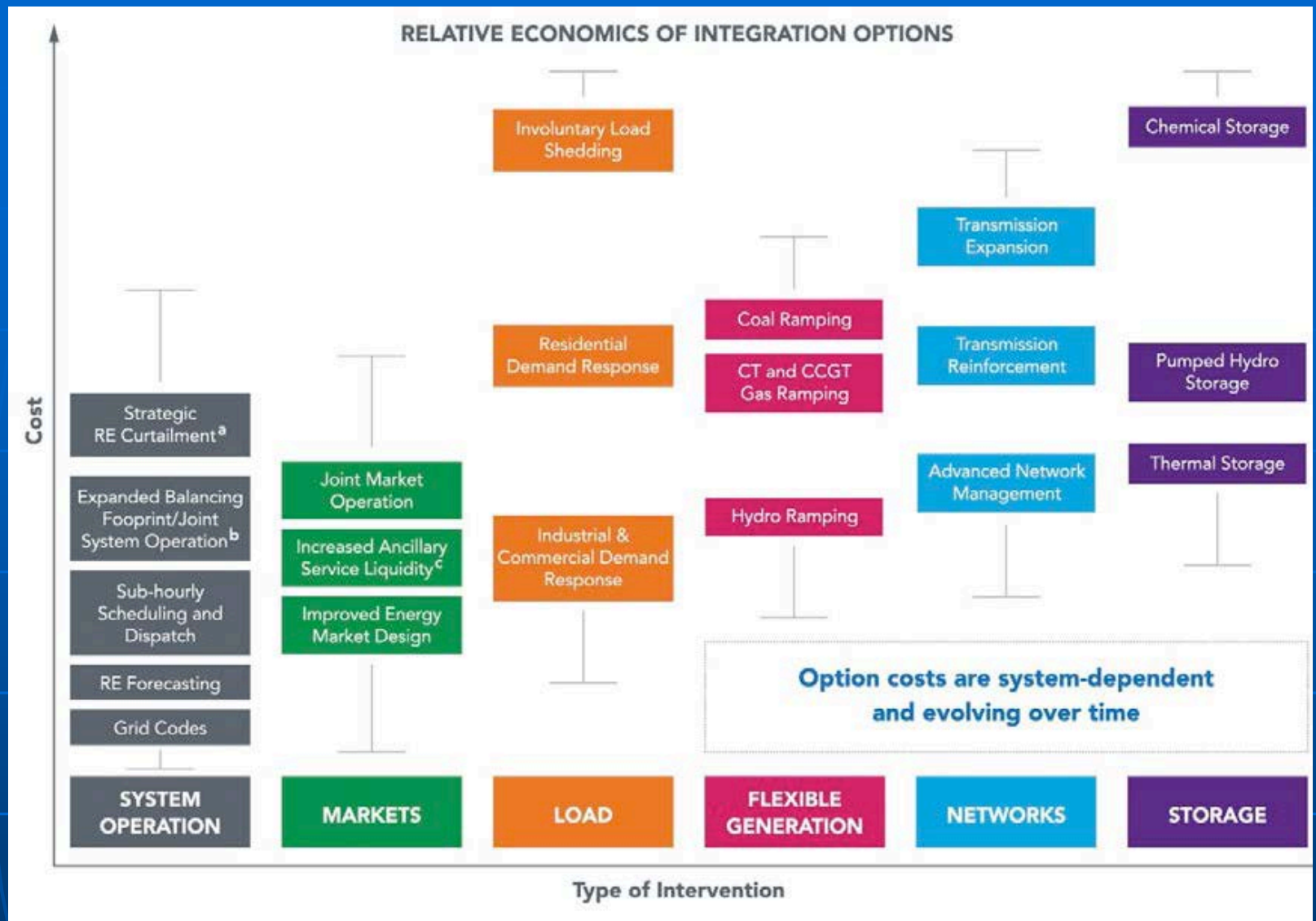


Renewables Integration

Bryan Hannegan, NREL

April 21, 2016



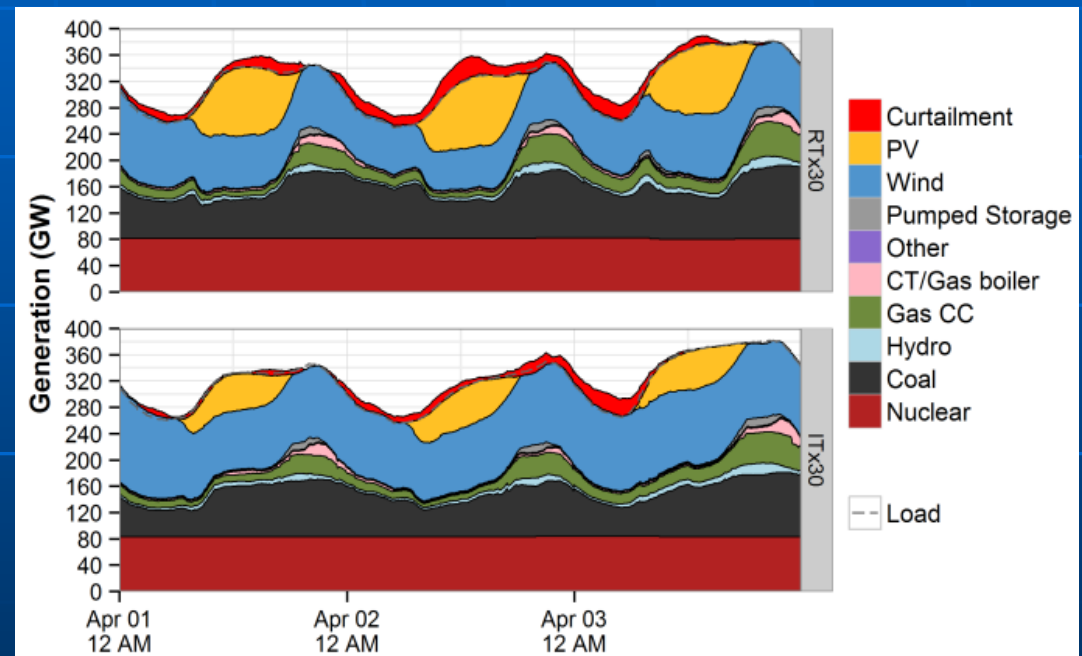
Cochran et al., NREL Pub 62607, 2015

Grid Integration Studies

Eastern Renewable Generation Interconnection Study

- Industry driven integration study of the Eastern Interconnection with over 300 GW of wind and solar capacity
- Advanced computing facilities used to enable unprecedented model fidelity.
- Wind and solar can be balanced with thermal and hydro at a 5-minute level
- Detailed regional and thermal fleet impact analysis
- 30+ member TRC with representation from utilities, RTOs, NERC, EPA, etc.

5-minute dispatch for three days with high VG and very low load



Utility PV Integration

AES Illumina 20MW PV Power Plant

CHALLENGE ADDRESSED

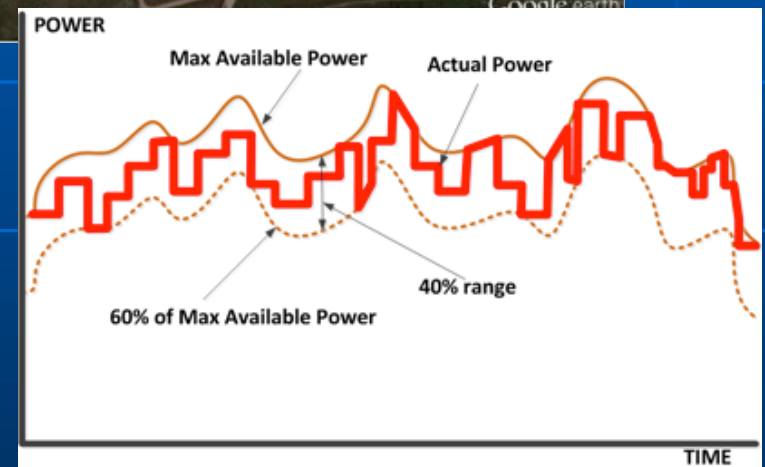
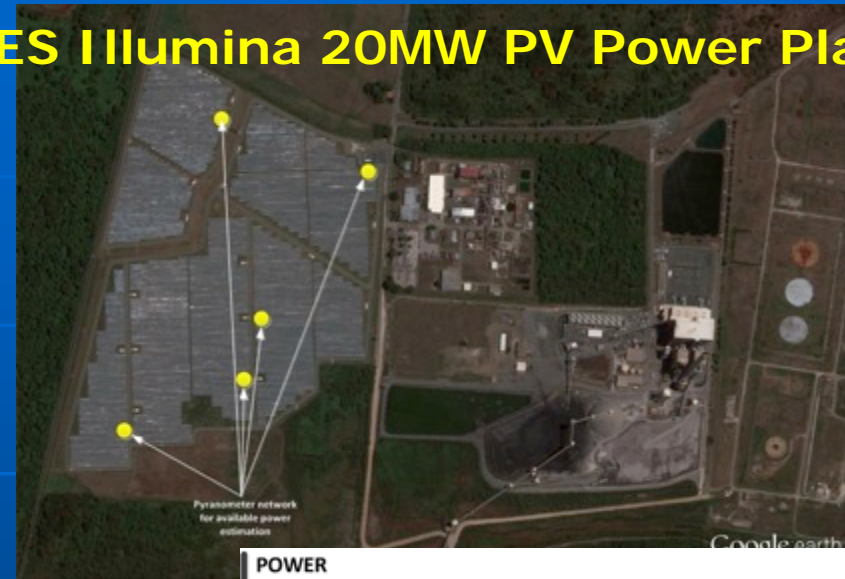
Demonstrate utility-scale PV can provide necessary ancillary services for island grid

R&D STRATEGY

Develop, install and validate new controls allowing AGC, up- and down-regulation within 500ms

IMPACT

Successful first of a kind real-world experiment using PV systems to maintain large-scale grid stability



Customer PV Integration

CHALLENGE ADDRESSED

Interconnection issues when connecting distributed PV at high penetration such as in Hawaii.

R&D STRATEGY

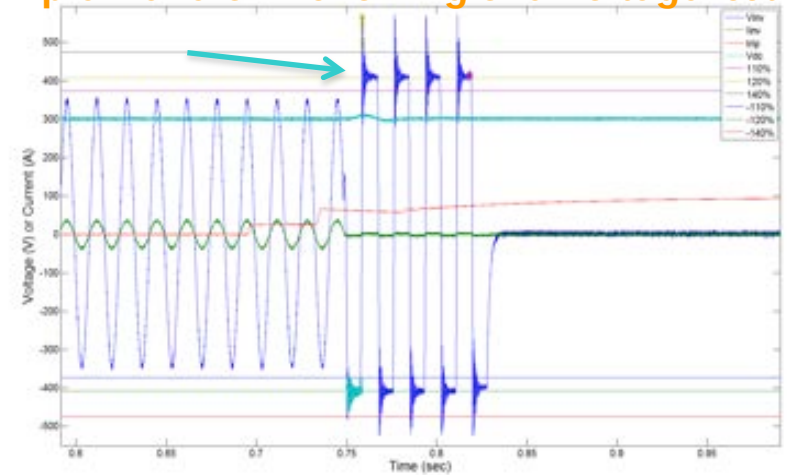
Test solar inverters for their ability to mitigate transient overvoltage impacts

IMPACT

HECO filed with the PUC to allow siting of PV systems with advanced inverters on neighborhood distribution circuits up to 250% of minimum daytime load (MDL).



Sample waveform showing overvoltage issue



Future Work

DEVICES AND INTEGRATED SYSTEMS

- Develop new grid interface devices to increase ability to provide grid services and utilization
- Coordinate and support the development of interconnection and interoperability test procedures for provision of grid services
- Common approach across labs and industry test-beds for effective validation of emerging technologies

