Essential Reliability Services From PV Plants

Mahesh Morjaria, Ph. D.
VP, PV Systems

Enabling a world powered by reliable, affordable solar electricity.

First Solar®

Can variable energy resources provide essential reliability services to reliably operate the grid?

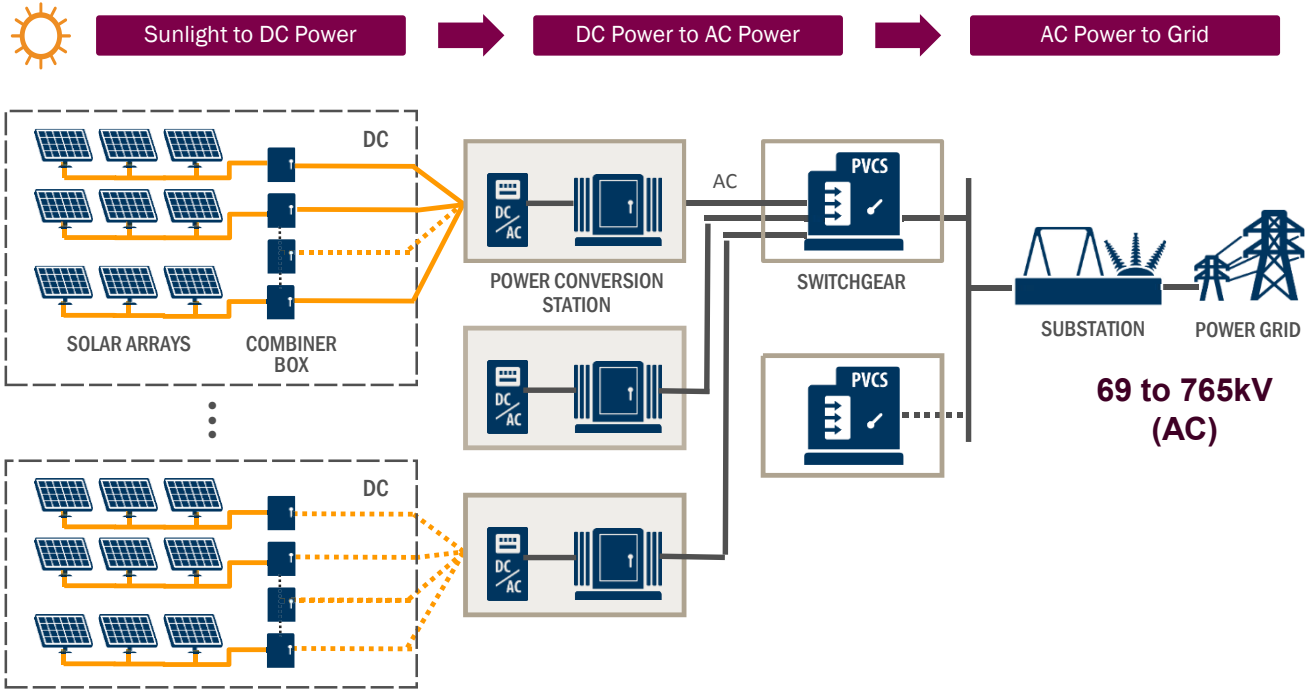
- NERC identified three essential reliability services to reliably integrate higher levels of renewable resources
  1. Frequency Control
  2. Voltage Control
  3. Ramping capability or Flexible Capacity

- Test results demonstrated utility-scale PV plant has the capability to provide these essential reliability services

- Advancement in smart controls technology allows these plants to provide services similar to conventional resources

- VERs (Variable Energy Resources) with the right operating characteristics are necessary to decarbonize the grid

PV Plant Schematic

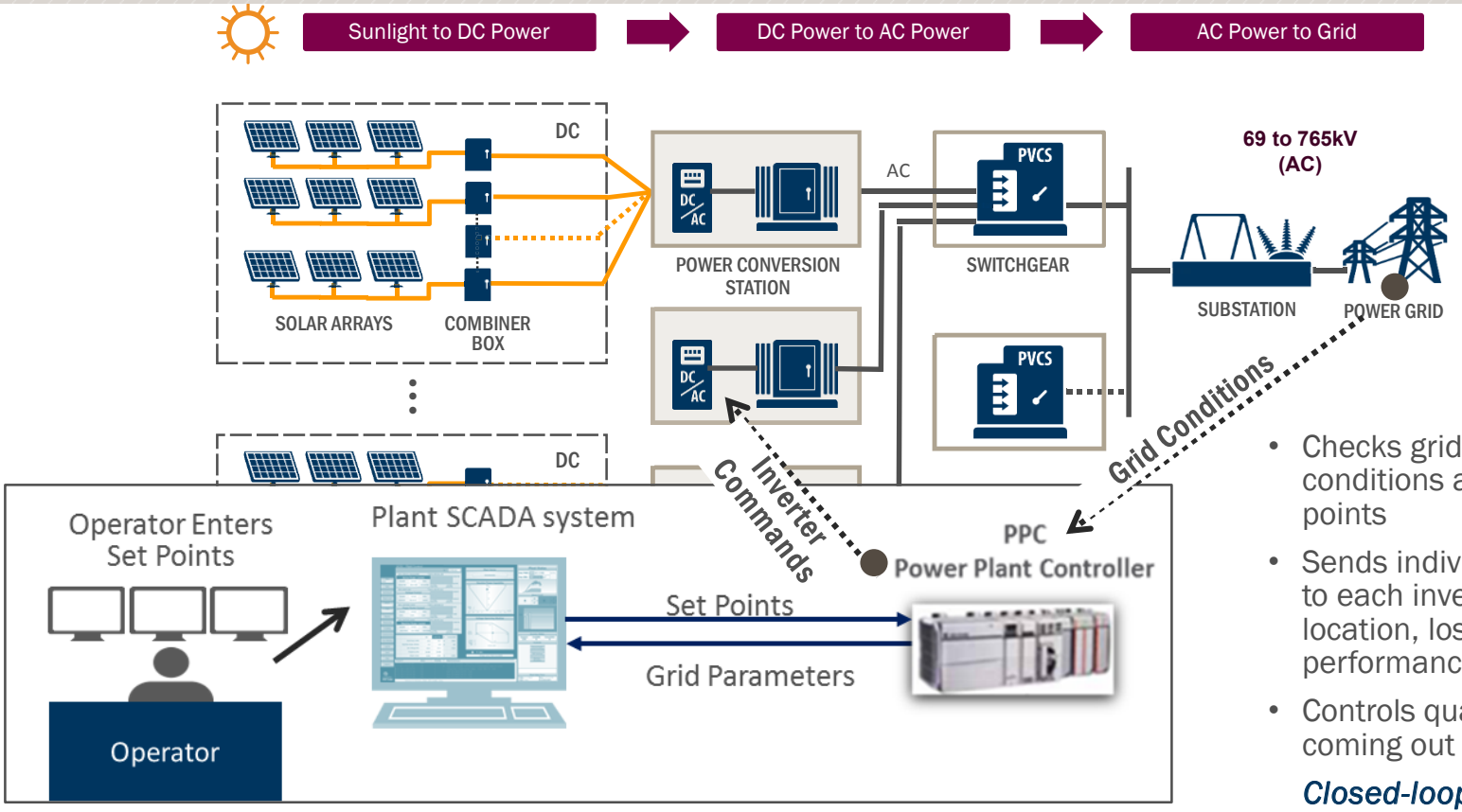


Typical DC Voltage 1kV or 1.5kV

Typical AC Collection Voltage 34.5kV (Alternatives 4.16kV to 27.6kV)

2017 © Copyright First Solar, Inc.

Plant Control System Enables Grid Friendly Features



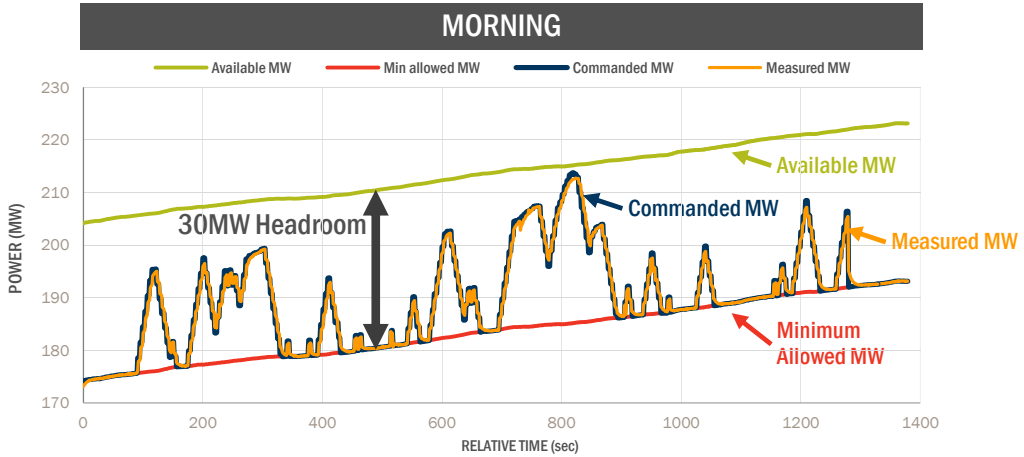
- Checks grid's actual conditions and required set points
- Sends individual instructions to each inverter based on location, losses, and performance
- Controls quality of power coming out of the PV plant

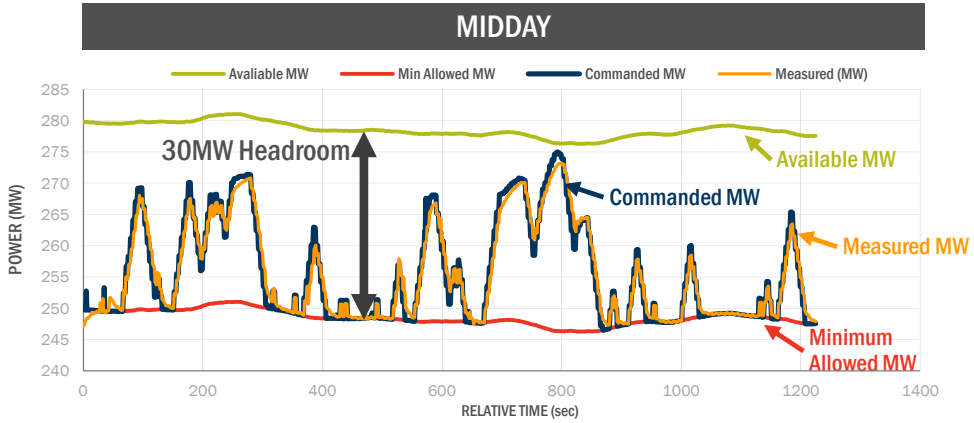
Closed-loop controls at 100 milliseconds!

2017 © Copyright First Solar, Inc.

Patent No. 8,774,974. Real-time photovoltaic power plant control system

AGC Participation Tests – 300 MW Utility-Scale PV Plant

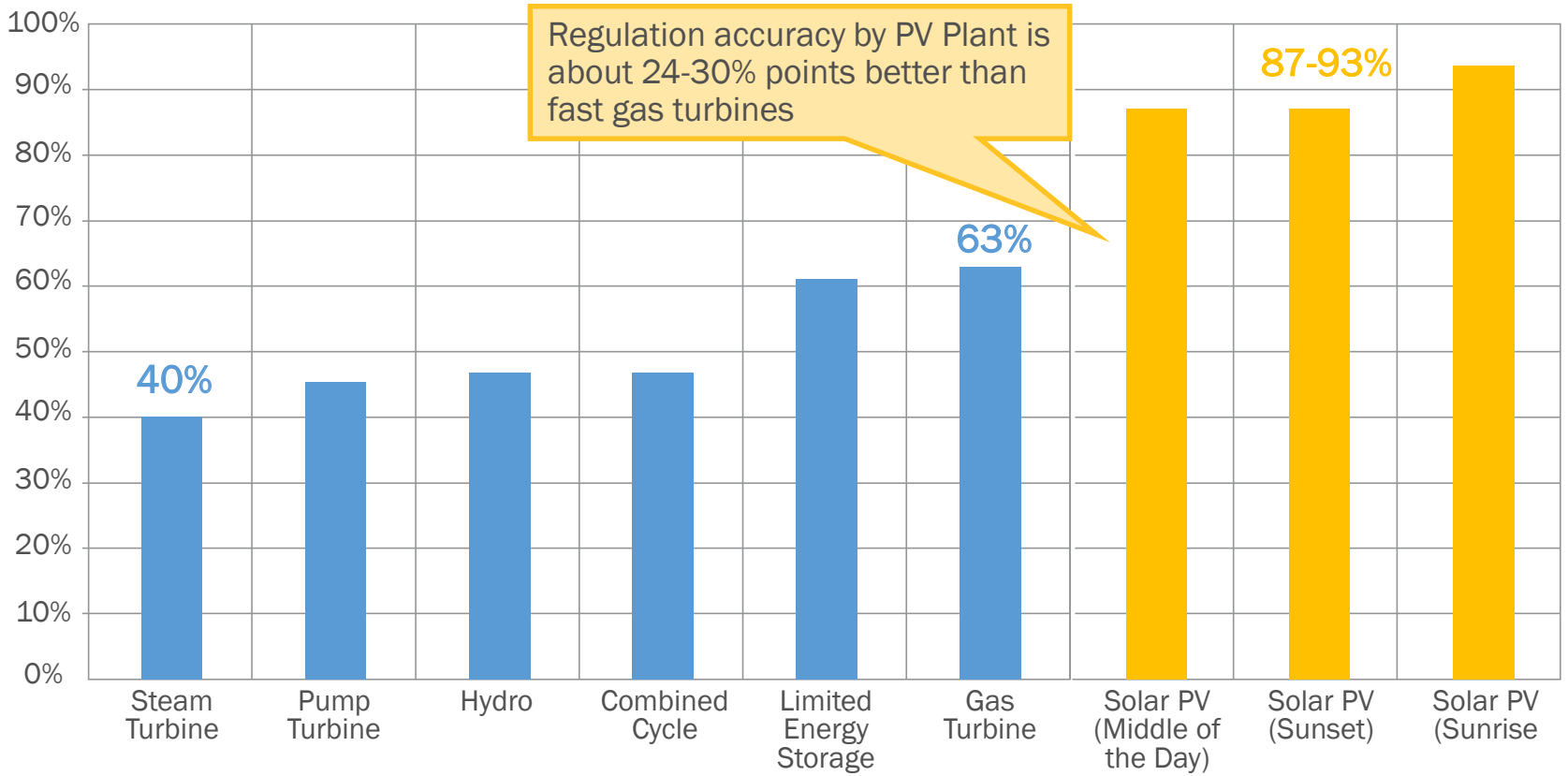




- 30MW headroom
- 4-sec AGC signal provided to Plant Controller
- Tests were conducted for
  - Sunrise
  - Middle of the day
  - Sunset

2017 © Copyright First Solar, Inc.

PV Plants Outperform Conventional Resources in Frequency Regulation



California ISO

Blue bars taken from the ISO's informational submittal to FERC on the performance of resources providing regulation services between January 1, 2015 and March 31, 2016

http://www.caiso.com/Documents/TestsShowRenewablePlantsCanBalanceLow-CarbonGrid.pdf

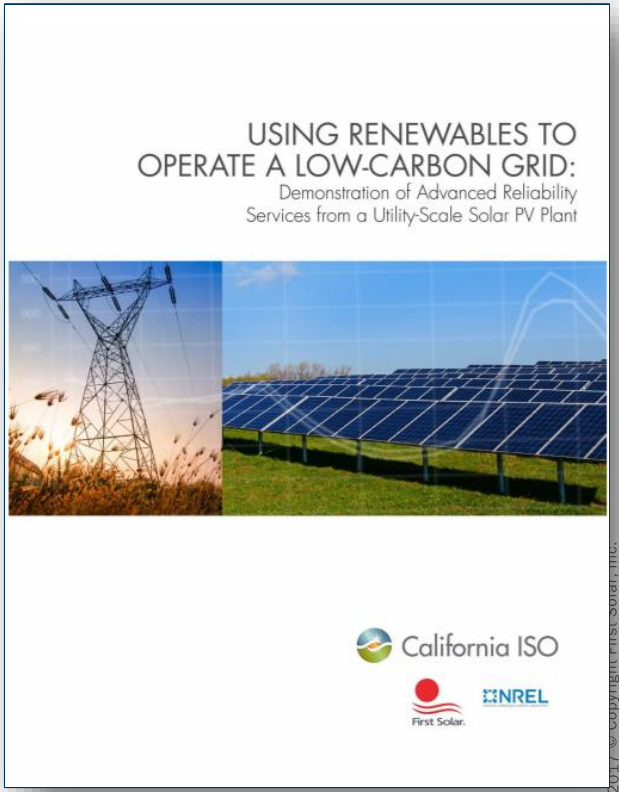
2017 © Copyright First Solar, Inc.

Utility-scale PV solar is a *flexible resource* that can enhance grid reliability

Dispatchable PV Plant

- Solar can provide NERC-identified essential services to reliably integrate higher levels of renewable resources, including:
  - Frequency Control
  - Voltage Control
  - Ramping capability or flexible capacity
- Automated Generation Control (AGC) regulation accuracy of 24-30 %points better than fast gas turbines
- Reduces need for services from conventional generation
  - Goes beyond simple PV energy value
  - Enables additional solar
  - Reduces need for expensive storage

CAISO: "Grid Friendly Utility-Scale PV Plants are Essential for Large-Scale PV Integration"

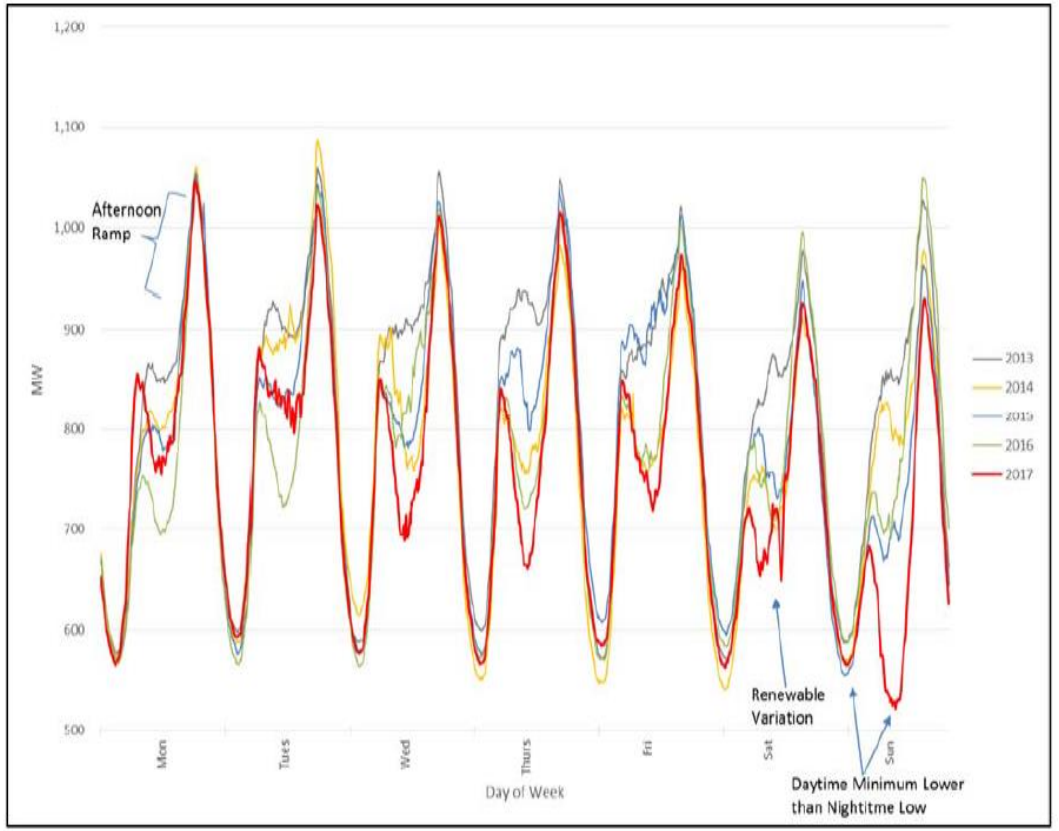


http://www.caiso.com/Documents/TestsShowRenewablePlantsCanBalanceLow-CarbonGrid.pdf

2017 © Copyright First Solar, Inc.

PV Plants with Grid Services Can Address Some of Hawaii Grid Challenges

- Traditional Generating resources are being displaced, along with the **ancillary services provided** by these resources
- **Dispatchable generating resources** are increasingly being taken offline to accommodate production from both grid-scale renewable energy resources and DER.
- As the grid becomes more dynamic, the need for **resources that can regulate grid frequency and provide fast frequency response** is increasing



Source: "Modernizing Hawai'i's Grid For Our Customers", June 2017 Draft Report

Discussion Points

- Use PV plants More Flexibly … both as energy source/reliability services …”low hanging fruit”
- Some level of curtailment may be more economical for system flexibility …add storage later when it becomes economical
- Reliability services from PV plant does not impact O&M cost unlike conventional plant
- Use DER inverters for voltage support (volt-var; volt-watt functions)

2017 © Copyright First Solar, Inc.