SOLAR ENERGY
TECHNOLOGIES OFFICE
U.S. Department Of Energy

Systems Integration Subprogram

Solar Forecasting II kickoff

July 2018

Solar Energy Technologies Office

- WHAT WE DO: The U.S. Department of Energy Solar Energy Technologies Office (SETO) supports early-stage research and development to improve the affordability, reliability, and performance of solar technologies on the grid. The office invests in innovative research efforts that securely integrate more solar energy into the grid, enhance the use and storage of solar energy, and lower solar electricity costs.

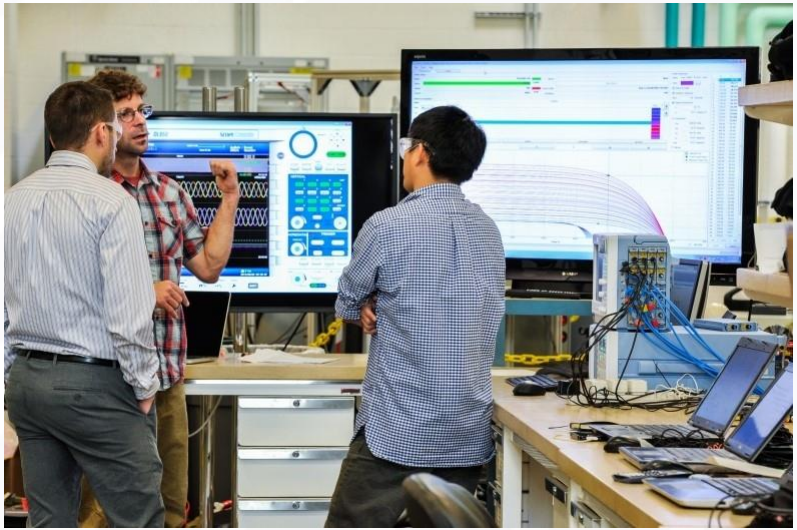
- Subprograms
  - Photovoltaic R&D
  - Concentrating Solar Power (CSP)
  - Systems Integration
  - Balance of Systems Soft Cost Reduction
  - Innovations in Manufacturing Competitiveness

Systems Integration Staff

- Guohui Yuan — Program Manager
- Emily Marchetti — Operation Specialist
- Thomas Rueckert — Technical Project Officer
- Patty Clark — Financial Program Analyst
- Kemal Celik — Technology Manager
- Tassos Golnas — Technology Manager
- Jeremiah Miller — Technology Manager
- Hariharan Krishnaswami — Senior Fellow
- Jian Fu — Technology Manager (on detail)

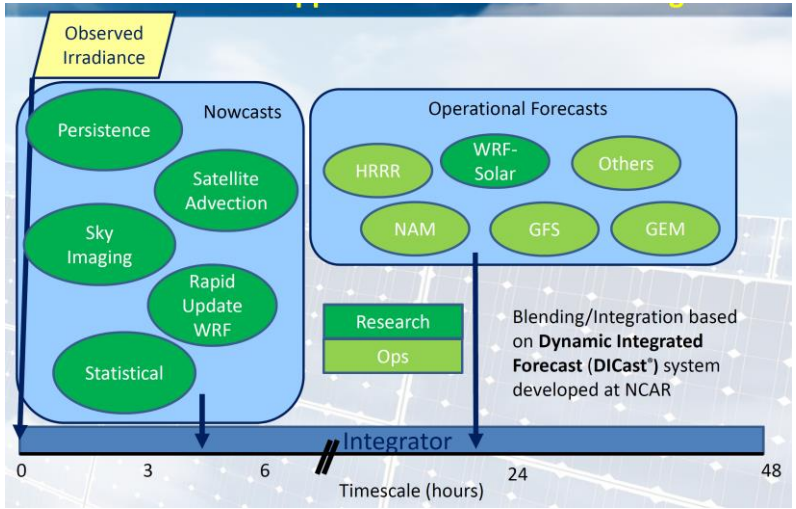
Systems Integration Research Areas

- Planning and operation
- Solar + X
- Power electronics
- Sensors and communication
- Codes and standards
- Studies and analysis



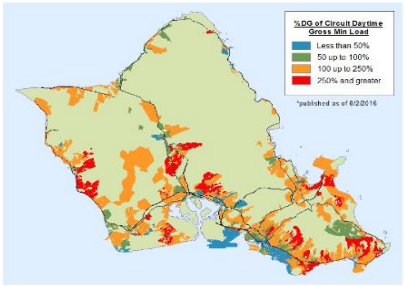
Solar Forecasting R&D

NCAR: WRF-Solar

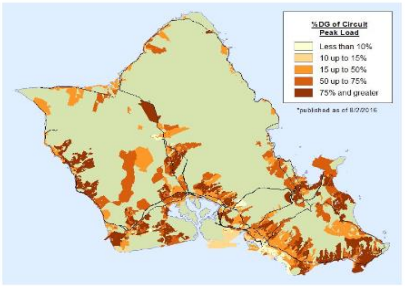


IBM: Watt-Sun

HECO

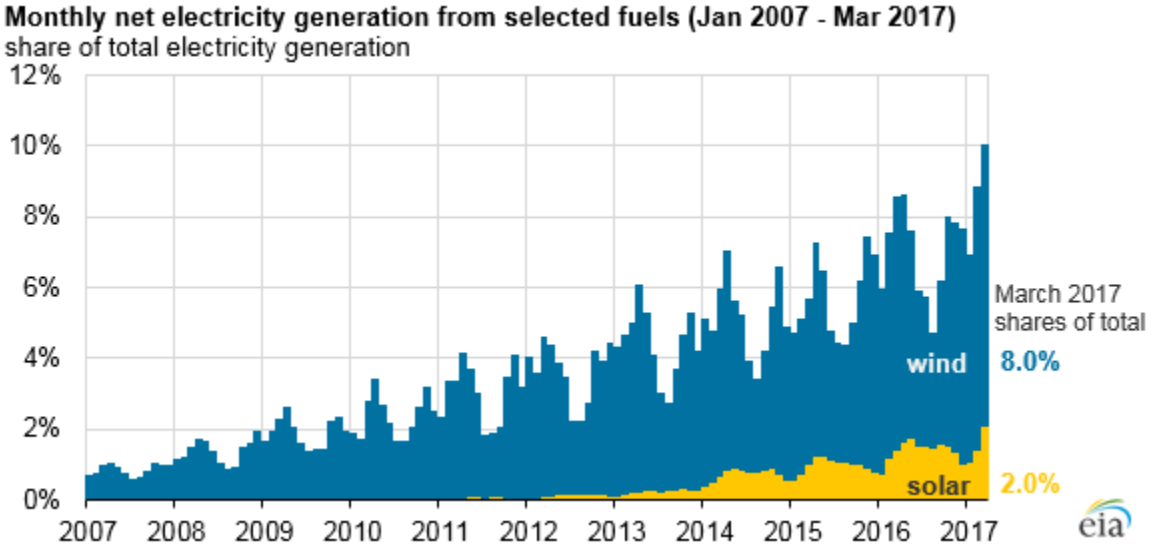


This map shows circuits with installed PV up to and greater than 250% of daytime minimum load (DML)*. For systems up to 10 kW, an interconnection study will not be needed if total PV on the circuit is equal to or less than 120% of DML. However, upgrades may be necessary.



This map shows distributed generation (mostly solar photovoltaic or PV) on each circuit compared to 15% of peak electricity demand, or "load" on each circuit. It also shows levels beyond 15%.

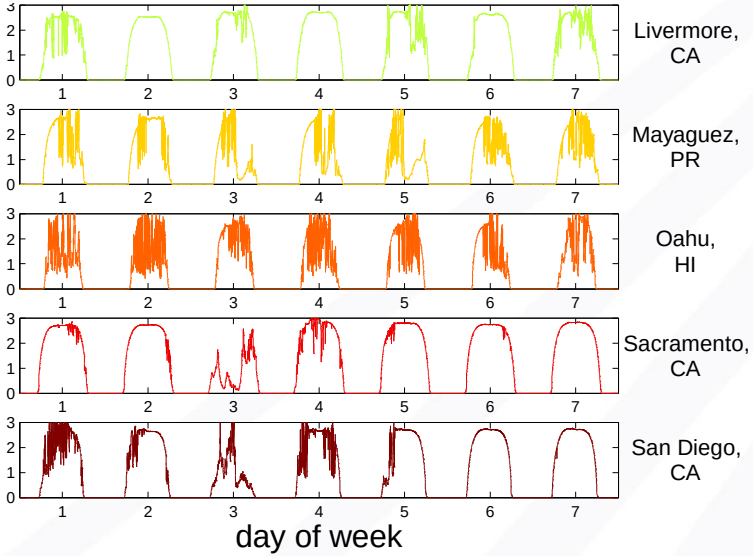
EIA: Wind and Solar Generate 10% Of Monthly Electricity in U.S.



- In March 2017, for the first time monthly electricity generation from wind and solar (including utility-scale plants and small-scale systems) exceeded 10% of total electricity generation in the United States,
- On an annual basis, wind and solar made up 7% of total U.S. electric generation in 2016.
- On an annual basis, solar made up nearly 2% of total U.S. electric generation in 2017.

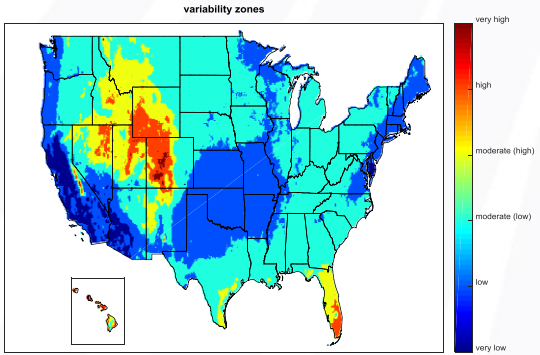
Solar Generation Variability

Sample measurements (1 min)



Resource measurement is critical

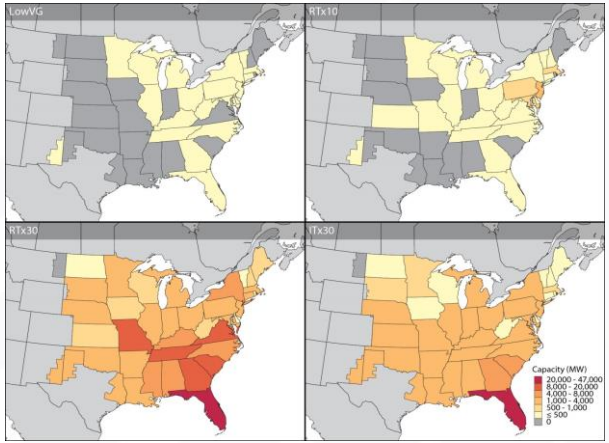
- Historical = NSRDB
- Real time = sensors
- Future = forecast

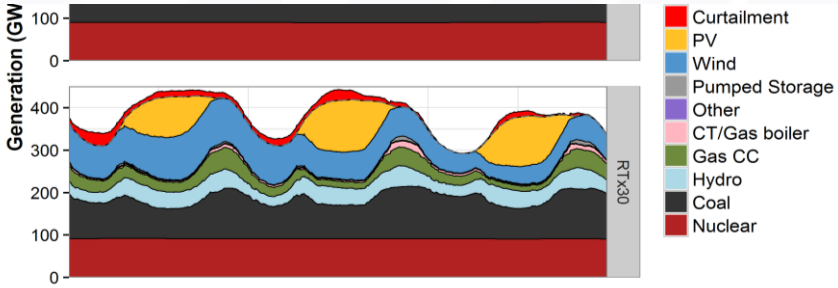


Eastern Renewable Grid Integration Study (ERGIS)

Modeling Tools

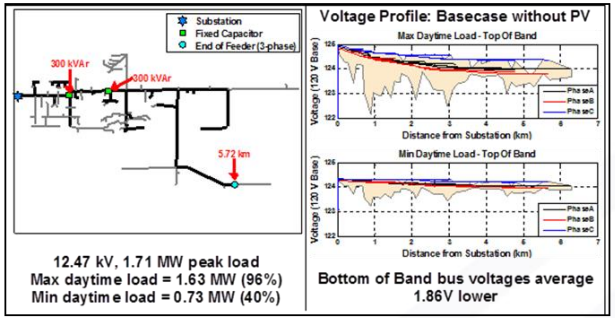
- ReEDS
  - Regional Energy Deployment System
  - Capacity expansion
  - Variability in wind and solar
  - Ancillary service requirements
- PLEXOS
  - Unit commitment and economic dispatch
  - Nodal DC power flow
  - Day-ahead (hourly)
  - Real-time (5-minute)
  - Mixed-integer



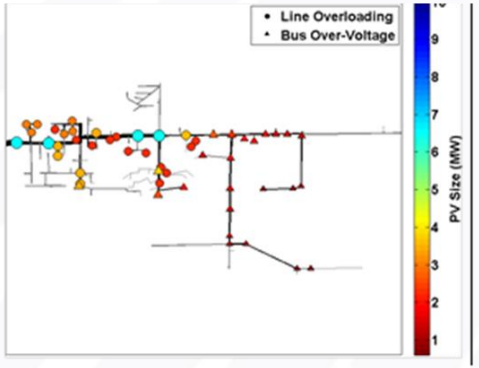


Detailed Quasi Real-Time Series (QSTS) Based Hosting Capacity Analysis for PV Integration

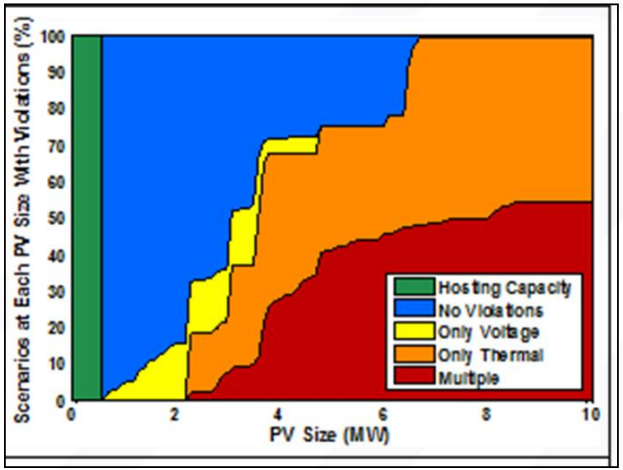
Feeder Info

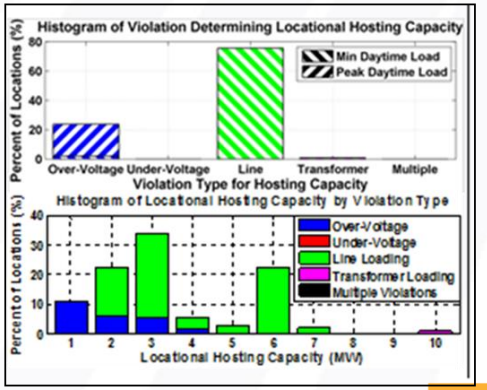


Hosting Capacity Map



Feeder Signature





2017 Solar Eclipse Impact on WECC

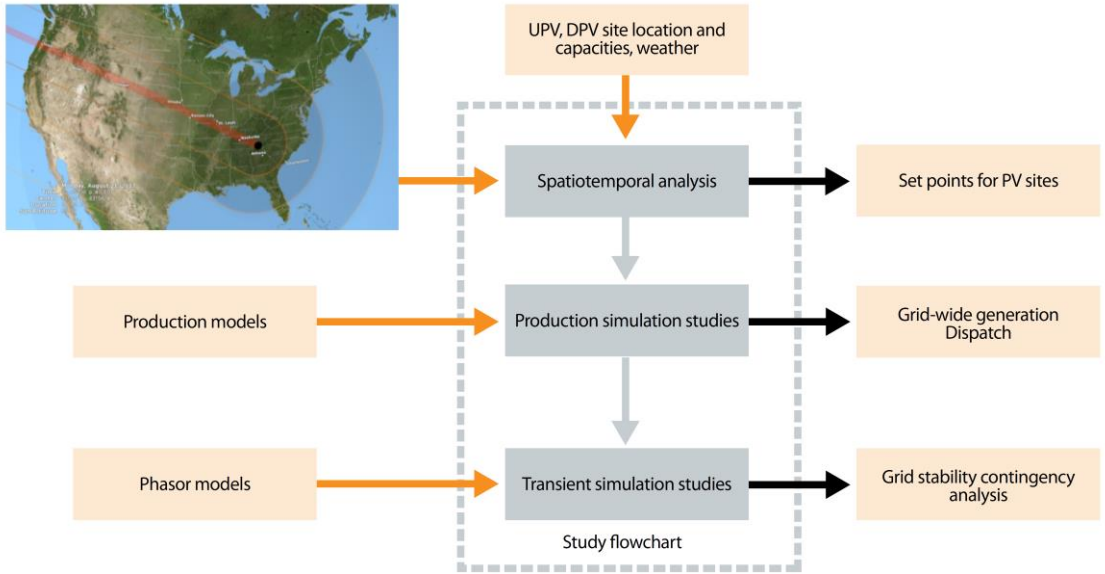
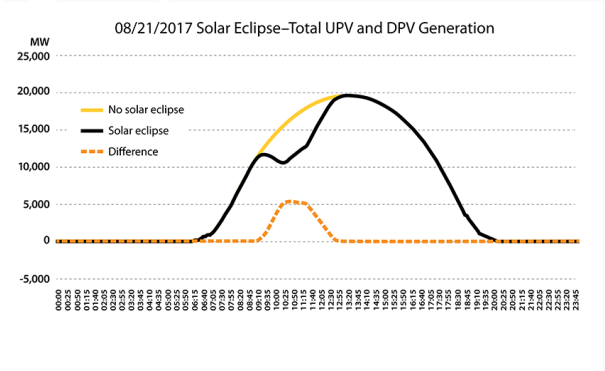


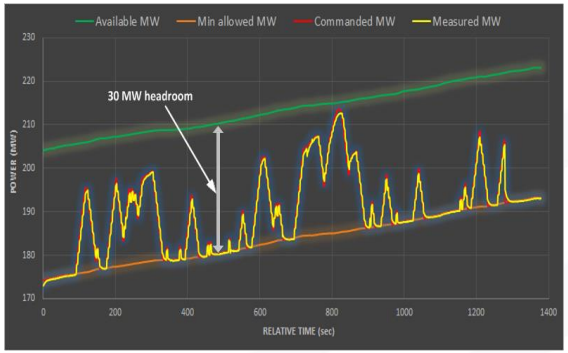
Figure 6. Flowchart of the eclipse study

minute-by-minute generation profiles

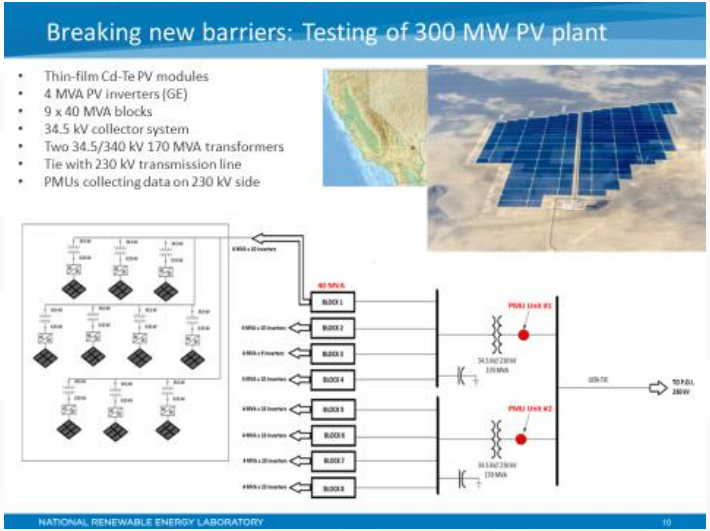


Solar PV Plant Providing Essential Reliability Services

- CAISO/First Solar 300-MW PV System Commissioning Test
- Winner of NARUC Innovation Award in 2017



- 4-sec AGC signal provided to PPC
- 30 MW headroom
- Tests were conducted for 30 minutes at:
  - Sunrise
  - Middle of the day
  - Sunset
- 1-sec data collected by plant PPC



Courtesy: NREL, Vahan Gevorgian

http://www.nrel.gov/docs/fy17osti/67799.pdf