SunShot U.S. Department of Energy

NREL Transforming ENERGY

Impact of Solar Eclipse 2017 on Grid Operations Panel Session: Impact of Climatic Events on the Operation and Planning

19PESGM3399

Dr. Santosh Veda (Santosh.Veda@nrel.gov)
Group Manager, Grid Automation & Control
National Renewable Energy Laboratory (NREL)

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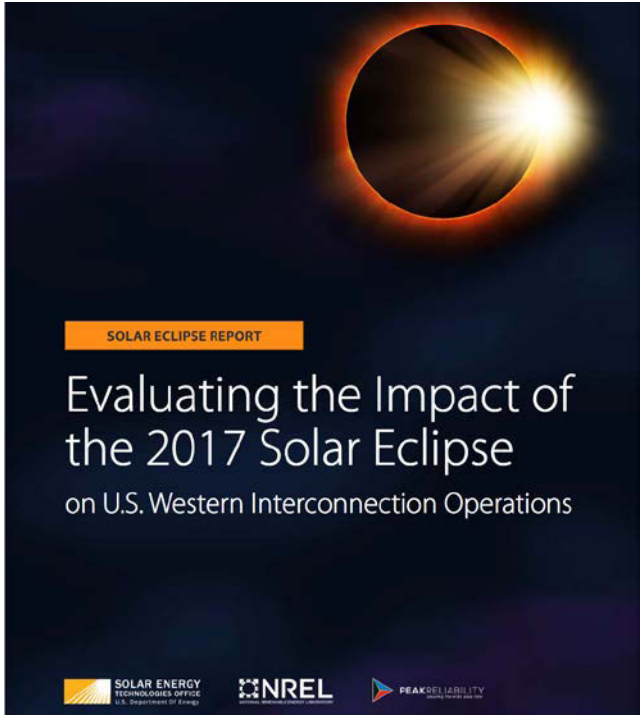
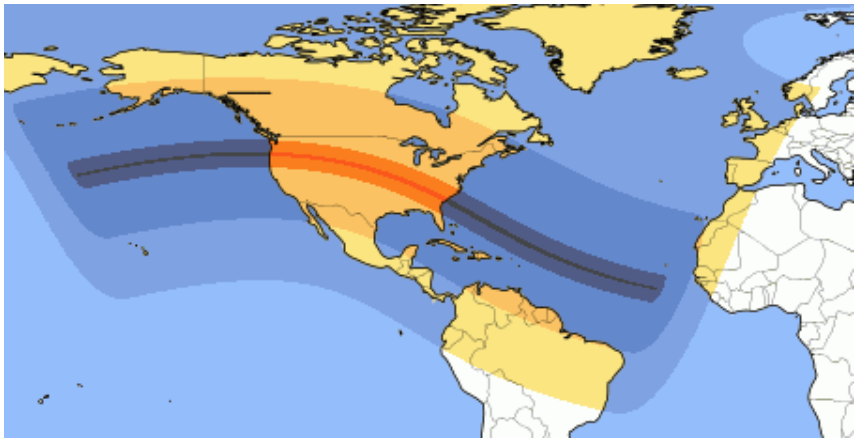
Outline

- Background
- Extreme Event Analysis Framework
- Pre-Event Analysis
- Post-Event Analysis
- Path Forward

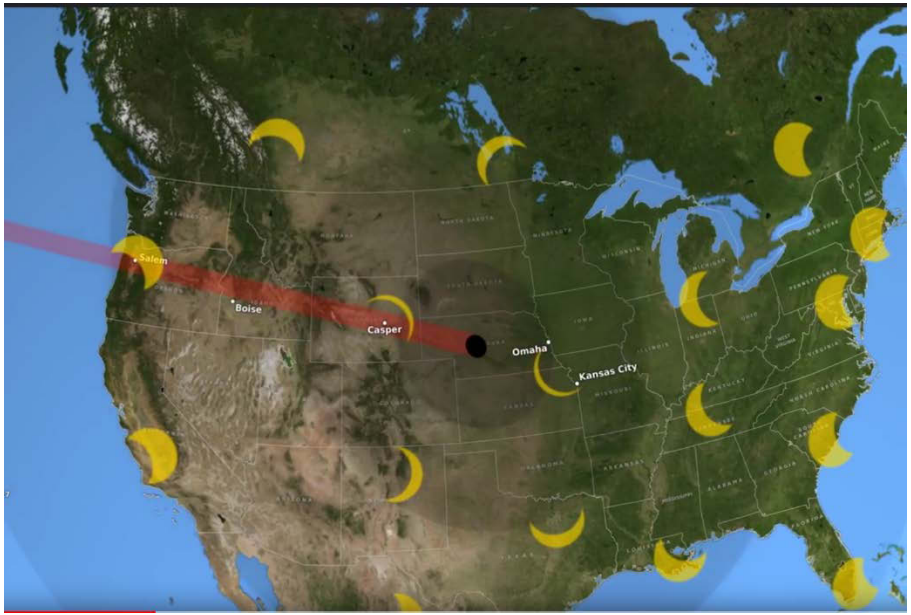


Project Objectives

- Learn from the past grid operational experience to prepare for the solar eclipse event on Aug 21, 2017
- Develop tools to investigate the impact on solar eclipse on grid operations
- Disseminate the lessons to industry stakeholders and public
- Extend the framework to perform extreme event analysis



Background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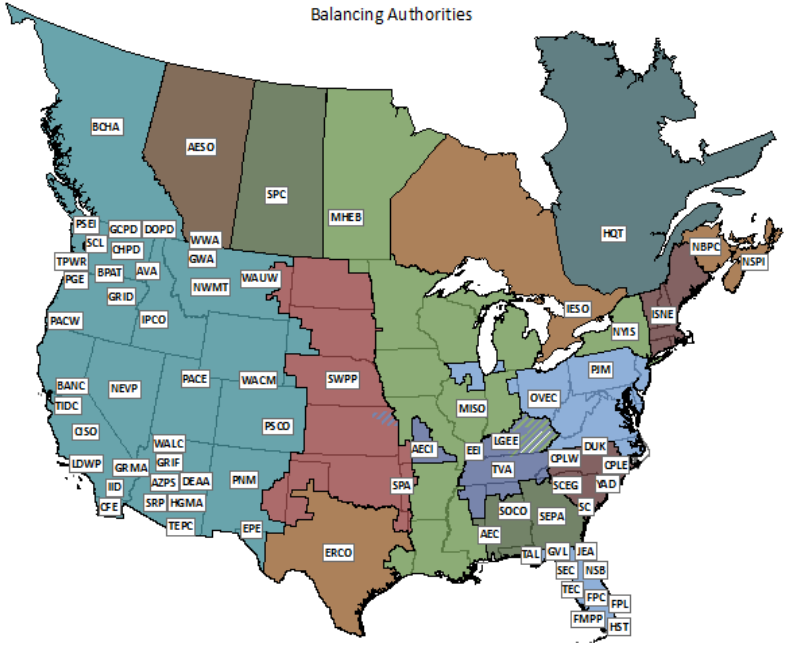
Boise
Casper
Omaha
Kansas City


Balancing Authorities
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AESO
SPC
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HQT
NBPC
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DOPD
SCL
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WWA
GWA
TPWR
PGE
BPAT
AVA
NWMT
WAUW
GRID
IESO
ISNE
NYIS
PACW
IPCO
PJM
BANC
NEVP
PACE
WACM
SWPP
OVEC
TIDC
MISO
CISO
PSCO
WALC
AECI
EEI
LGEE
DUK
CPLW
CPLE
LDWP
GRMA
GRIF
TVA
AZPS
DEAA
PNM
SPA
SCEG
YAD
IID
SRP
HGMA
SC
CFE
SOCO
SEPA
TEPC
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FPL
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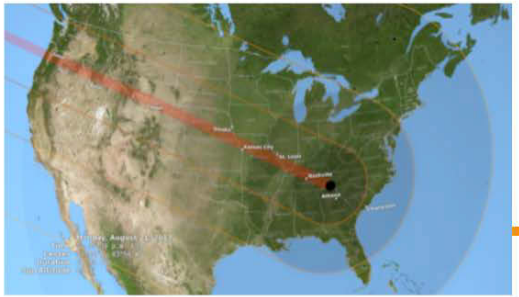
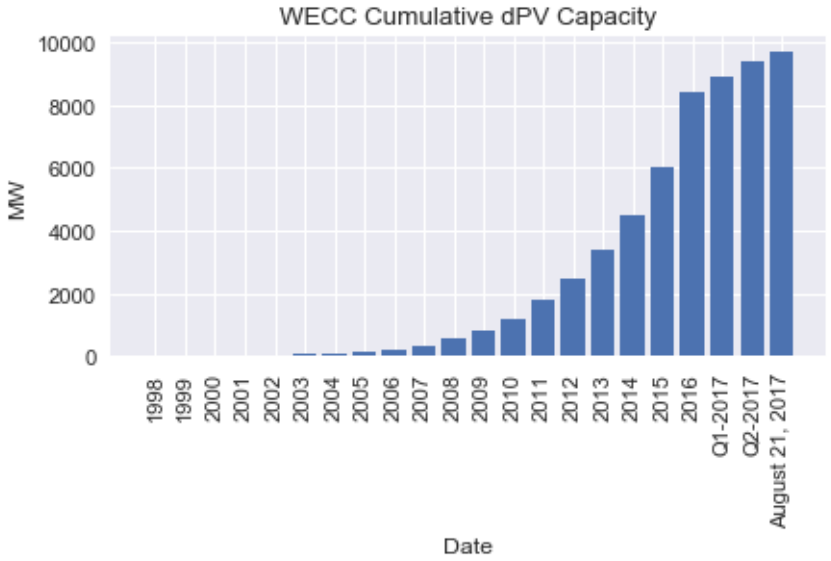
Extreme Event Analysis Framework



Estimating PV capacity

- Estimated the capacity and location of utility and distributed PV sites
  - Distributed Photovoltaic is derived from the Lawrence Berkeley National Laboratory (LBNL)'s Tracking the Sun (TTS) report



Distributed PV Capacity in WECC

Utility Area	Estimated Distributed PV Capacity (MW)	Utility Area	Estimated Distributed PV Capacity (MW)
APS	2160	PACE	57
BPA	109	PG&E	1513
El Paso	261	PSCO	101
IID	201	SCE	2016
IPCO	453	SDGE	522
LADWP	1077	Sierra	97
NM	449	WAPA	81
NVP	169		

9.2GW Distributed PV across WECC

Estimating Impact on PV

- Insolation profiles for a prototypical August 21 were calculated at each generator location using SAMPA
- Weather data was supplied from NSRDB TMY (NSRDB) and supplemented with atmospheric data from MODIS (NASA)
- SAM v2016.08.01 with PVWatts v5 was used to calculate generation profiles for each characteristic uPV and dPV system at each generator location
- Profile for both eclipse and non-eclipse days were generated using the SAMPA-derived insolation profiles

Impact on PV output

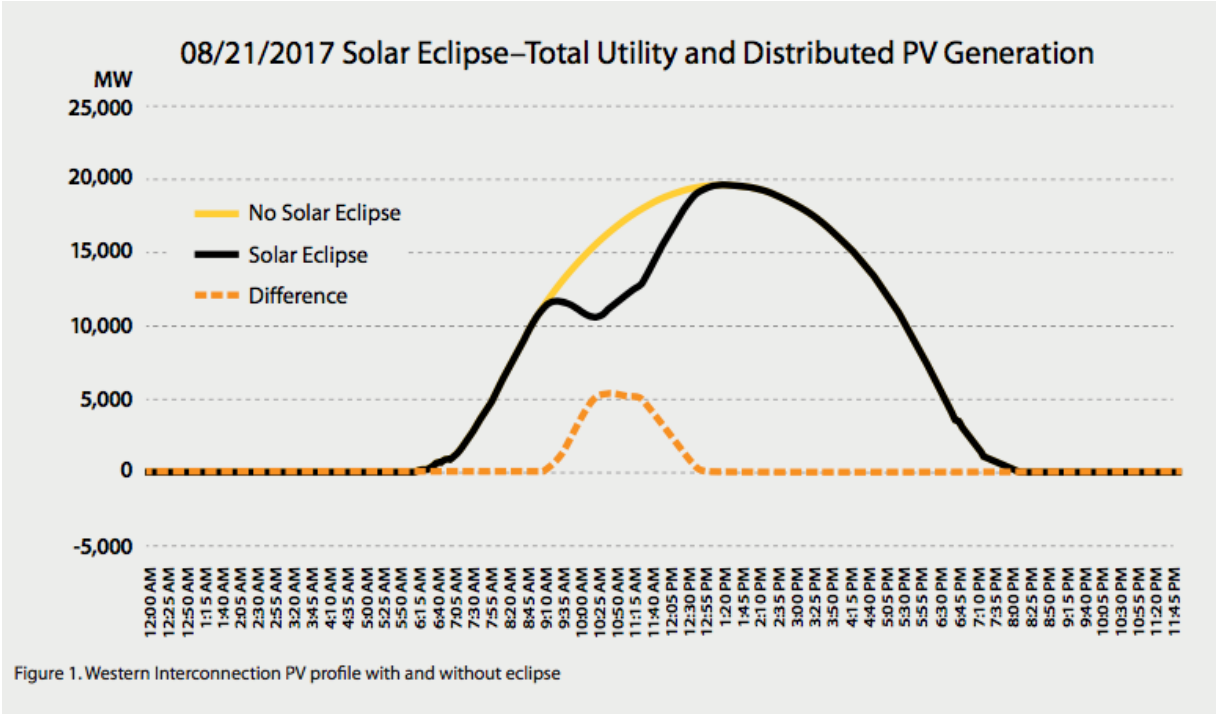
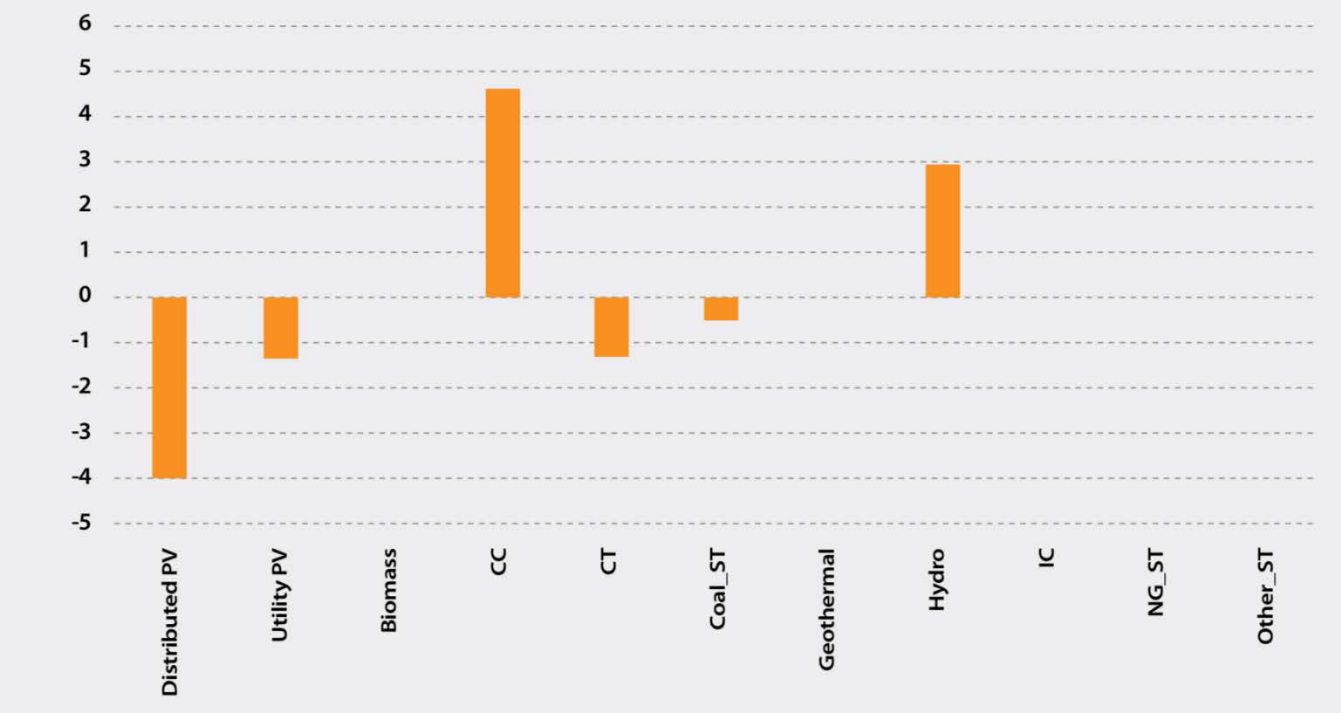


Figure 1. Western Interconnection PV profile with and without eclipse

Production Cost Simulation

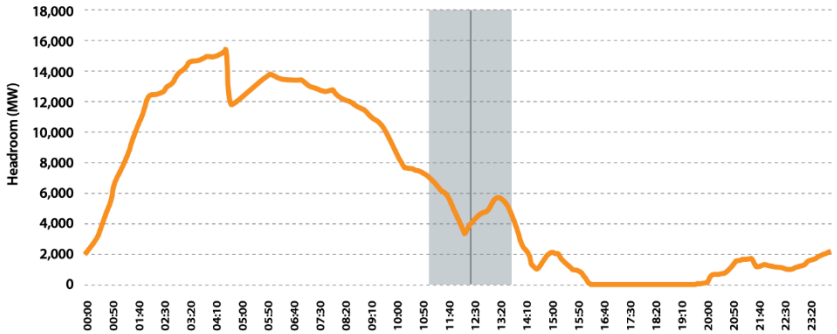
- Performed production simulation using PLEXOS
  - First scenario - standard operation model
  - Second scenario standard operation model but with the solar eclipse limiting the output of solar generators, both distributed and utility scale solar generation

Change in Energy Production

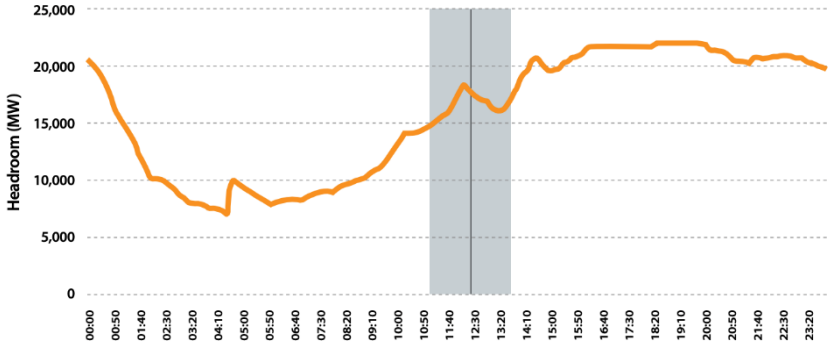


Available Flexibility for NG fleet

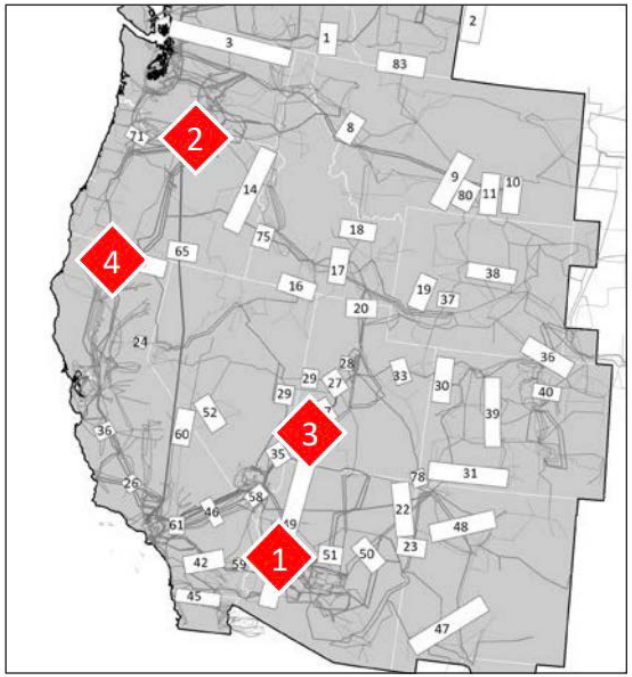
Aggregate Headroom



Aggregate Footroom



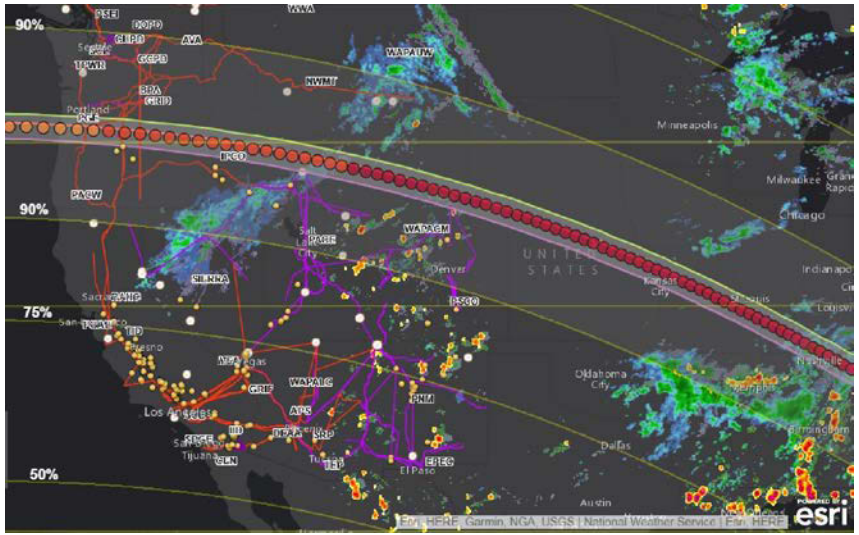
Transient Simulation Studies



1. Loss of Palo Verde generators
2. Loss of Pacific DC Intertie (PDCI)
3. Loss of Intermountain HVDC line
4. Loss of one of the lines along the California-Oregon, Intertie

Preparing for grid operations

- Coordinate operating plans across BAs
- Multiple planning studies with ongoing and scheduled outages
- Monitor the system as usual and will request tighter control as system conditions dictate

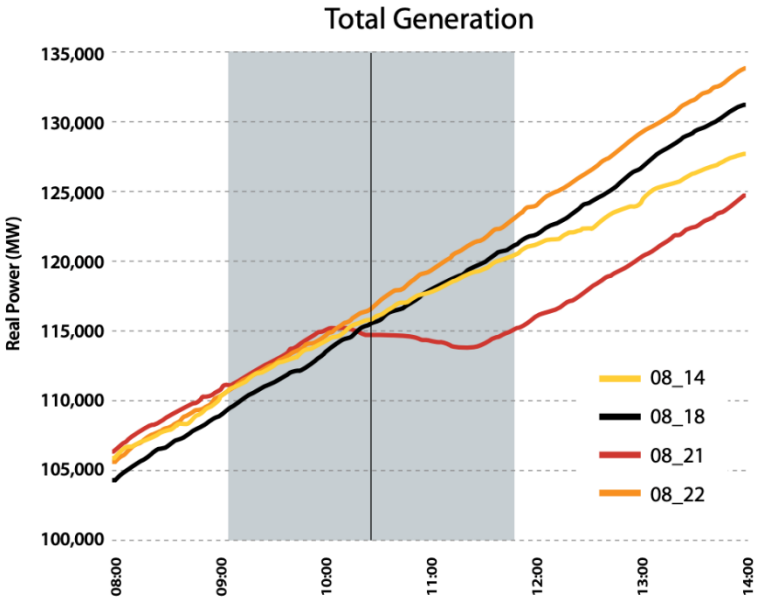


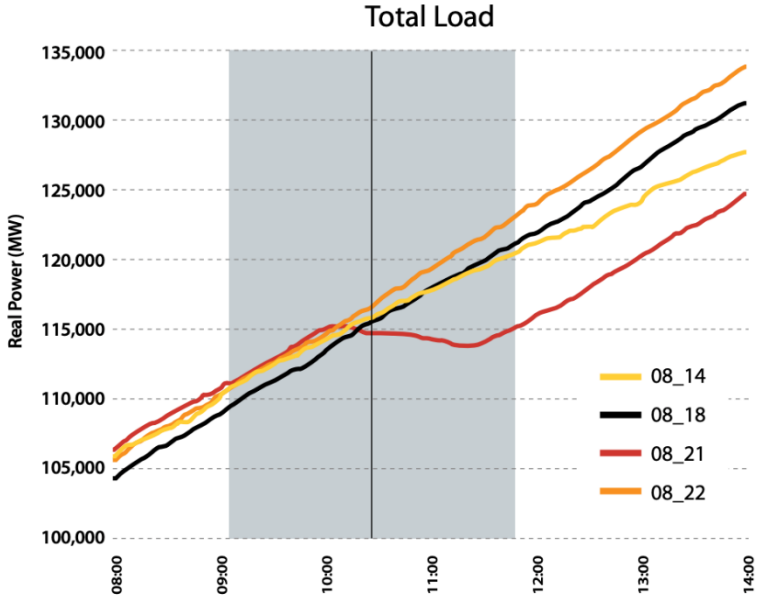
Post-Event Analysis

Eclipse Day Data

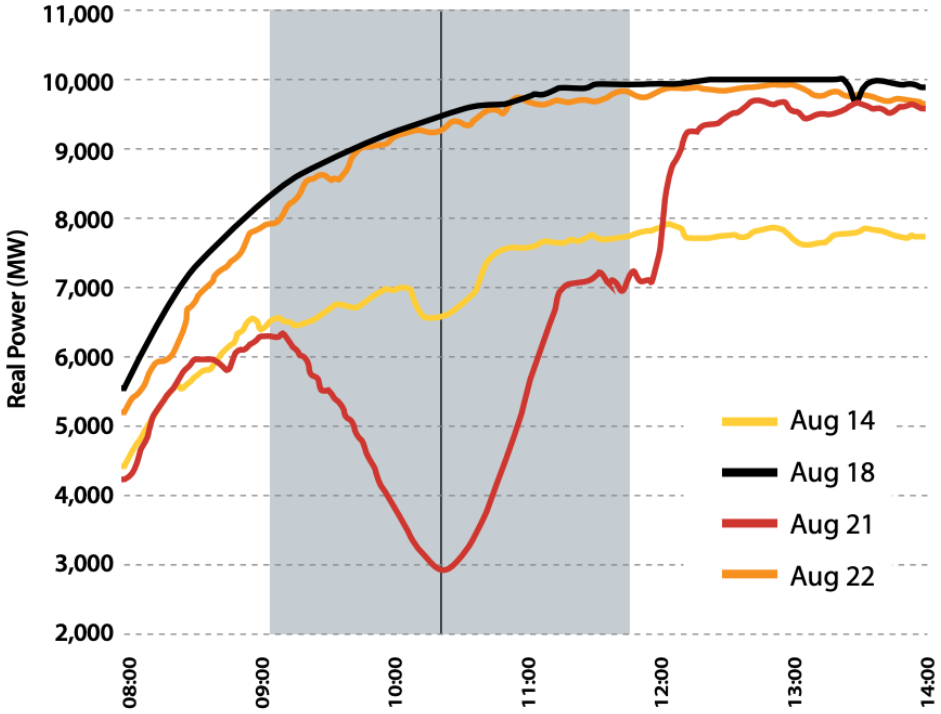
- Peak Reliability collected high resolution data from across the footprint
  - Real-time Measurements
  - EMS-solved cases
- Selected Four Representative Days – Aug 14, Aug 18, **Aug 21**, Aug 22

System-wide Load and Generation

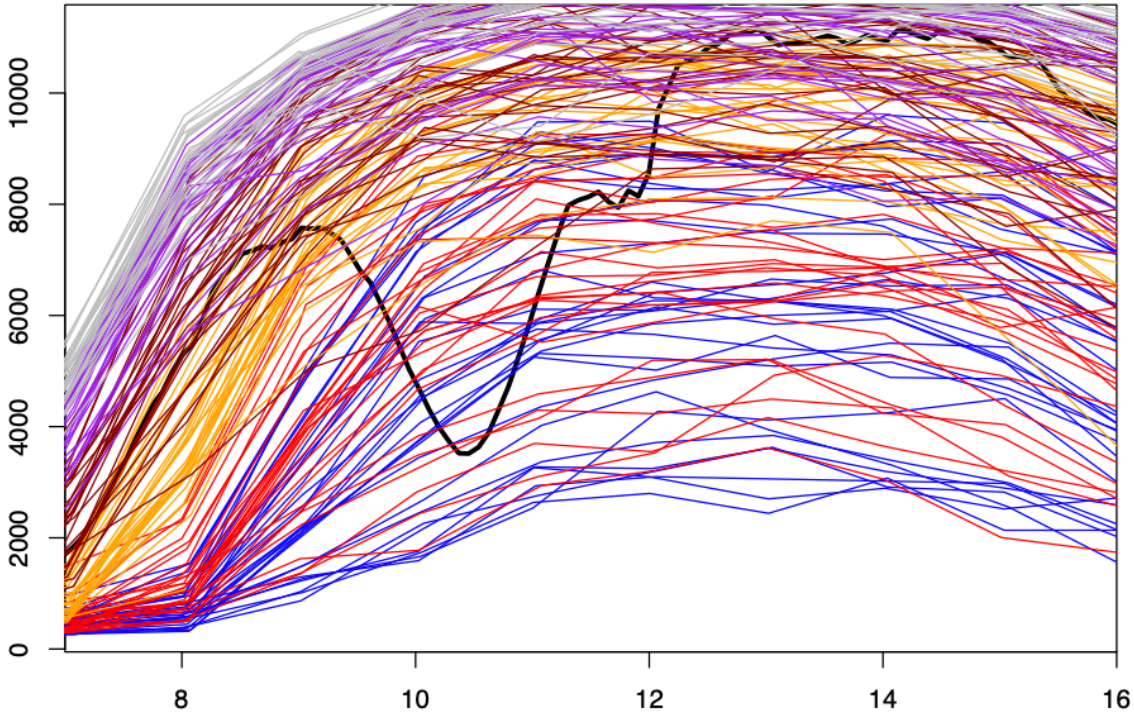




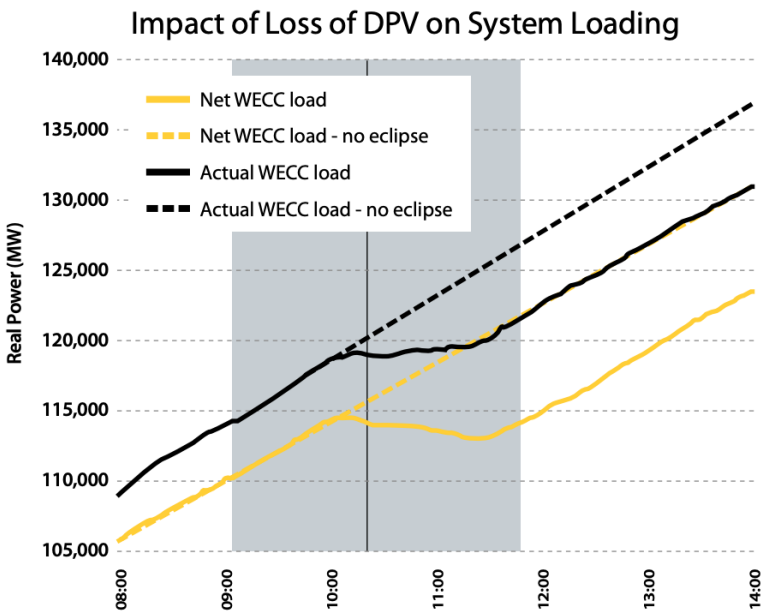
Utility PV Generation

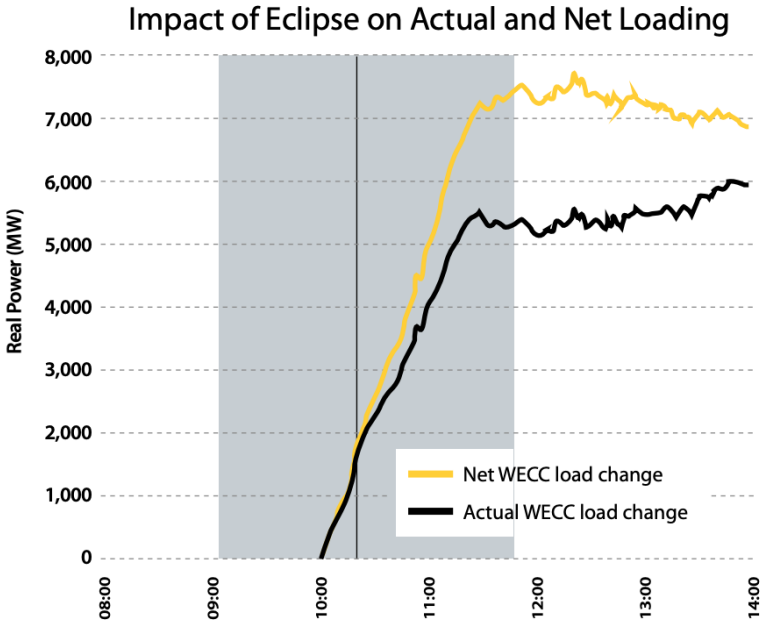


Normalized Annual PV Output

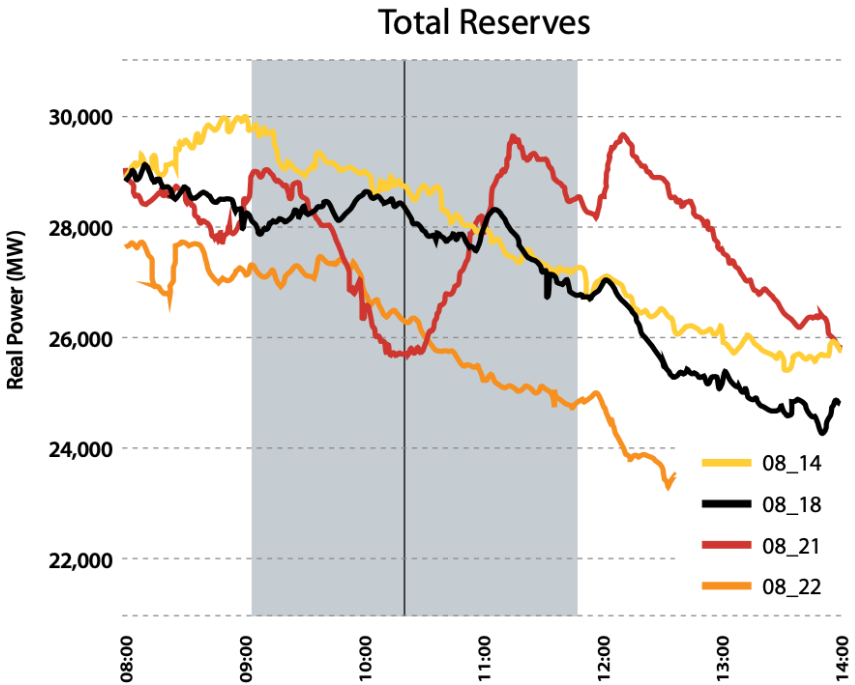


Impact on System Loading



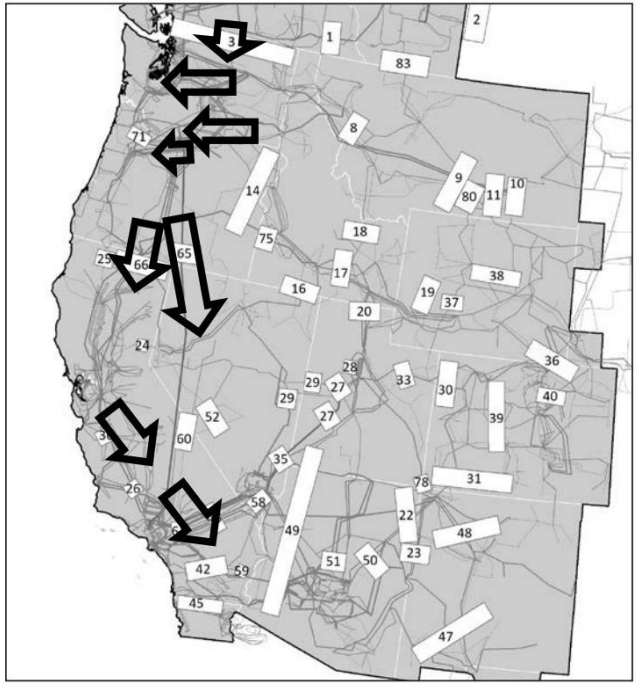


Impact on System Reserves

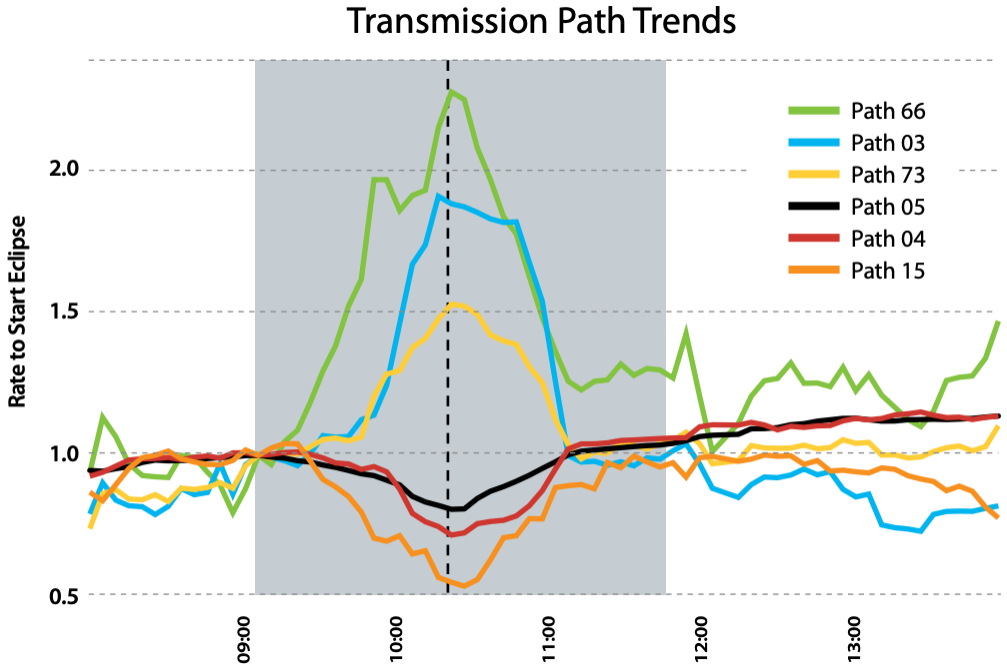


Impact on Transmission Paths

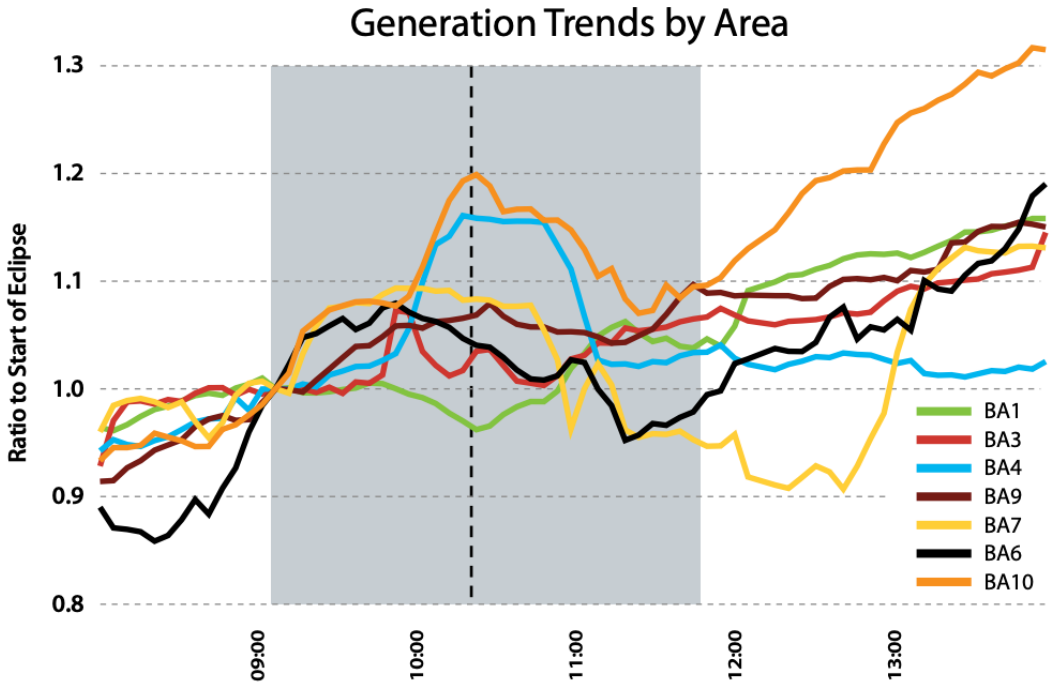
Path #	Path Name	Path Rating Transfer Limit (MW)		Primary Direction (Positive Flow)
		E to W (N to S)	W to E (S to N)	
Path 03	NorthWest to British Columbia	3,150	2,000	S to N
Path 04	NorthWest to British Columbia	10,200		E to W
Path 05	Bonneville Power Administration to Bonneville Power Administration	7,000		E to W
Path 15	Pacific Gas and Electric to Pacific Gas and Electric	500	360	N to S
Path 61	Southern California Edison to Southern California Edison	2,400	900	N to S
Path 65	PDCI	3,100	3,100	N to S
Path 66	California-Oregon Intertie	4,800	3,675	N to S
Path 73	North of John Day			



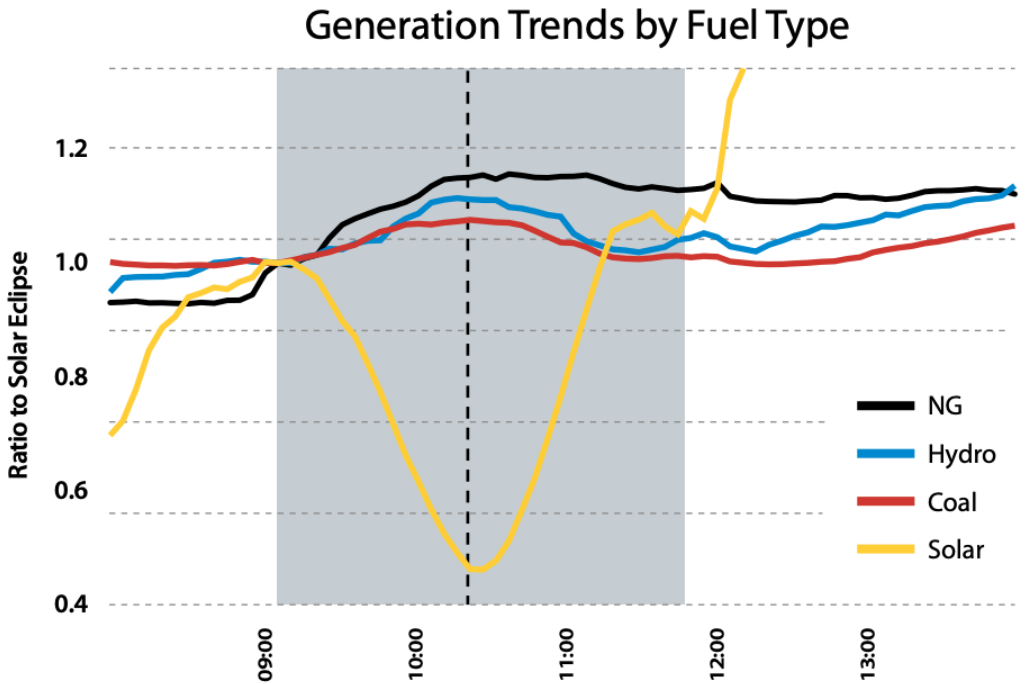
Affected Transmission Paths



Impact of Generation by Area



Impact of Generation by Fuel Type



Challenges

- Lack of appropriate models (transient and production cost models)
- Uncertainty with weather (system loading, wind output)
- Other factors (human behavior, transient cooling effect)

Path Forward

- Mature the Extreme Event Analysis Framework
  - Other large-scale disturbances
  - Multi-domain simulation
  - Resiliency studies
  - System restoration planning

Thank you

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