

First Solar®

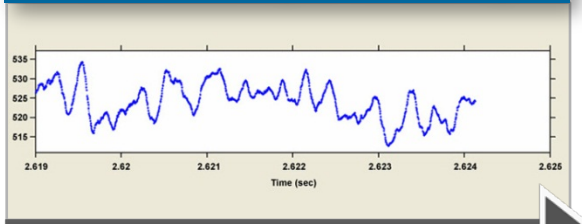
Impact of Solar Generation on Grid Stability & Reliability

- Dr. Mahesh Morjaria
(mahesh.morjaria@firstsolar.com)

© Copyright 2013, First Solar, Inc.

Key Topics – Impact of PV Solar on Power Grid

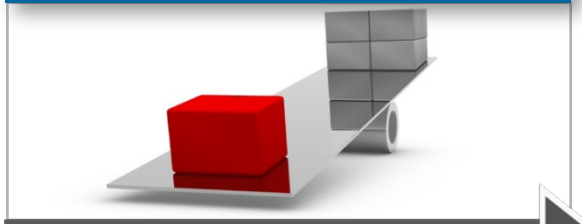
Grid Stability & Reliability



Milliseconds to Minutes

- PV solar intermittency raises grid stability and reliability concerns

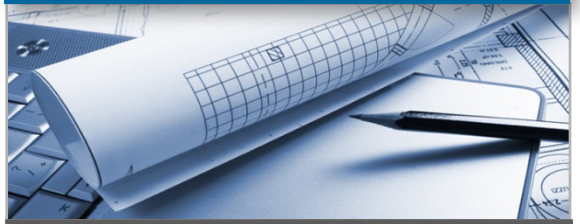
Load Balancing



Hours to Days

- PV Variability increases operational complexity

Power Systems Planning & Design



Years

- Higher PV penetration requires increased grid flexibility

© Copyright 2013, First Solar, Inc.

NERC Task Force on Intermittent Resources Impact to the Grid



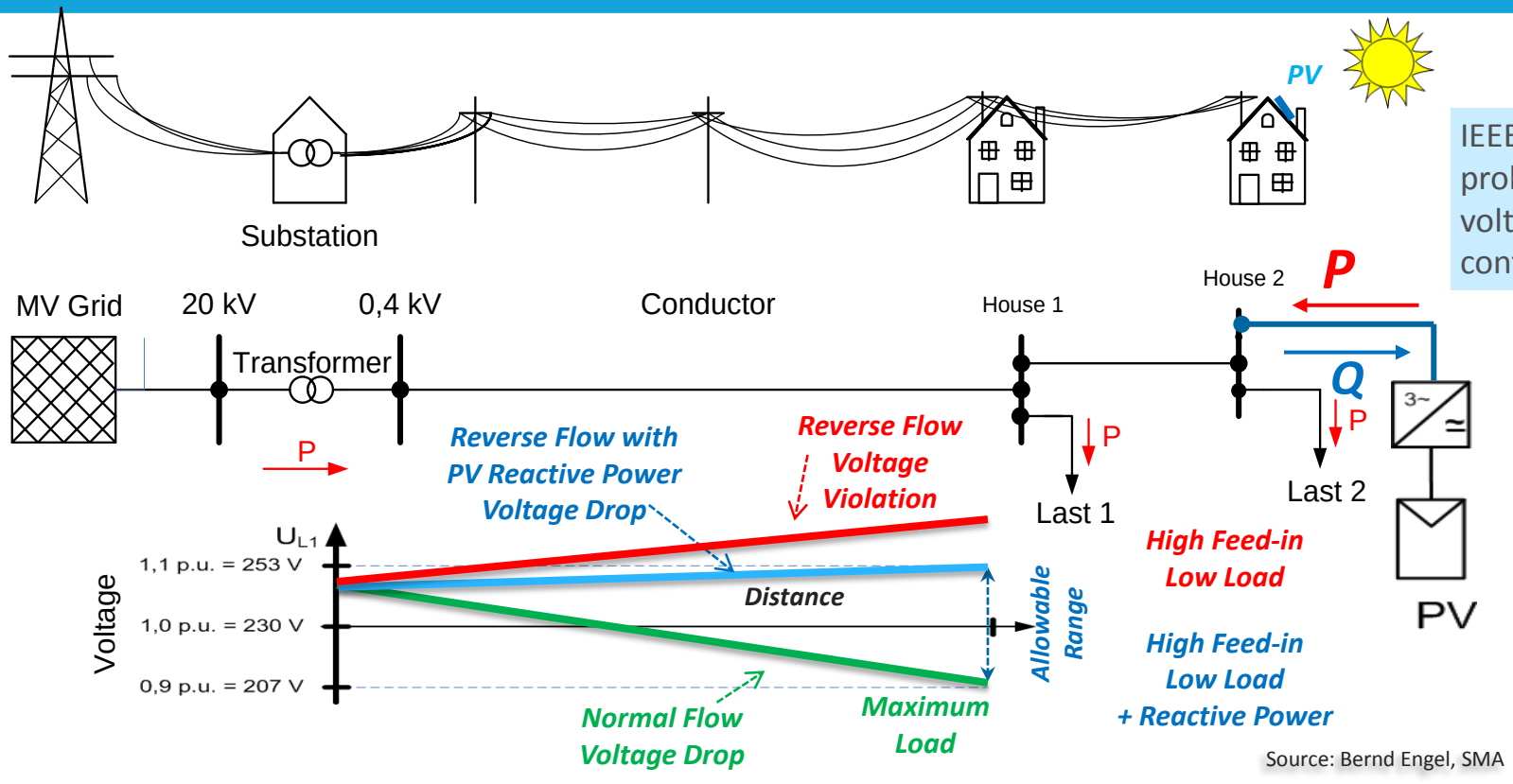
*"Modern solar plants can now contribute to the **reliability and efficiency** of grid operation by offering the following capabilities:"*

- ✓ Voltage, VAR control and/or power factor regulation
- ✓ Fault ride through
- ✓ Real power control, ramping, and curtailment
- ✓ Primary frequency regulation
- ✓ Frequency droop response
- ✓ Short circuit duty control

Utility-scale plants can support this
… but how about Distributed PV?

© Copyright 2013, First Solar, Inc.

Voltage Support – Power Flow Reversal – Distributed PV Impact



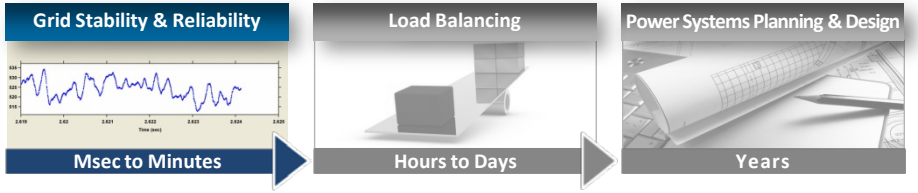
IEEE 1547 prohibits voltage control

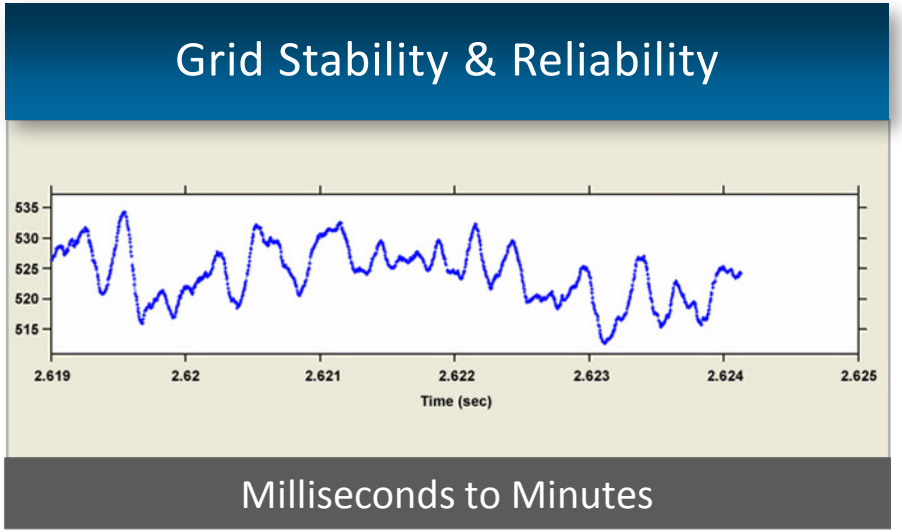
Source: Bernd Engel, SMA

PV With Reactive Power Capability Avoids Costly Network Upgrades

© Copyright 2013, First Solar, Inc.

Variable Generation Integration Topics





CONCERN

- Solar PV generation does not contribute to the reliability of bulk generation

LEARNING

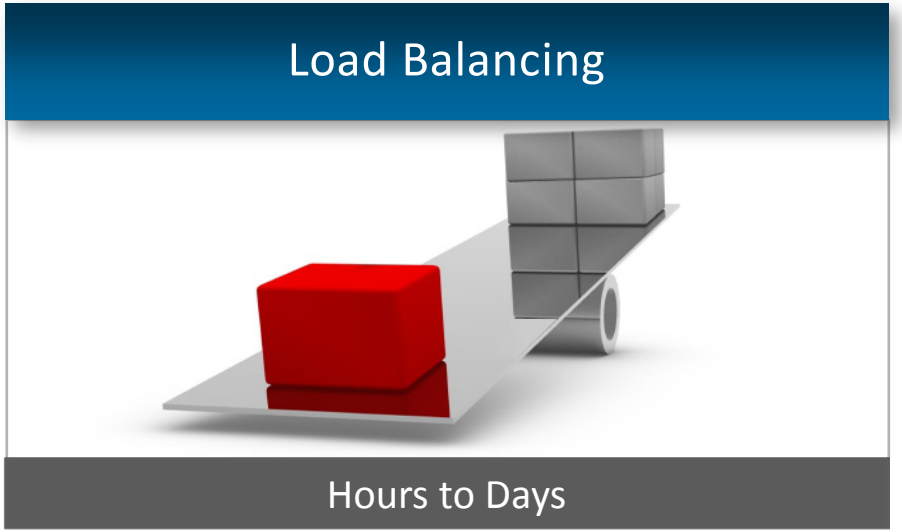
- Add grid controls to support reliability and grid security

Source: Pacific North West Laboratory, Grid Stability; The Challenges of power grid stability. http://eioc.pnnl.gov/research/gridstability.stm

© Copyright 2013, First Solar, Inc.

Variable Generation Integration Topics





CONCERN

- Solar Generation is not fully dispatchable
- Adds variability and uncertainty . . . complicates daily dispatch .

LEARNING

- Integrate forecasting into daily operation
- Improved operating procedures – balancing area, frequent updates, ramping support

© Copyright 2013, First Solar, Inc.

Adjusting the Grids needs every 4 second

Load Graph

Current System Demand:
(Actual Demand at this point in time)
27102 MW

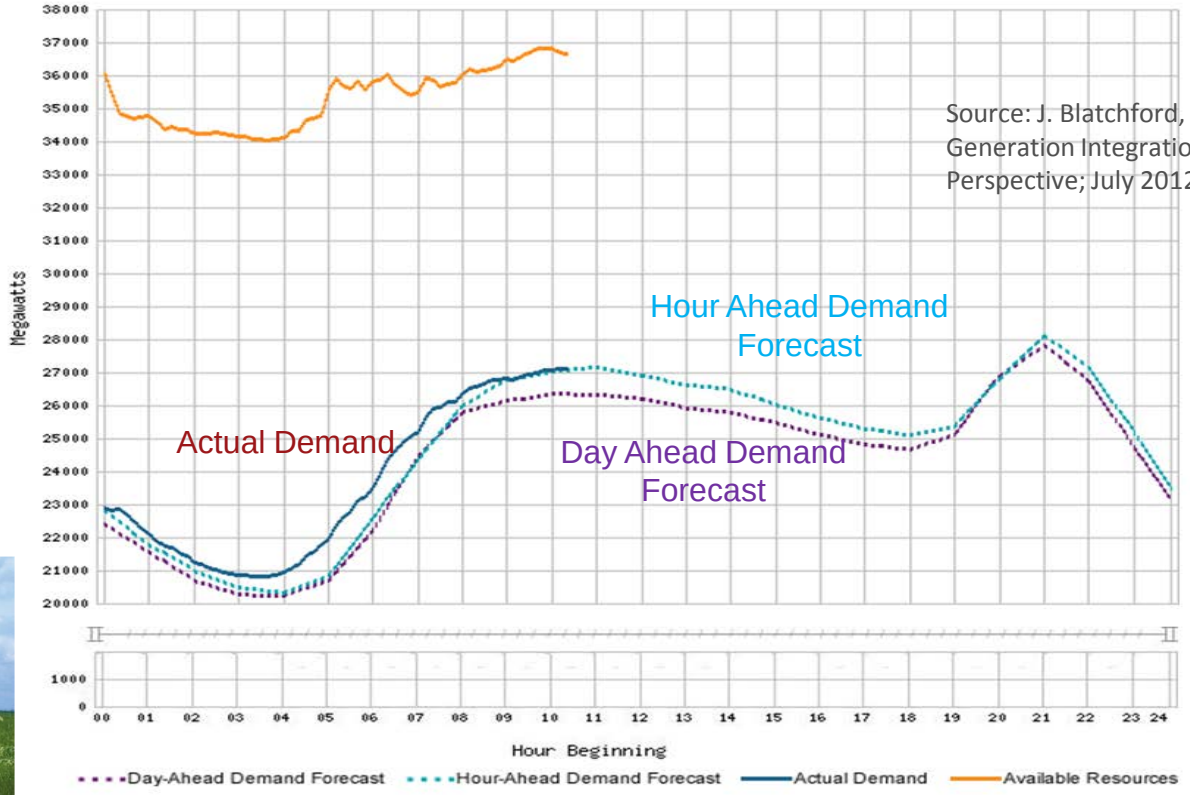
Today's Peak Demand:
(Highest point thus far today)
27103 MW

Today's Forecast Peak Demand:
(Highest point expected today. Does not appear post-peak.)
28096 MW

Tomorrow's Forecast Peak Demand:
(Not included on graph)
26825 MW

Information is current as of 05-Apr-2012 10:20 . If browser does not support auto refresh, select reload.

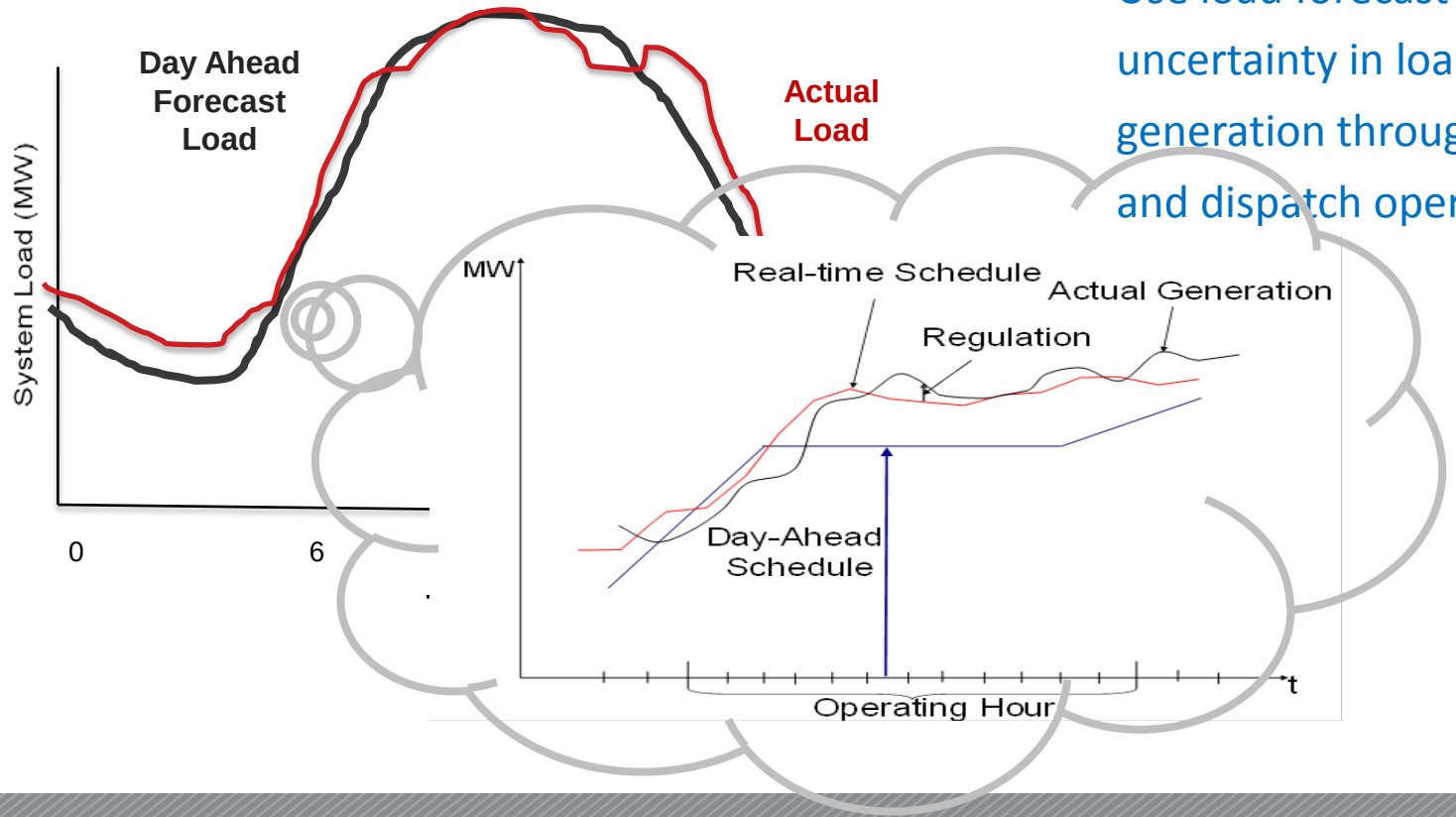




Source: J. Blatchford, Variable Generation Integration: CAISO Perspective; July 2012

© Copyright 2013, First Solar, Inc.

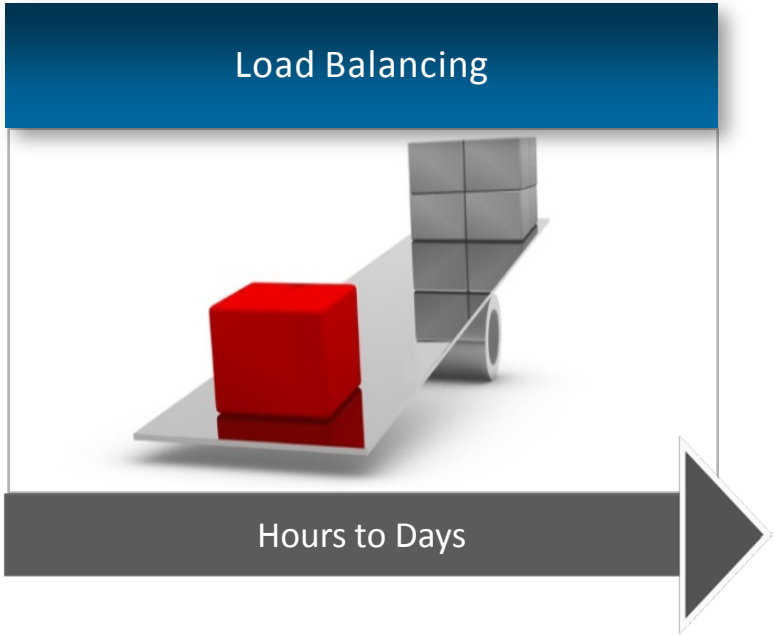
Grid Operators Deal with Variability & Uncertainty



- Use load forecast and uncertainty in load and generation through regulation and dispatch operation

© Copyright 2013, First Solar, Inc.

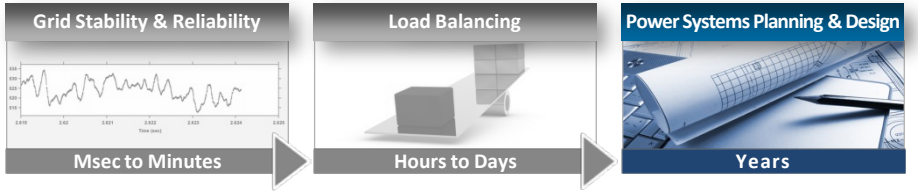
Key Learning of Integrating Variable Generation



- Integrate forecasting into daily operation
- Update operating procedures - balancing area, frequent updates, ramping support

© Copyright 2013, First Solar, Inc.

Variable Generation Integration Topics





CONCERN

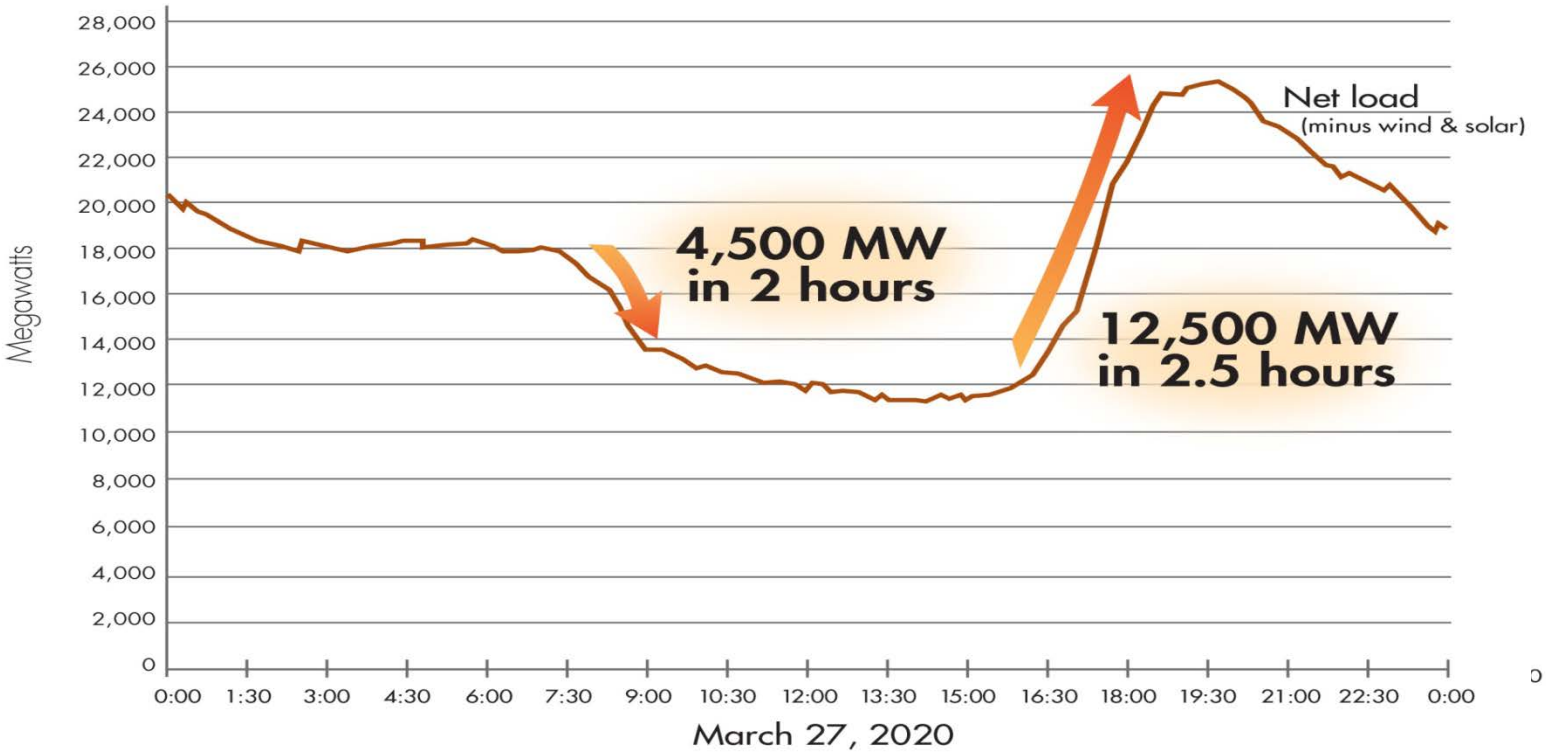
- Variable generation requires grid flexibility

LEARNING

- Adopt diverse resource portfolio to increase flexibility and reduce risks

© Copyright 2013, First Solar, Inc.

Net Load and Flexible Capacity Needs



Source: CAISO

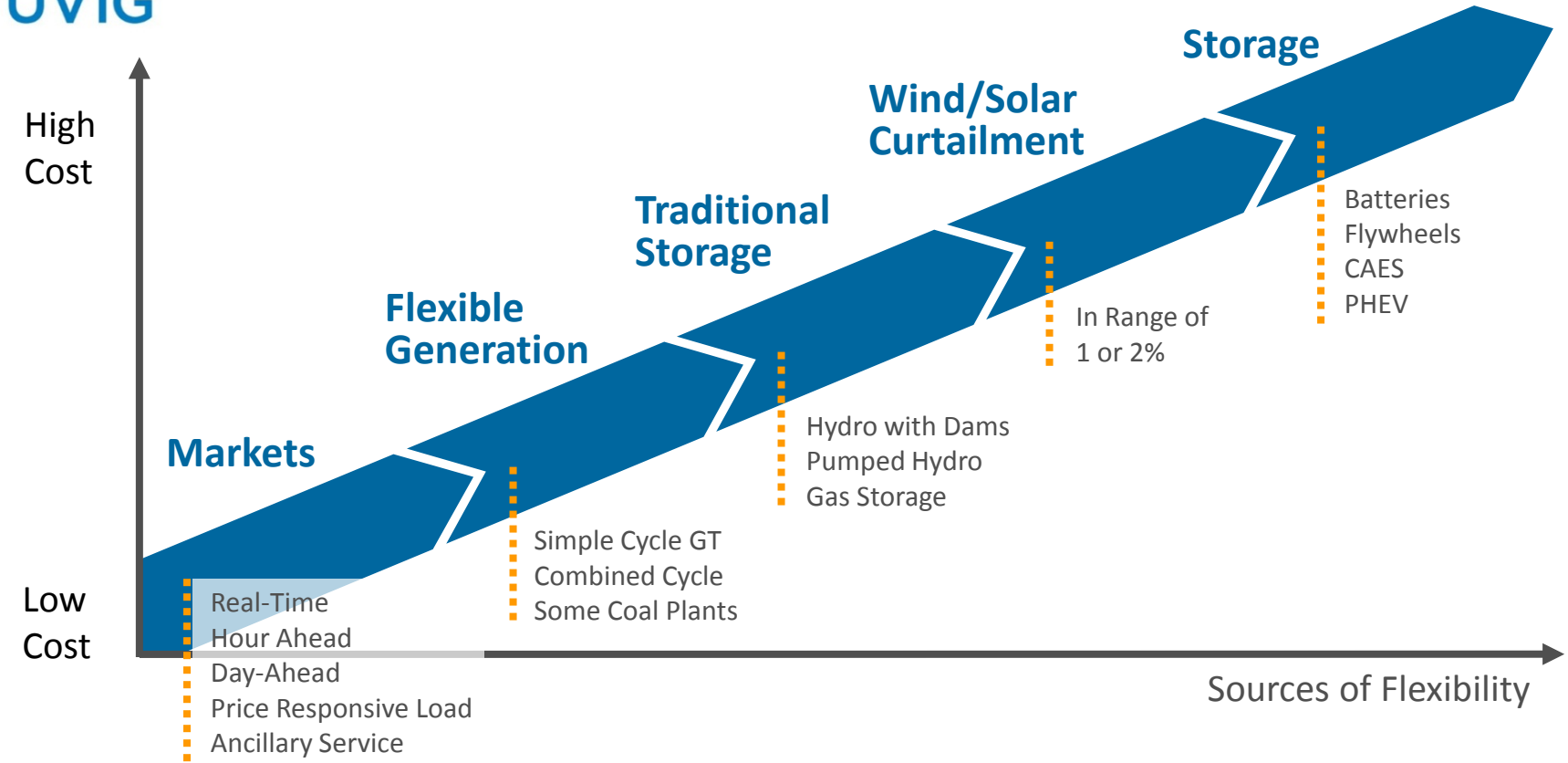
Matt Burkhart
SDGE, Sempra
Feb 13,2013
Solar Power Gen San Diego

© Copyright 2013, First Solar, Inc.

11

Flexibility Supply Curve

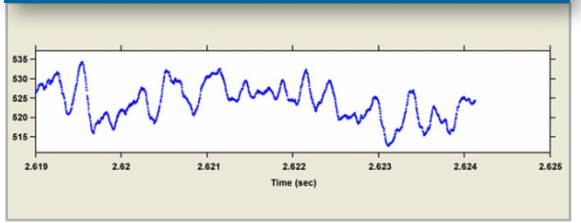
Study needed to determine shape of Flexibility Supply Curve and Quantify Costs



© Copyright 2013, First Solar, Inc.

Variable Generation … Key Lessons Learned

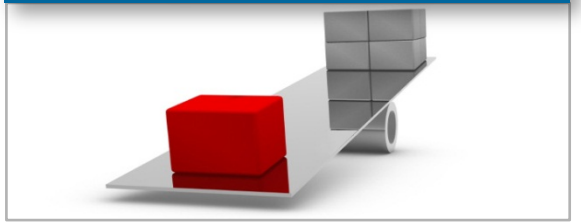
Grid Stability & Reliability



- Add grid controls to support reliability and grid security

Milliseconds to Minutes

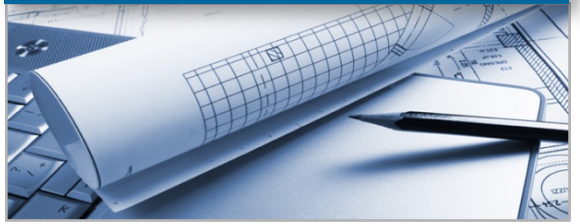
Load Balancing



- Integrate forecasting into daily operation
- Improved operating procedures – balancing area, frequent updates, ramping support

Hours to Days

Power Systems Planning & Design



- Adopt diverse resource portfolio to increase flexibility and reduce risks

Years

© Copyright 2013, First Solar, Inc.

Conclusions



- Modern PV systems can contribute actively to grid stability and reliability
- PV variability can be managed without significant impact to existing grid infrastructure through site diversity and forecasting
- PV power system is a cost-effective energy resource
- Lessons learned to date on Renewable Integration
  - Large-scale PV has been successfully integrated into grids worldwide
  - No reported issues due to often cited barriers: PV variability, harmonics, DC current injection, anti-islanding failure or protection coordination
  - Bulk energy storage has not been necessary for variable generation integration

© Copyright 2013, First Solar, Inc.