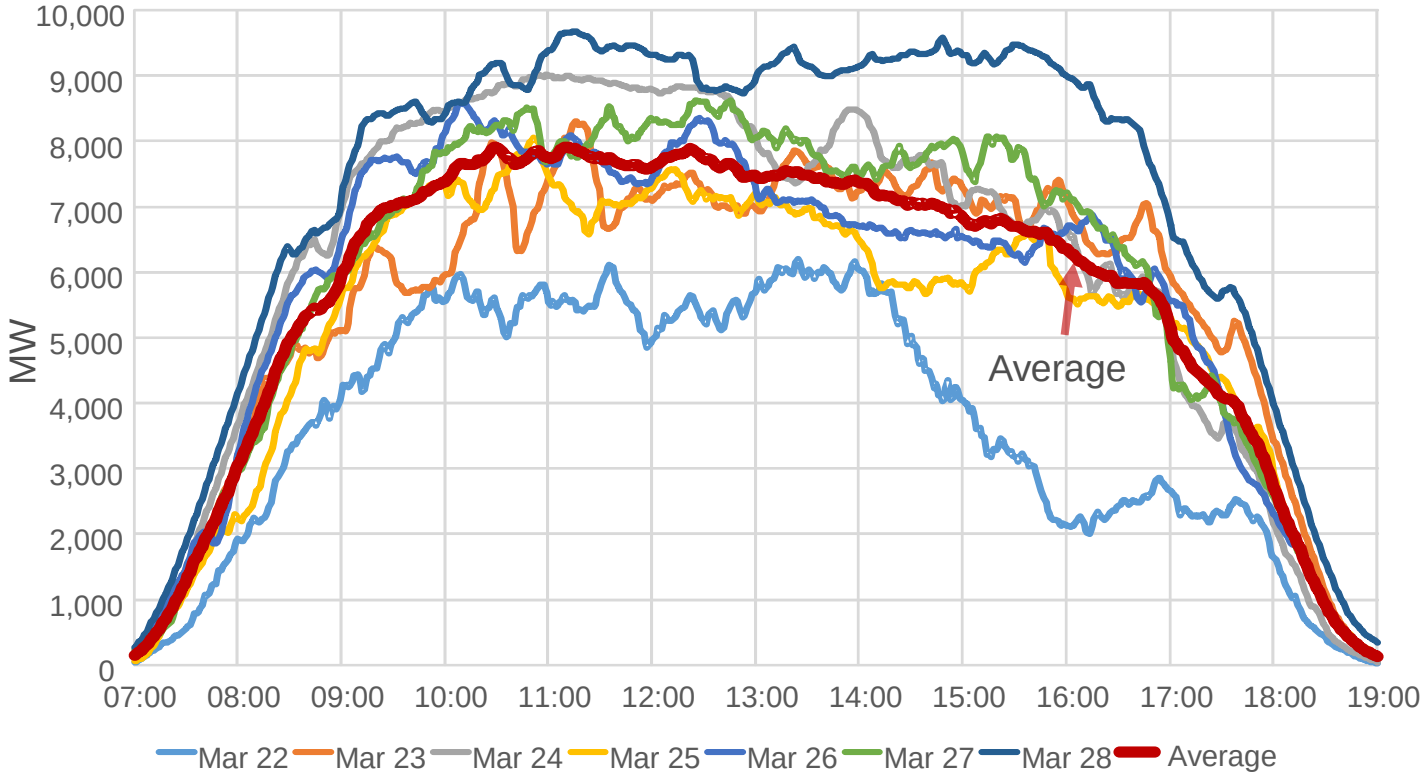
- Ramping Capability is the ability to use real-power control to raise or lower resources over a period of time to maintain the balance of load – generation.

- Real power control is needed when major load shifts (e.g. morning ramp-up, afternoon ramp-down, and evening ramp-up)

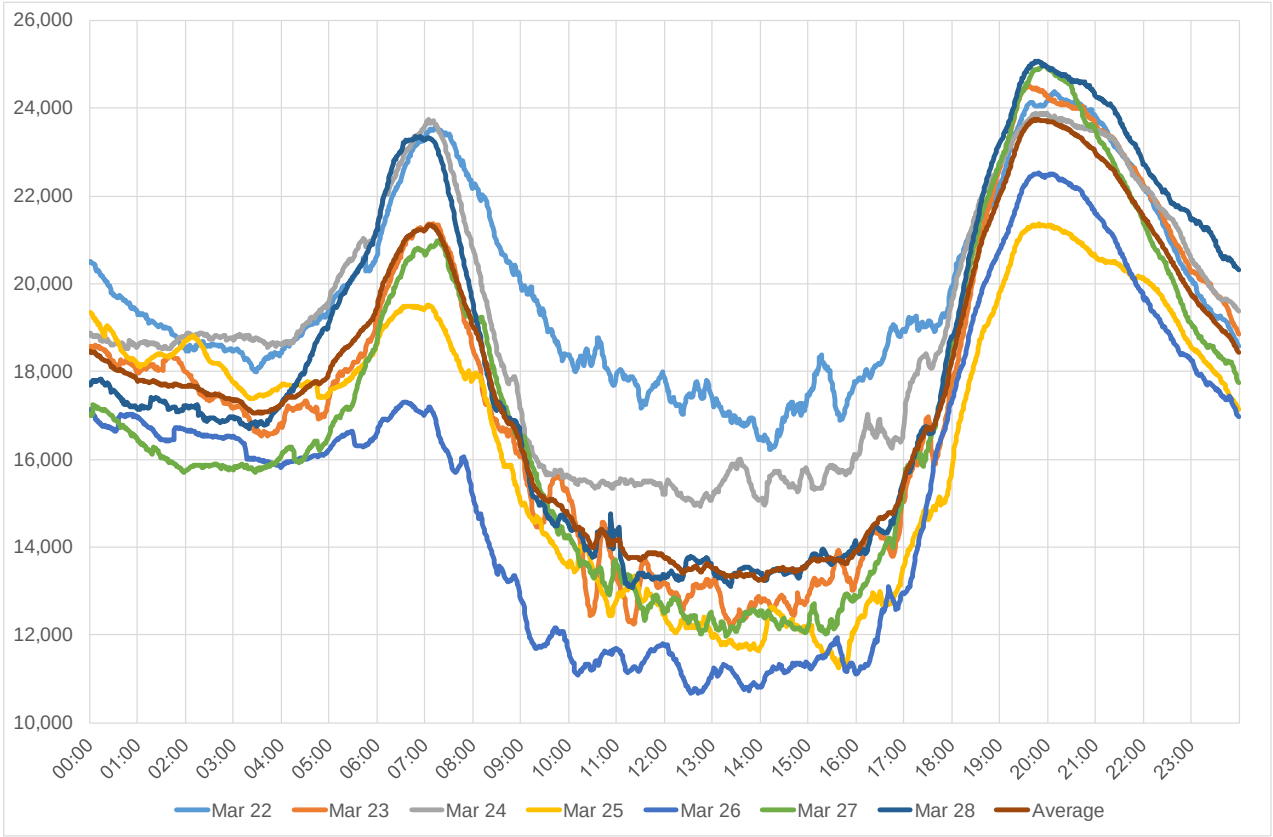
- As the daily load curve changes due to off-peak load changes ramping needs change.

- Lack of Ramping Capability can lead to system imbalance

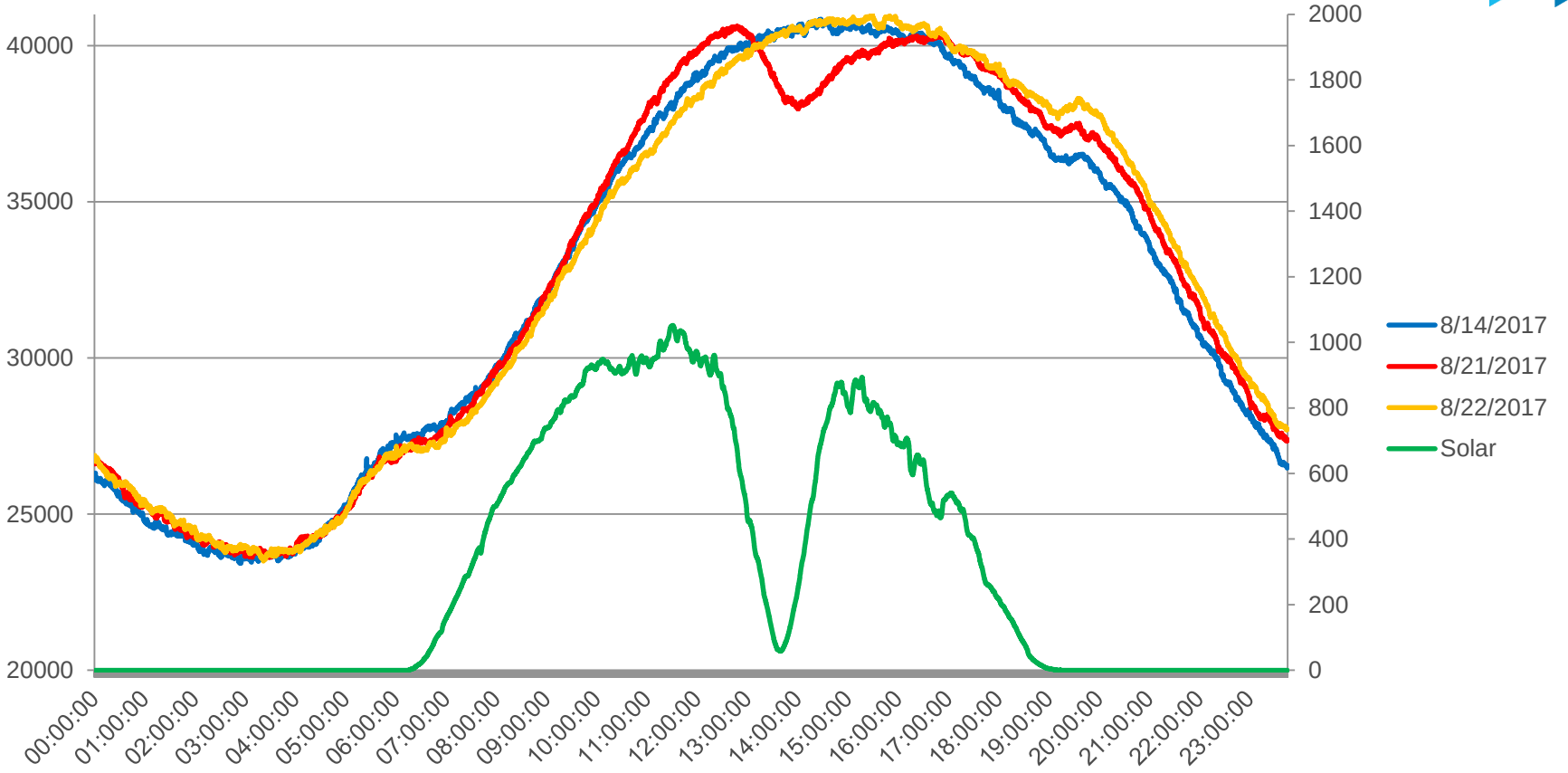
New Issue for some – Solar Variability



Net Load Varies from Day to Day



Variability Solar Eclipse 8/21/2017



Understanding VER Impacts on Balancing/Ramping

The impact of VER on the BPS is not a simple issue

- At lower penetration levels, the overall impact of VER is minor and can be managed by existing BPS resources and tools

- At higher penetration levels, issues may develop that impact a Balancing Authorities ability to balance load and generation.

Control Performance Standard 1 (CPS1)

- CPS1 assigns each Balancing Authority a share of the responsibility for control of frequency and the amount is directly related to the Balancing Authority Frequency Bias.
- CPS1 captures the relationship between ACE and Frequency using statistical measures to determine each Balancing Authority's contribution to such "noise" relative to what is deemed permissible.
  - If frequency is low, but ACE is positive (tending to correct frequency error), the Balancing Authority gets extra CPS1 points.
  - If ACE is aggravating the frequency error, CPS1 will be less than 200 percent. CPS1 can even go negative.

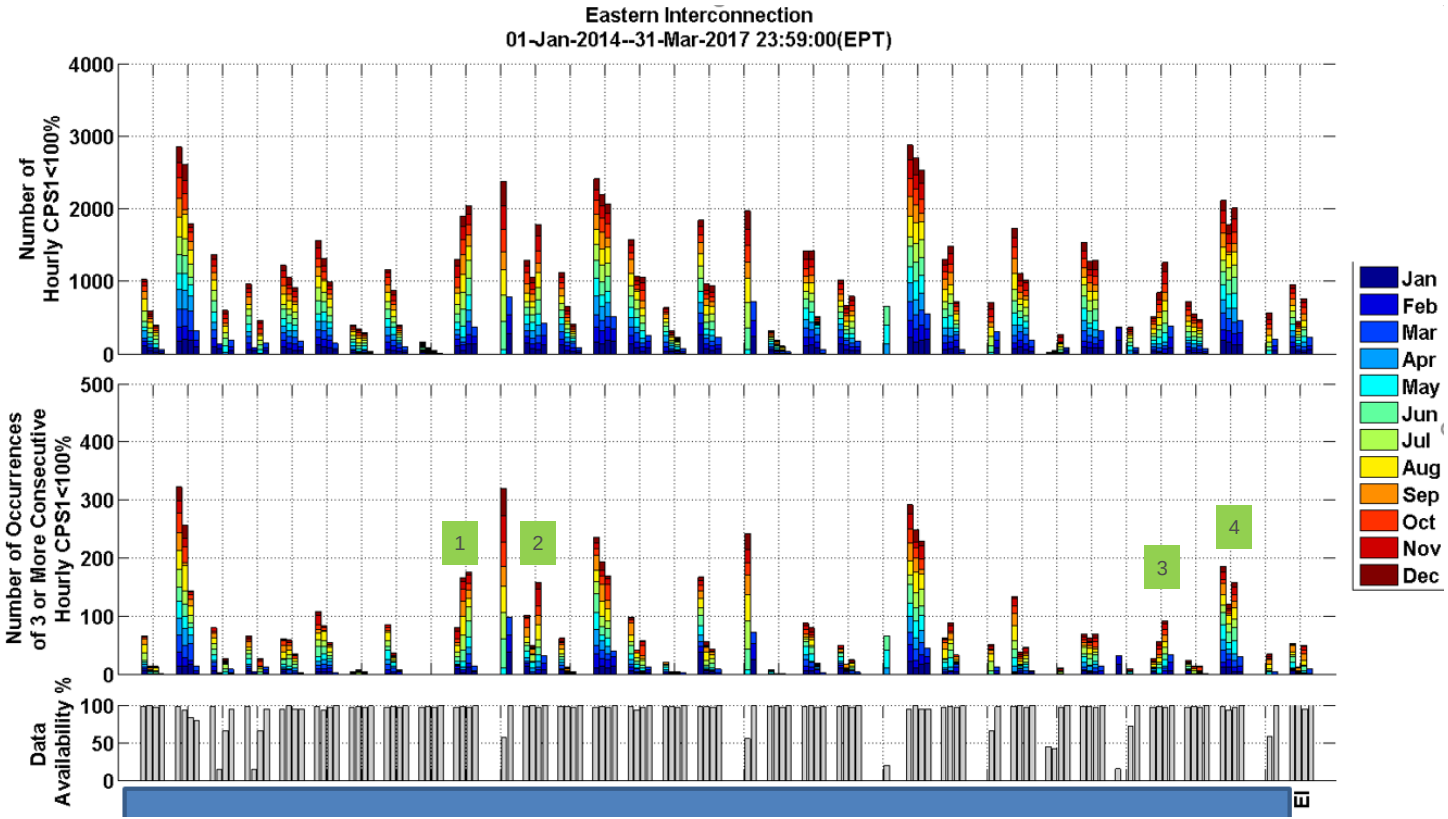
Historical Balancing/Ramping

The ERSWG has developed a historical screening methodology and is finalizing a forward looking screening methodology to assist Balancing Authorities in monitoring for potential balancing issues.

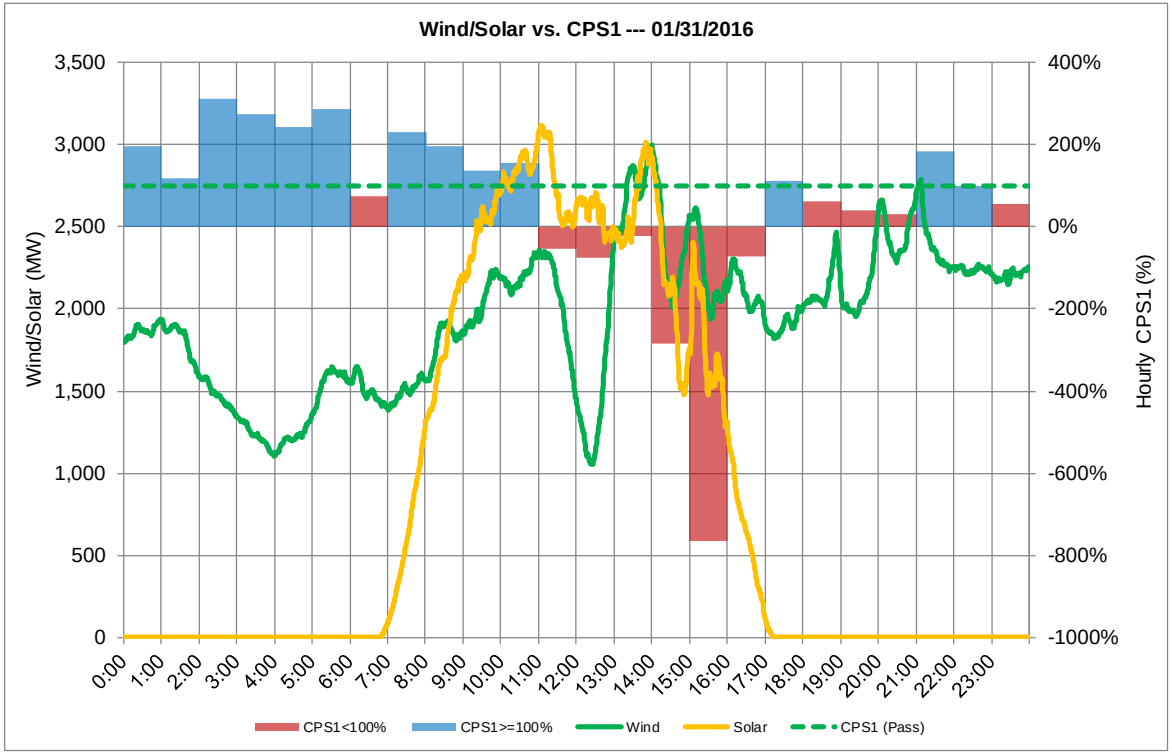
Balancing/Ramping Historical Analysis

- Based on analysis of hourly CPS1 trends for each BA
  - **Not a compliance evaluation**
  - CPS1 analysis method has been vetted by the OC Resources Subcommittee (RS)
  - RS process includes outreach to BA when indicated by the analysis of trends
  - RS is incorporating the rolling review of CPS1 metrics and BA outreach into their ongoing processes
- RS will provide annual input to the PC Performance Analysis Subcommittee for the State of Reliability Report

Evaluate and Outreach



Intra-hour variability and uncertainty can result in inability to control the interconnection frequency/ACE in real-time



CPS1 is evaluated on a rolling 12-month average. Over the past few years, the rolling average has been declining as a result of some poor daily performances. Thus, the BA needs to take measures to improve daily performance on days with higher variability.

Forward-Looking Balancing/Ramping

Current Activities

- Developed a model for prospective identification of potential concerns
  - Finalize a high level screening that is a comparison of non-dispatchable vs dispatchable resources during low load periods
  - Currently incorporating volunteer BAs test results and refining process
  - Process is under review by the PC Reliability Assessment Subcommittee (RAS)

Next Steps

- Data collection administered by the RAS going forward
- Results to be included in future Long-Term Reliability Assessment reports

Additional Information

- 2016 ERS Whitepaper on Sufficiency Guidelines has examples of more detailed analysis methods

Balancing Summary

Frequency can be thought of as the pulse of the grid

ACE is to a BA what frequency is to the Interconnection.

AGC automatically adjusts generation to control the BA's ACE

Regulating Reserves are key during normal operations.

Contingency Reserves are key following a disturbance.

Generator governor controls, AGC, and manual actions are all used to return a Balancing Authority's ACE to pre-disturbance values within **15 minutes**.

Links to Reference Material

- ERS Framework Report
- ERS Sufficiency Guideline Report
- Balancing and Frequency Control


Southern Company

Extra Slides

The equation for Area Control Error (ACE) is:

$$ACE = (NI_A - NI_S) - 10B\,(F_A - F_S) - I_{ME}$$

Where:

NI_A is Actual Net Interchange
NI_S is Scheduled Net Interchange
B is Balancing Authority Bias
F_A is Actual Frequency
F_S is Scheduled Frequency
I_{ME} is Interchange (tie line) Metering Error

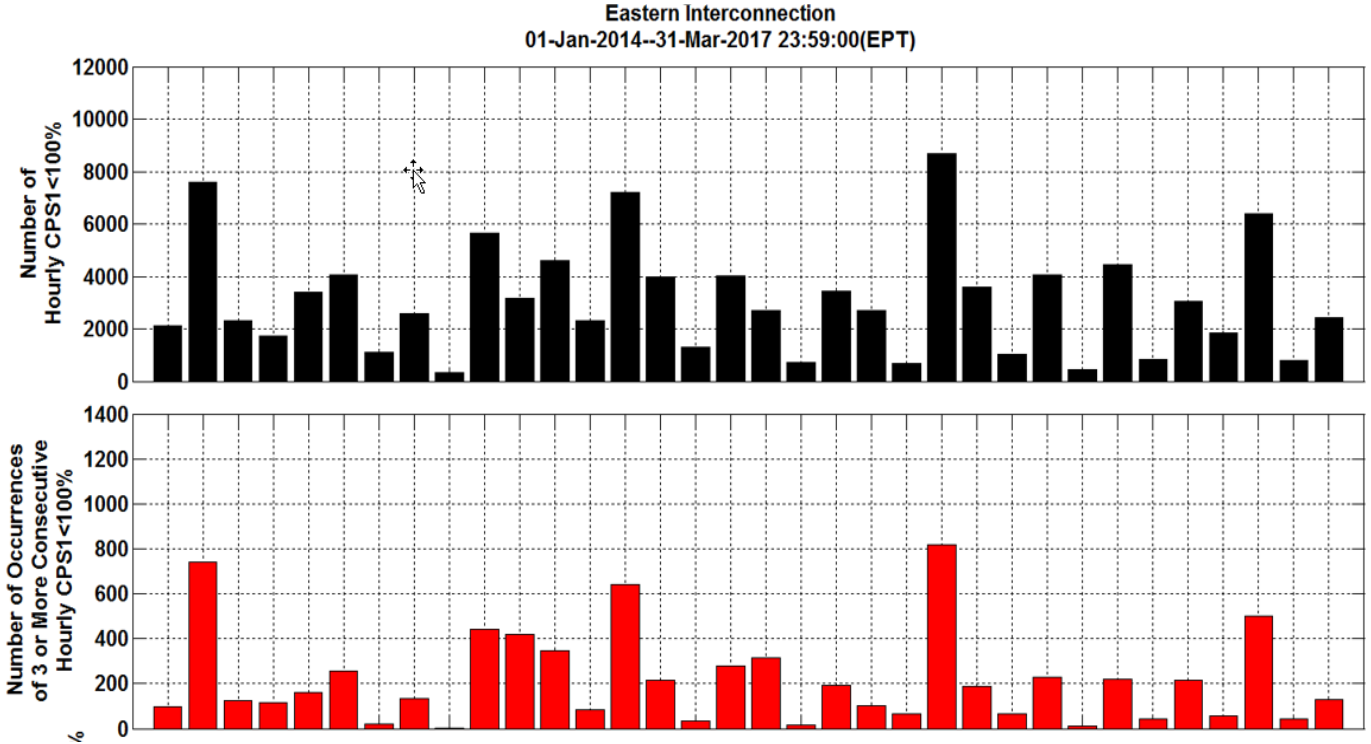
Example

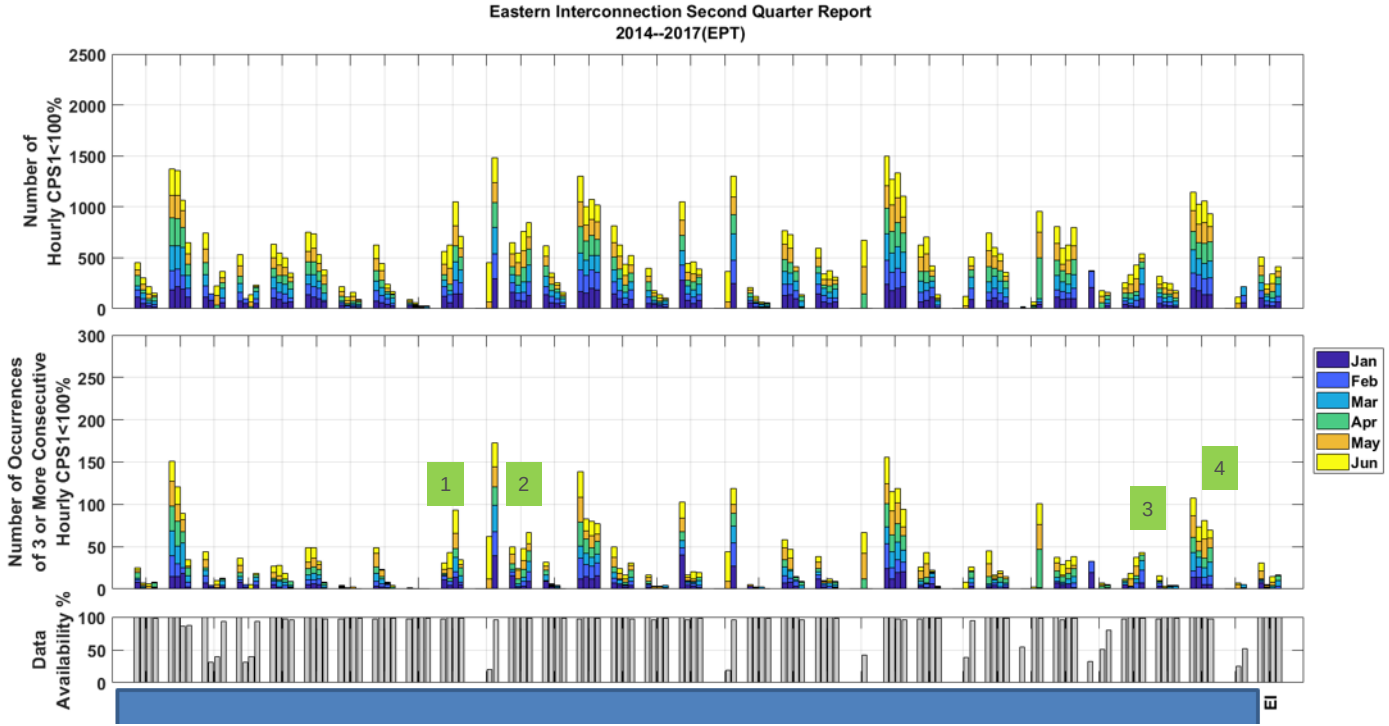
Assume a Balancing Authority with a Bias of -50 MW / 0.1 Hz is purchasing 300 MW. The actual flow into the Balancing Authority is 310 MW. Frequency is 60.01 Hz. Assume no time correction or metering error.

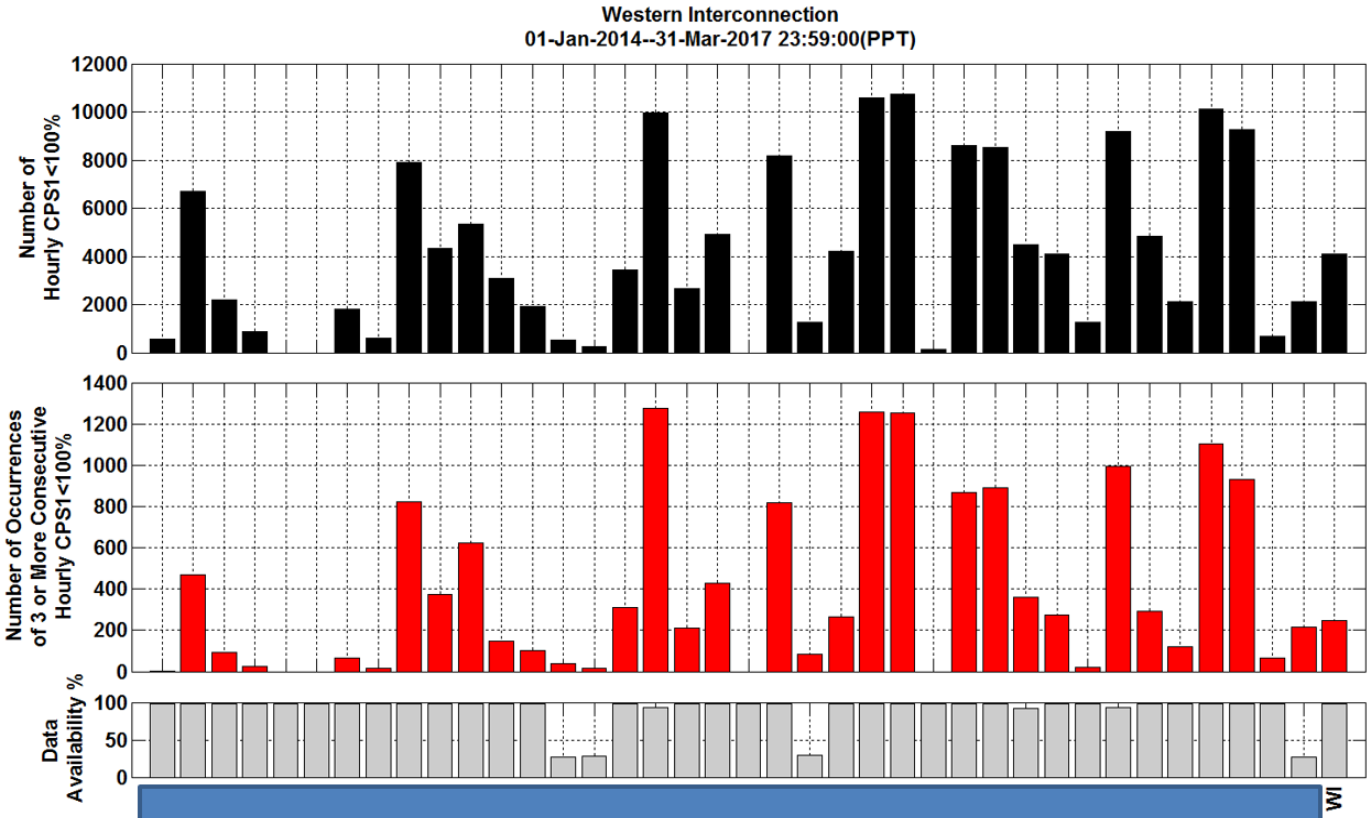
$$ACE = (NI_A - NI_S) - 10B\,(F_A - F_S) - I_{ME}$$

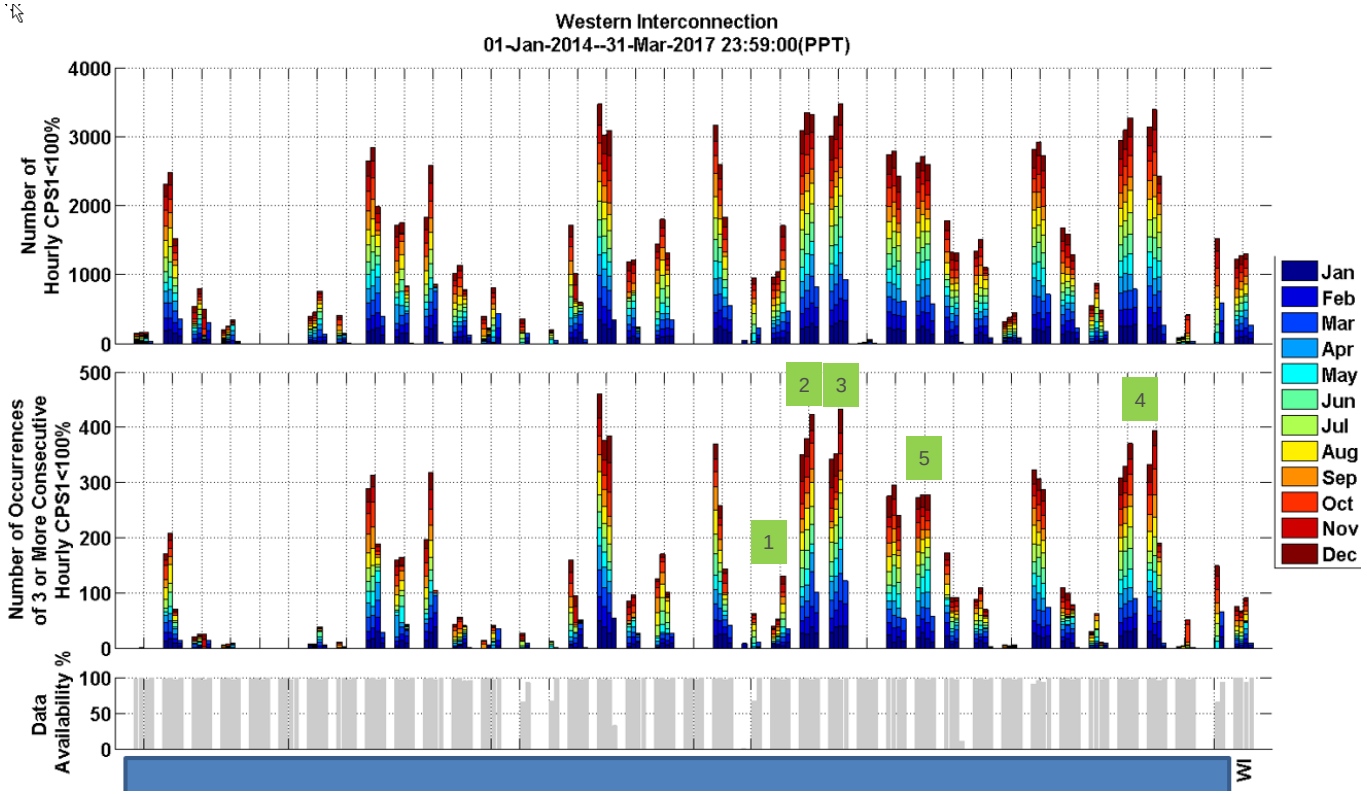
$$ACE = (-310 - (-300)) - 10*(-50)*(60.01 - 60.00) = (-10) - (-5) = -5\ MW$$

The Balancing Authority should be generating 5 MW more to meet its obligation to the Interconnection.


Eastern Interconnection
01-Jan-2014--31-Mar-2017 23:59:00(EPT)
Number of Hourly CPS1<100%
12000
10000
8000
6000
4000
2000
0
Number of Occurrences of 3 or More Consecutive Hourly CPS1<100%
1400
1200
1000
800
600
400
200
0
%


Eastern Interconnection Second Quarter Report
2014--2017(EPT)
Number of Hourly CPS1<100%
Number of Occurrences of 3 or More Consecutive Hourly CPS1<100%
Data Availability %
EI
1
2
3
4
Jan
Feb
Mar
Apr
May
Jun

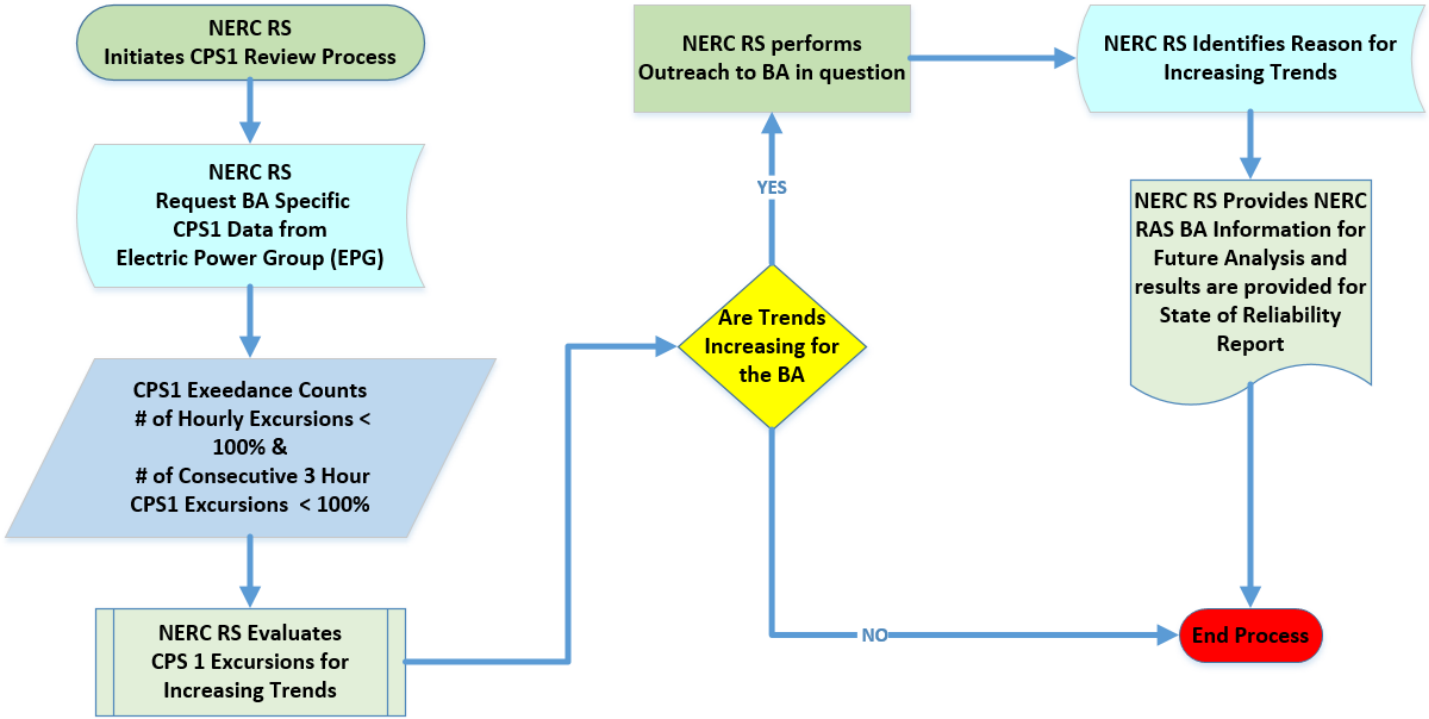

Western Interconnection
01-Jan-2014--31-Mar-2017 23:59:00(PPT)
Number of Hourly CPS1<100%
12000
10000
8000
6000
4000
2000
0
Number of Occurrences of 3 or More Consecutive Hourly CPS1<100%
1400
1200
1000
800
600
400
200
0
Data Availability %
100
50
0
WI


Western Interconnection
01-Jan-2014--31-Mar-2017 23:59:00(PPT)
Number of Hourly CPS1<100%
Number of Occurrences of 3 or More Consecutive Hourly CPS1<100%
Data Availability %
WI
1
2
3
4
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

WESTERN INTERCONNECTION

1/1/2014-3/31/2017

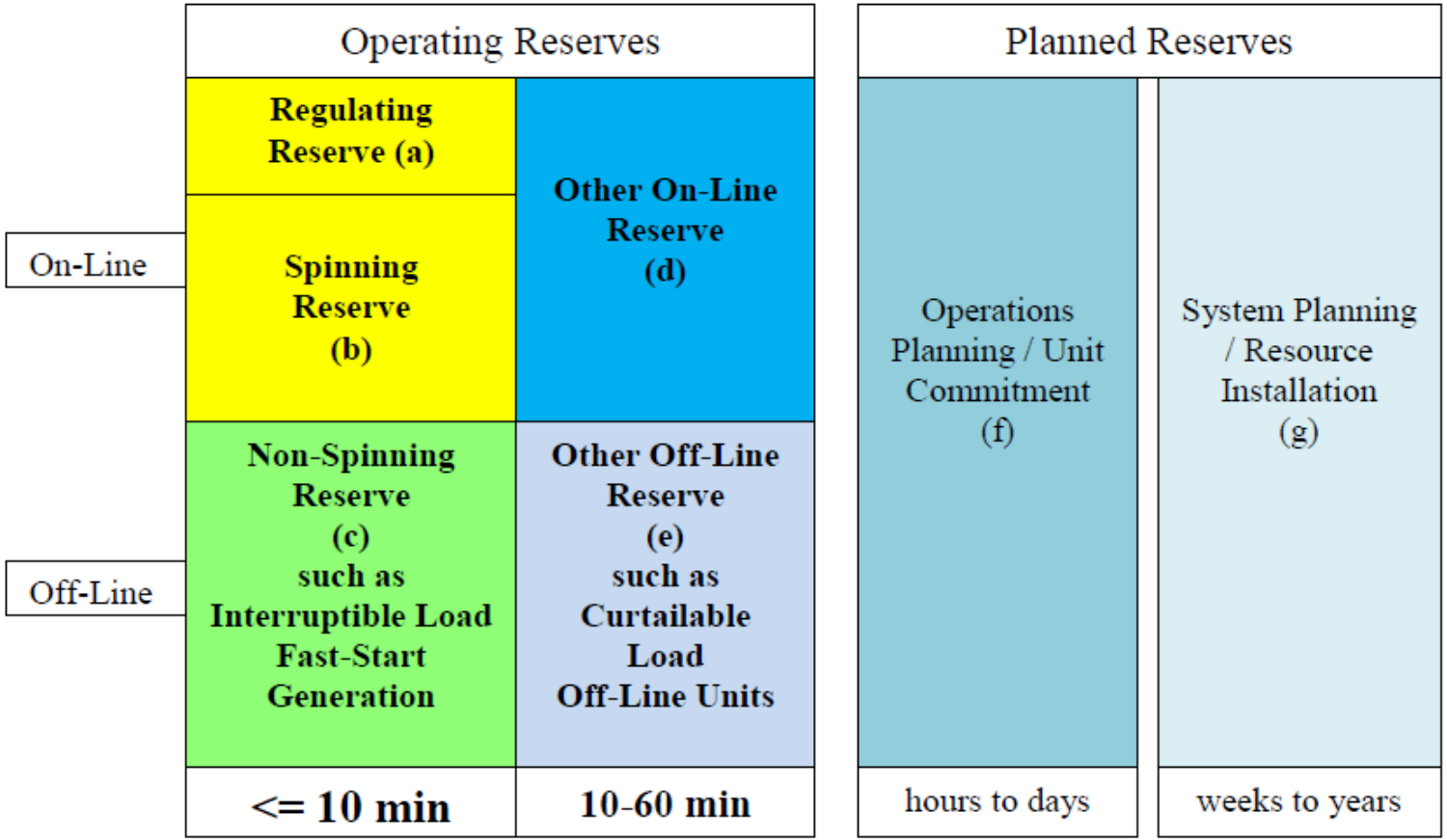
Historical Measure 6 - CPS 1 Metric Evaluation Process Flow



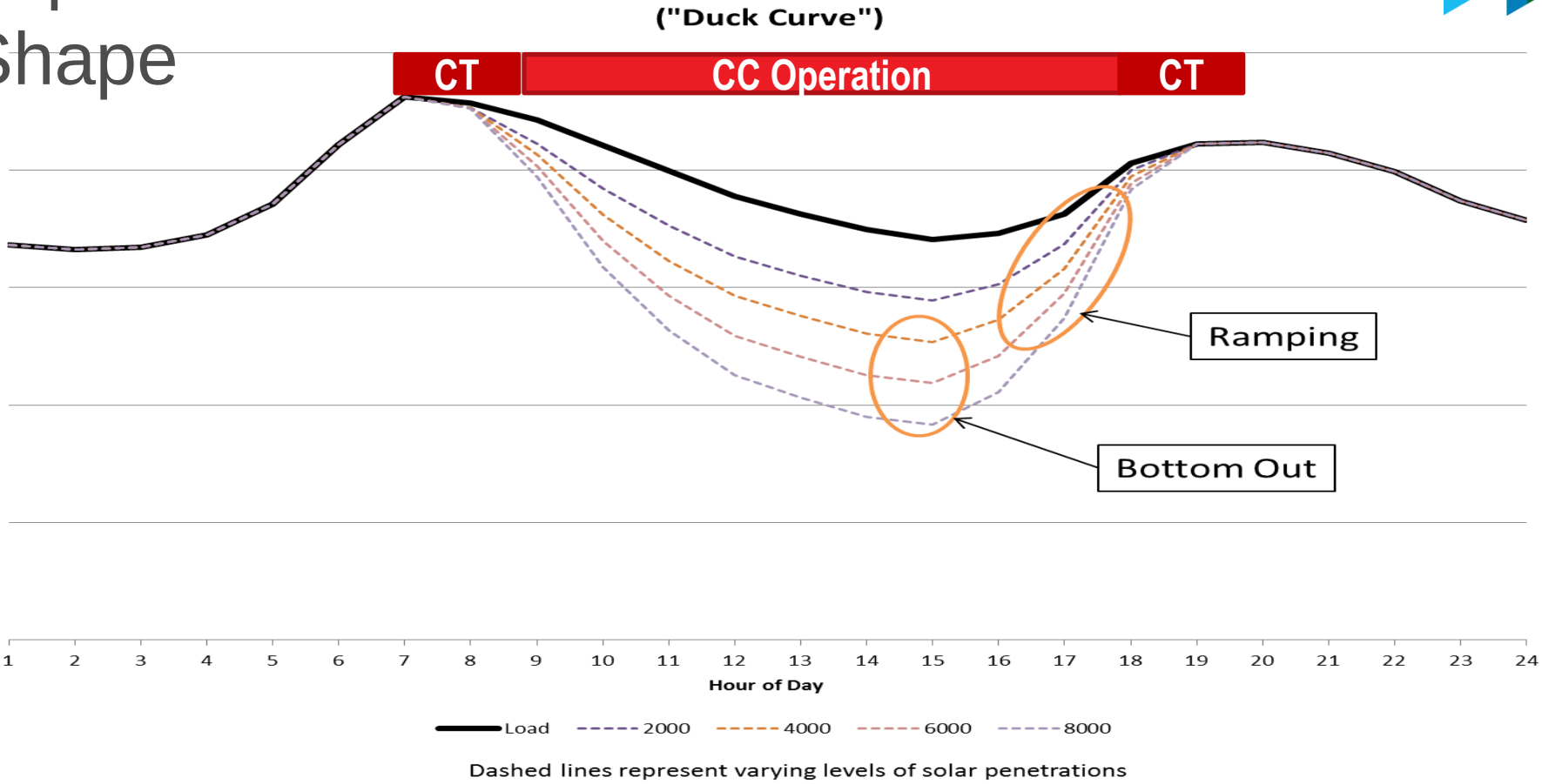
Regulating Reserves

- An amount of reserve, responsive to Automatic Generation Control, which is sufficient to provide normal regulating margin.

Reserves Continuum



Impacts of Solar Penetration on Winter Load Shape



Opportunities

Changing resource mix

- Impacts to basic elements of Bulk Electric System reliability
  - Frequency Response
  - Voltage Response
  - Load/Resource Balancing and Ramping
- Impacts of distribution connected resources on the reliability of the Bulk Electric System
  - Visibility?
  - Controllability?
- NERC is developing recommendations and measures to assess the impacts of the evolving resource mix on an industry wide basis.