CAISO Impact Analysis – August 21, 2017 Solar Eclipse

Rebecca Webb
Power Systems Forecaster Specialist

UVIG Forecasting Workshop

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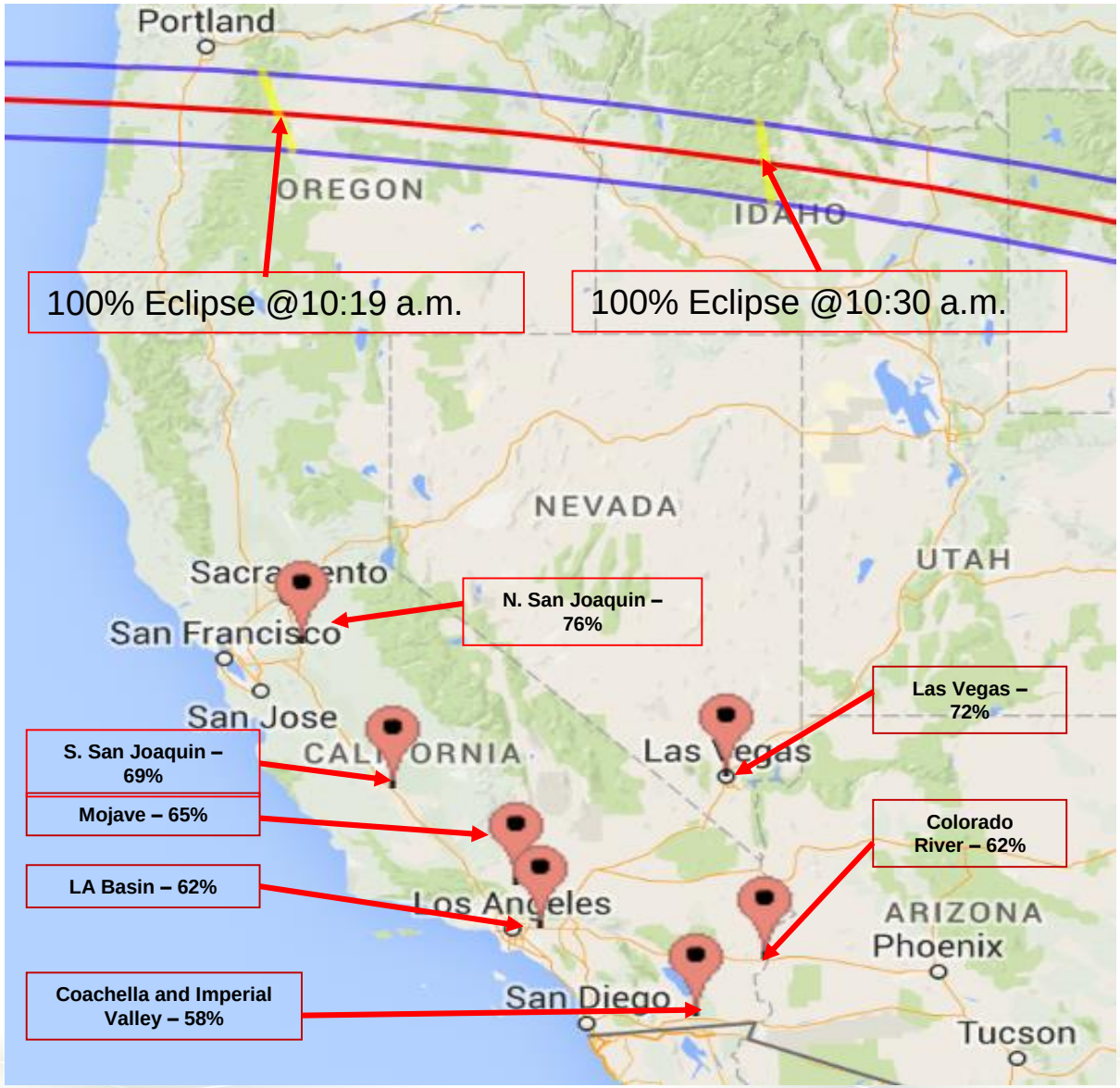
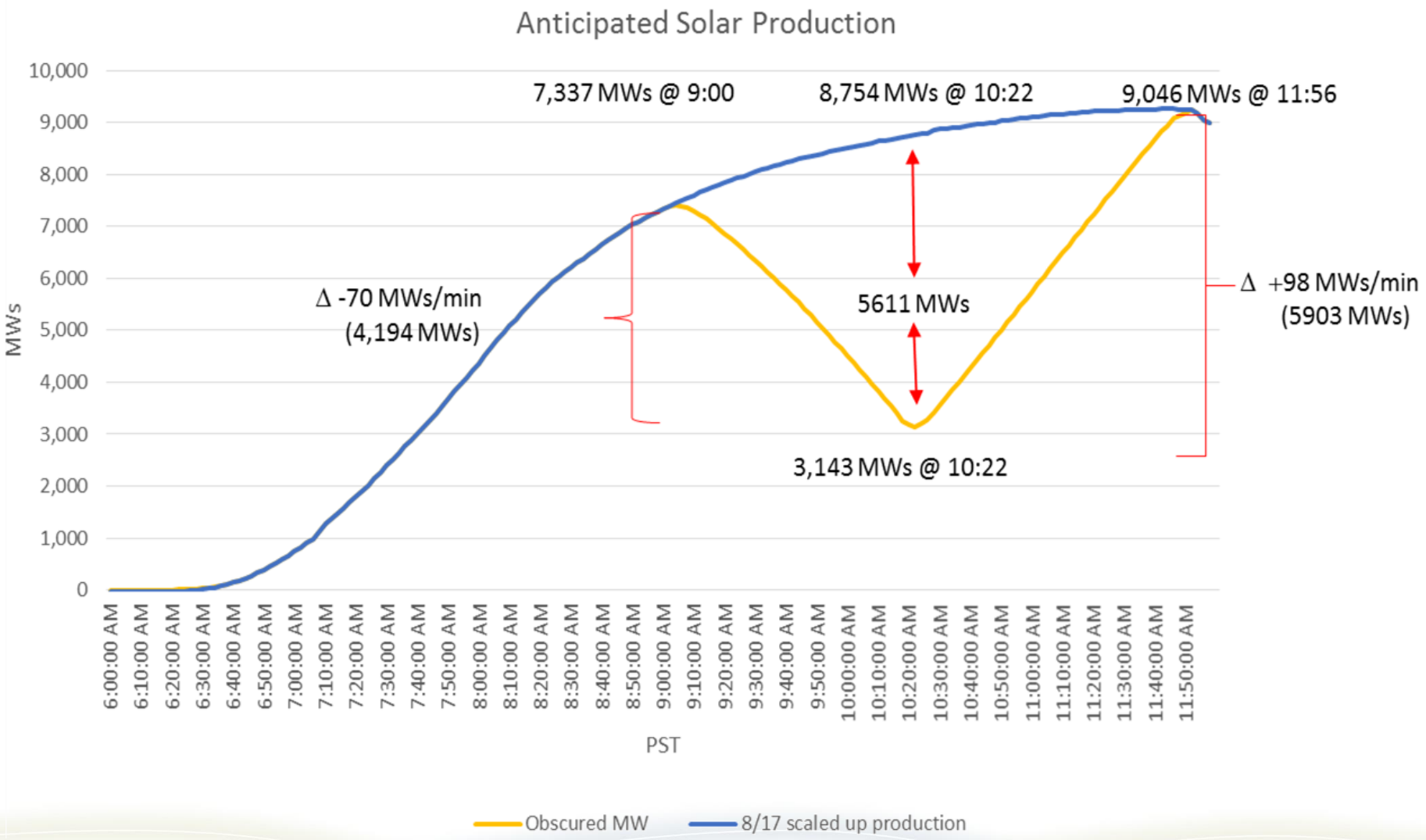
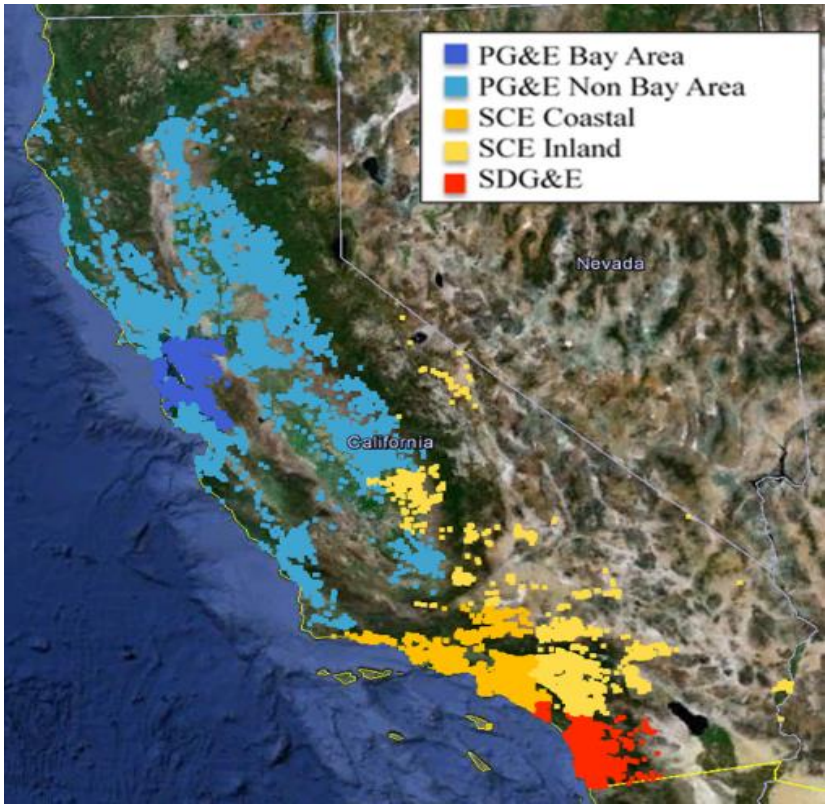
Effect on the ISO balancing area

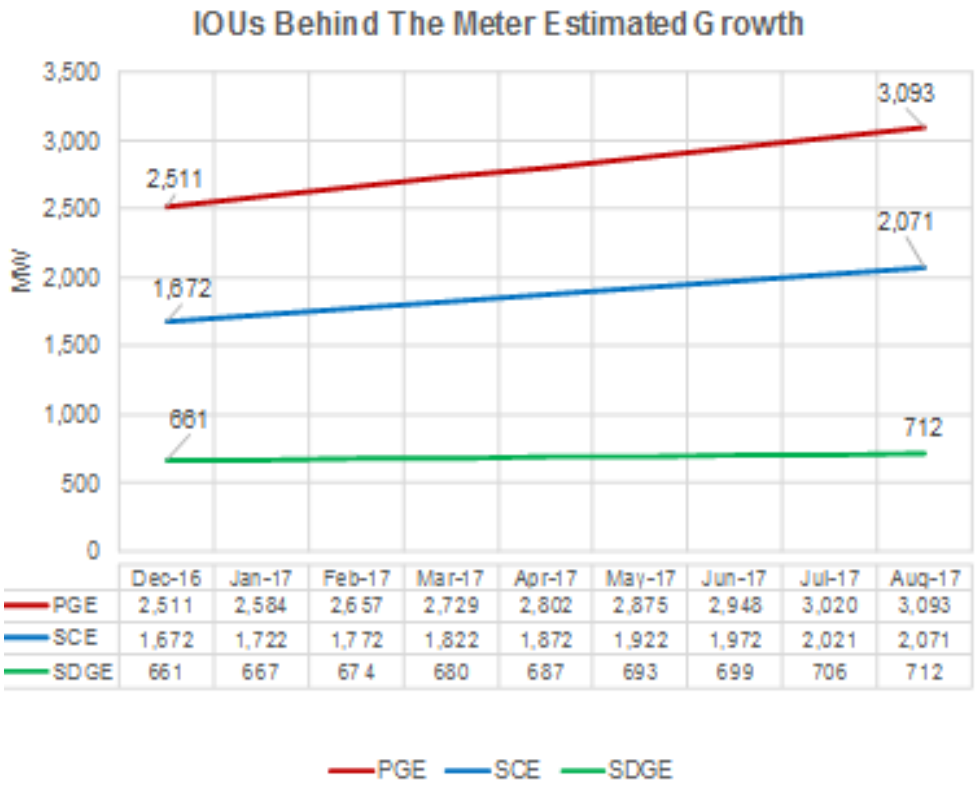


Potential MW impact on grid connected solar



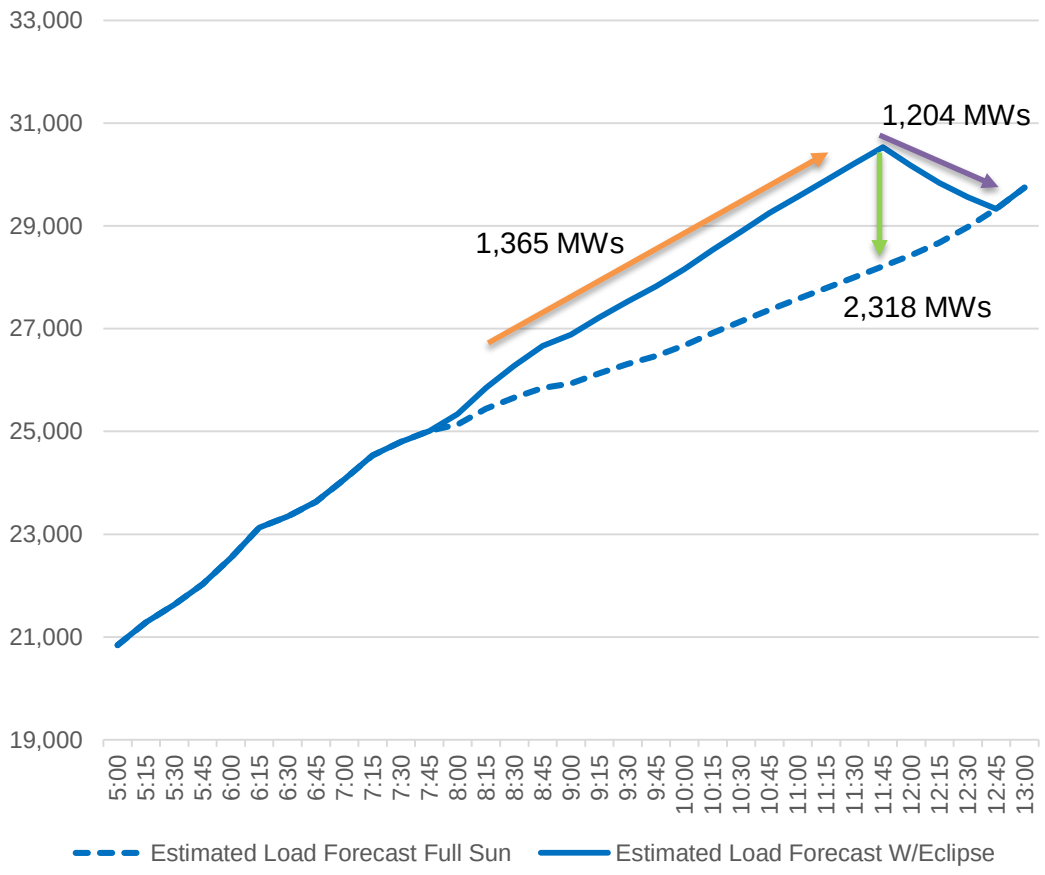
Expected capacities of behind-the-meter solar





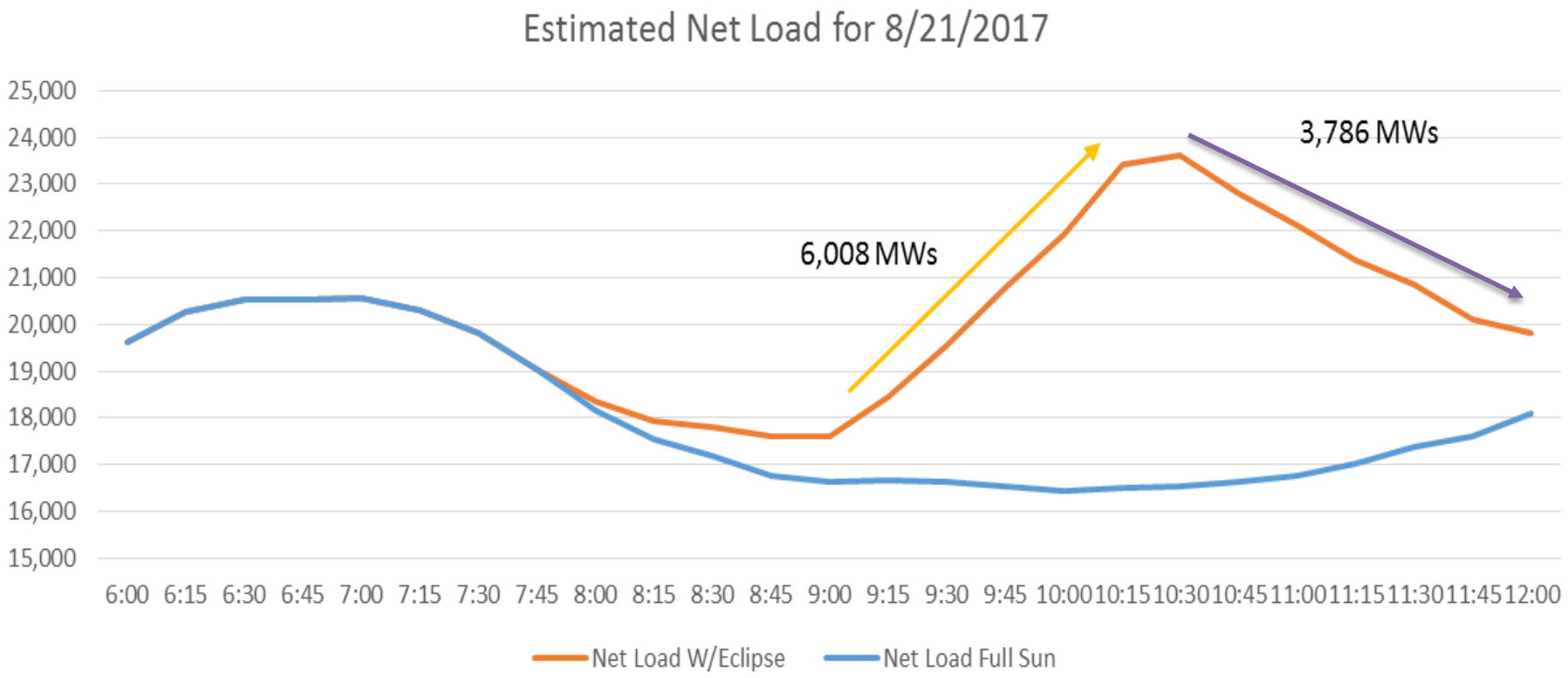
	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17
PGE	2,511	2,584	2,657	2,729	2,802	2,875	2,948	3,020	3,093
SCE	1,672	1,722	1,772	1,822	1,872	1,922	1,972	2,021	2,071
SDGE	661	667	674	680	687	693	699	706	712

Potential impact of behind-the-meter on ISO load



Time (HB)	MW Change	% Load Increase
9:00	953	4%
9:15	1085	4%
9:30	1218	5%
9:45	1350	5%
10:00	1483	6%
10:15	1616	6%
10:30	1748	6%
10:45	1881	7%
11:00	1990	7%
11:15	2100	8%
11:30	2209	8%
11:45	2318	8%
12:00	1739	6%
12:15	1159	4%
12:30	580	2%

Potential impact on net load



Solar eclipse summary

- Large scale solar reduction:
  - Estimated to be 4,194 MW's
- Gross load increase
  - Estimated to be 1,365 MW's
  - Note this based off clear sky, no marine layer
- Net load effect
  - Estimated to be an increase of 6,008 MW's
  - Note this accounts for estimated wind production
- Ramp rate
  - Typical average ramp rate is around 29 MW/Min
  - Ramp rate during eclipse will be approximately 90 MW/Min on the return and 70 MW/Min on the drop off

Expected impact on EIM entities

Entity	Distribution MWs	Grid Connected MWs
APS	569	506
NVE	169	350
PAC		900
PSE		0.5
Total	738	1,757

Lessons learned from Europe

- Transmission System Operators
  - Higher reserves
  - Committed to zero Area Control Error
  - Strategic use of pump storage
  - Limited generation planned outages
  - Reduced high voltage direct current line capacities between the Nordic, United Kingdom and Continental Europe.
  - Activated emergency telecommunications, with back up
  - Specialized training for operators.
  - Raised awareness with market players and distribution system operators.
- Germany
  - Procured 2 times normal regulations
  - Germany established special operational concepts for reserves
- Italy
  - Reduce northern net transfer capability
  - Reduced day ahead PV production from 7 a.m. to 2 p.m.

Market mechanisms and processes used during the solar eclipse

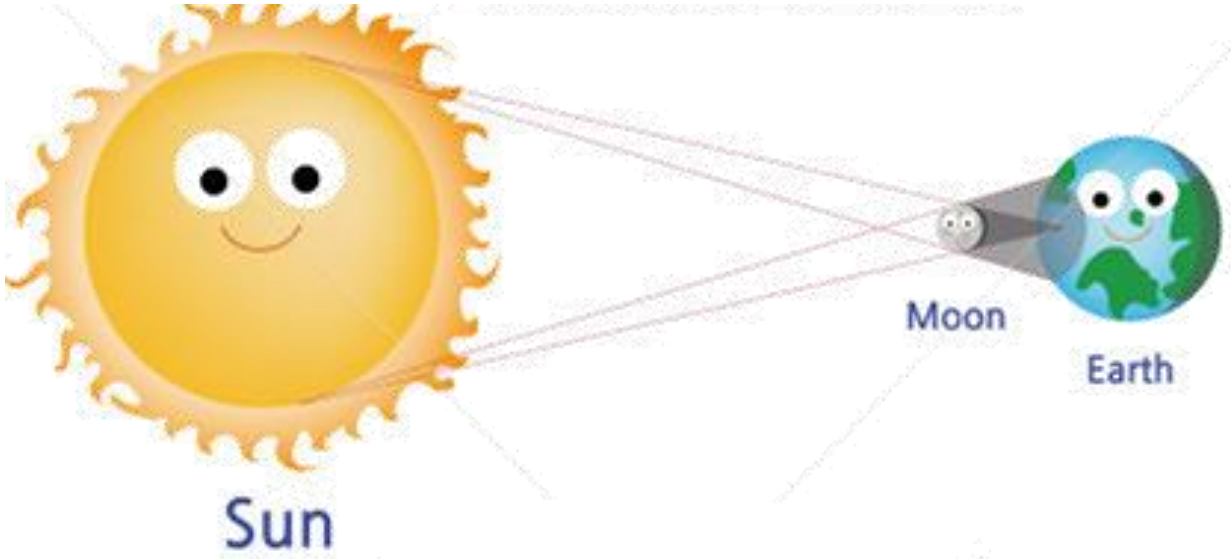
• Reserves procurement	• Gas supply needs
• Flex-ramp usage	• SC interaction
• Special operating procedures	• WECC/Peak RC coordination
• Use of EIM transfer capability	• Hydro generation
• Internal market simulation	• Flex alerts*
• Market participant coordination	• Pre-curtailment of renewables*
• Ramp rate limitations on return of renewables*	• Virtual bid behavior suspension*
• Manual operator intervention*	• Day +2 conference bridge

Our Forecast Service Providers will be **producing a forecast accounting for the solar eclipse** that will automatically feed through the ISOs daily processes. The aggregate forecast for large scale solar will be available to the market participants, as well as public, through the OASIS applications.

* = Potential processes that may be used

Timeline

- September – Dec 2016 (Completed)
  - Announced eclipse study at the September 2016 Market Performance and Planning Forum and requested input
  - Stakeholder web conference October 2016
  - Circulate with scheduling coordinators for comment
  - Comments due Nov 3rd 2016
  - Start roof top solar effects on load study
- January – June 2017 (In Progress)
  - Develop Solar Eclipse Procedure
  - Publish procedure
  - Present procedure at the May Board of Governors meeting
  - Present final procedure at the July Market Performance Planning Forum
  - Following Event; review Solar Eclipse and identify lessons learned



Thank you.