Briefing on using renewables to integrate renewables

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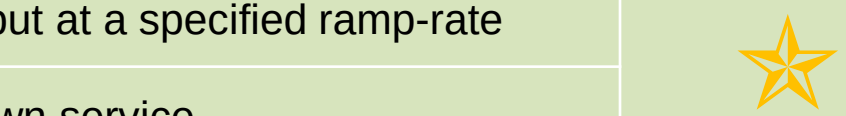
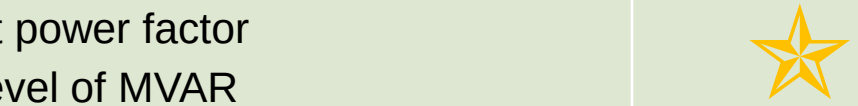
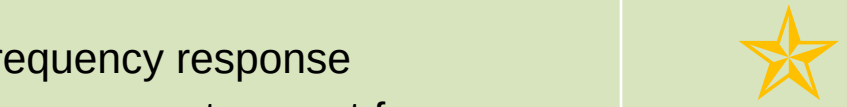
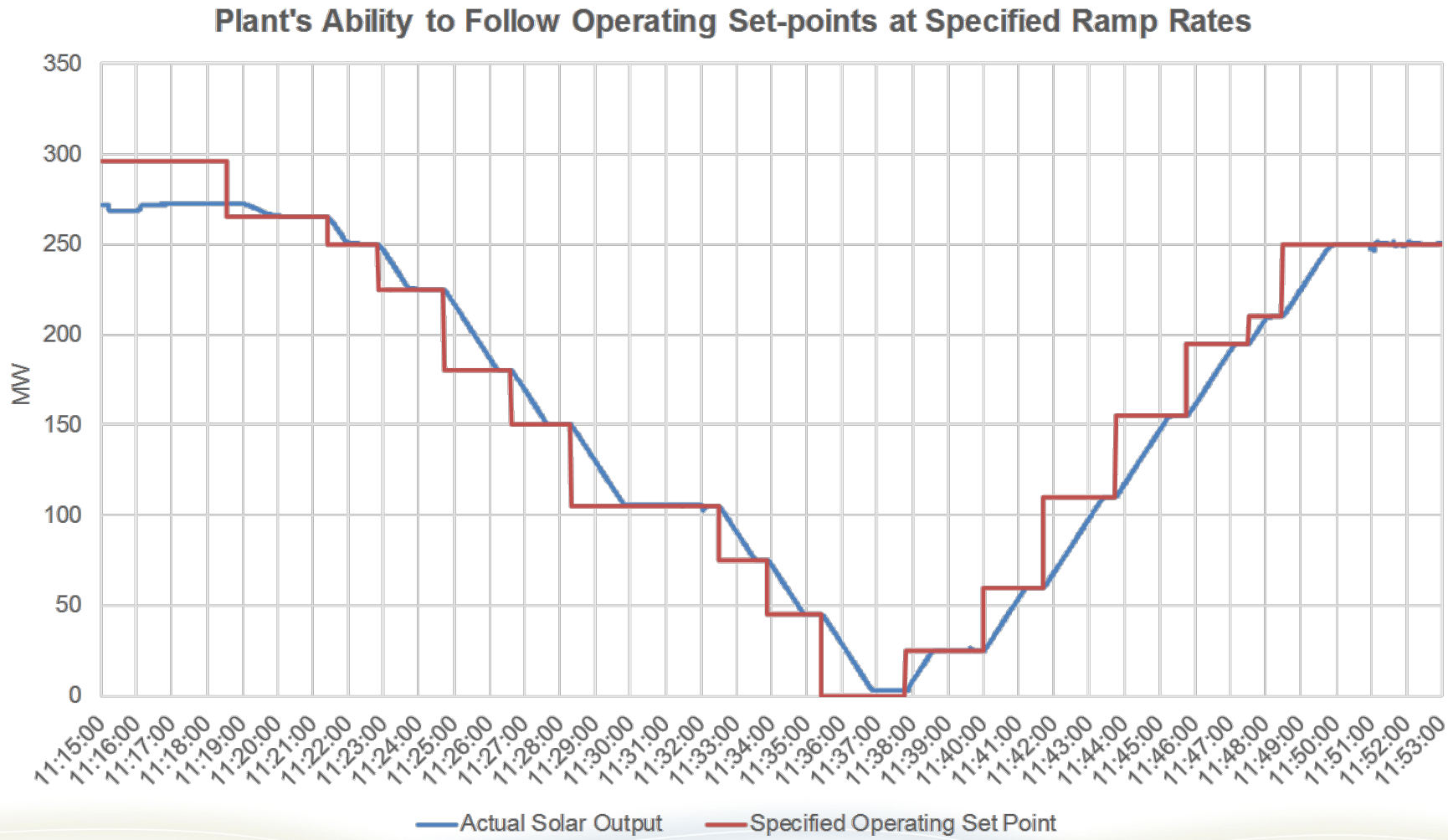
Can variable energy resources provide essential reliability services to reliably operate the grid?

- NERC identified three essential reliability services to reliably integrate higher levels of renewable resources
  - Frequency control
  - Voltage control
  - Ramping capability or flexible capacity
- Test results demonstrated the plant has the capability to provide these essential reliability services
- Advancement in smart inverter technology allows VERs to provide services similar to conventional resources
- VERs with the right operating characteristics are necessary to decarbonize the grid

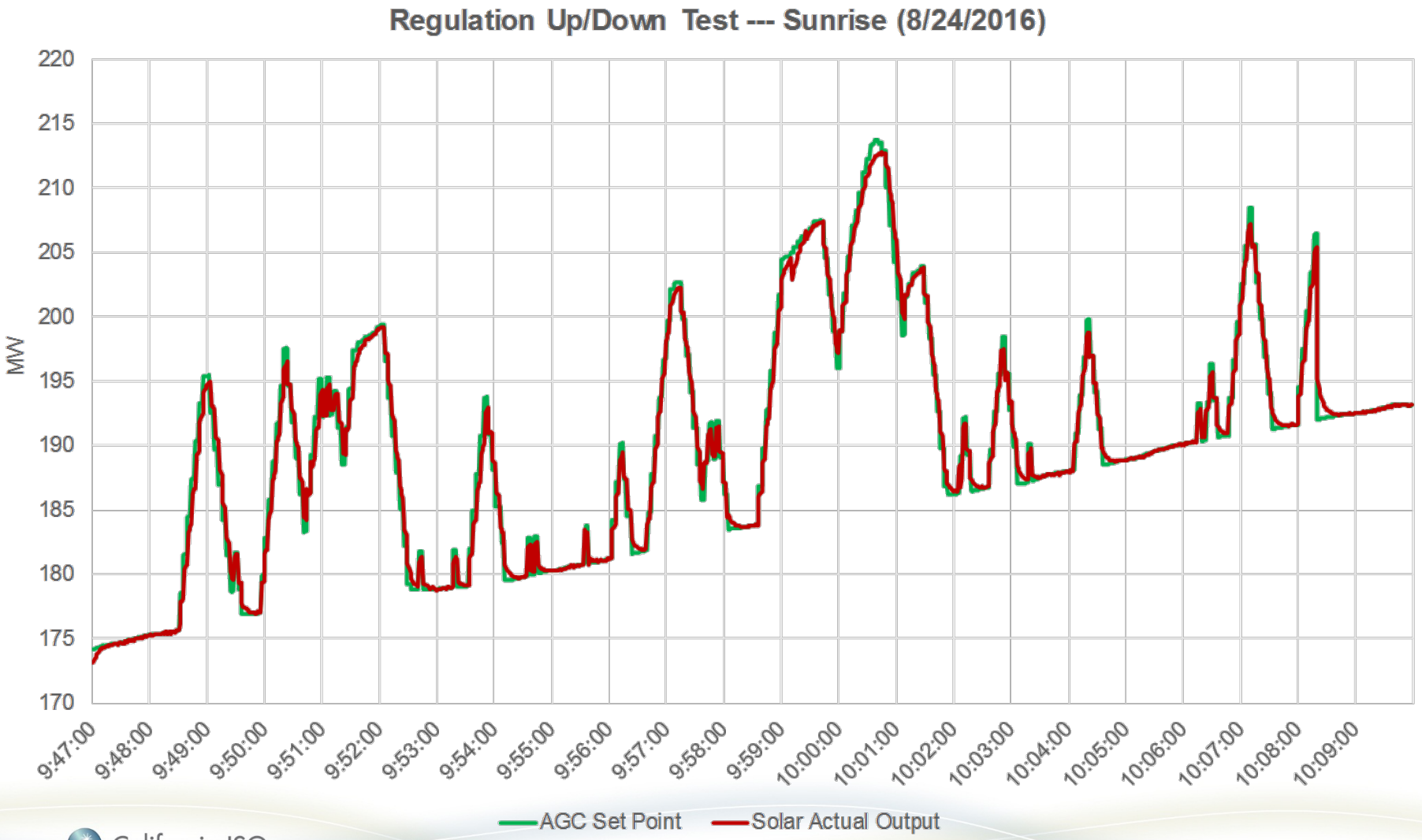
The ISO, First Solar and NREL demonstrated how a 300 MW solar PV plant can provide essential reliability services

	Test	Performance
Ramping	• Ramp its real-power output at a specified ramp-rate	
	• Provide regulation up/down service	
Voltage	• Provide reactive power support in various modes - Control a specified voltage schedule - Operate at a constant power factor - Produce a constant level of MVAR - Provide controllable reactive support (droop setting) - Capability to provide reactive support at night	
Frequency	• Provide frequency response for low frequency and high frequency events - Control the speed of frequency response - Provide fast frequency response to arrest frequency decline	

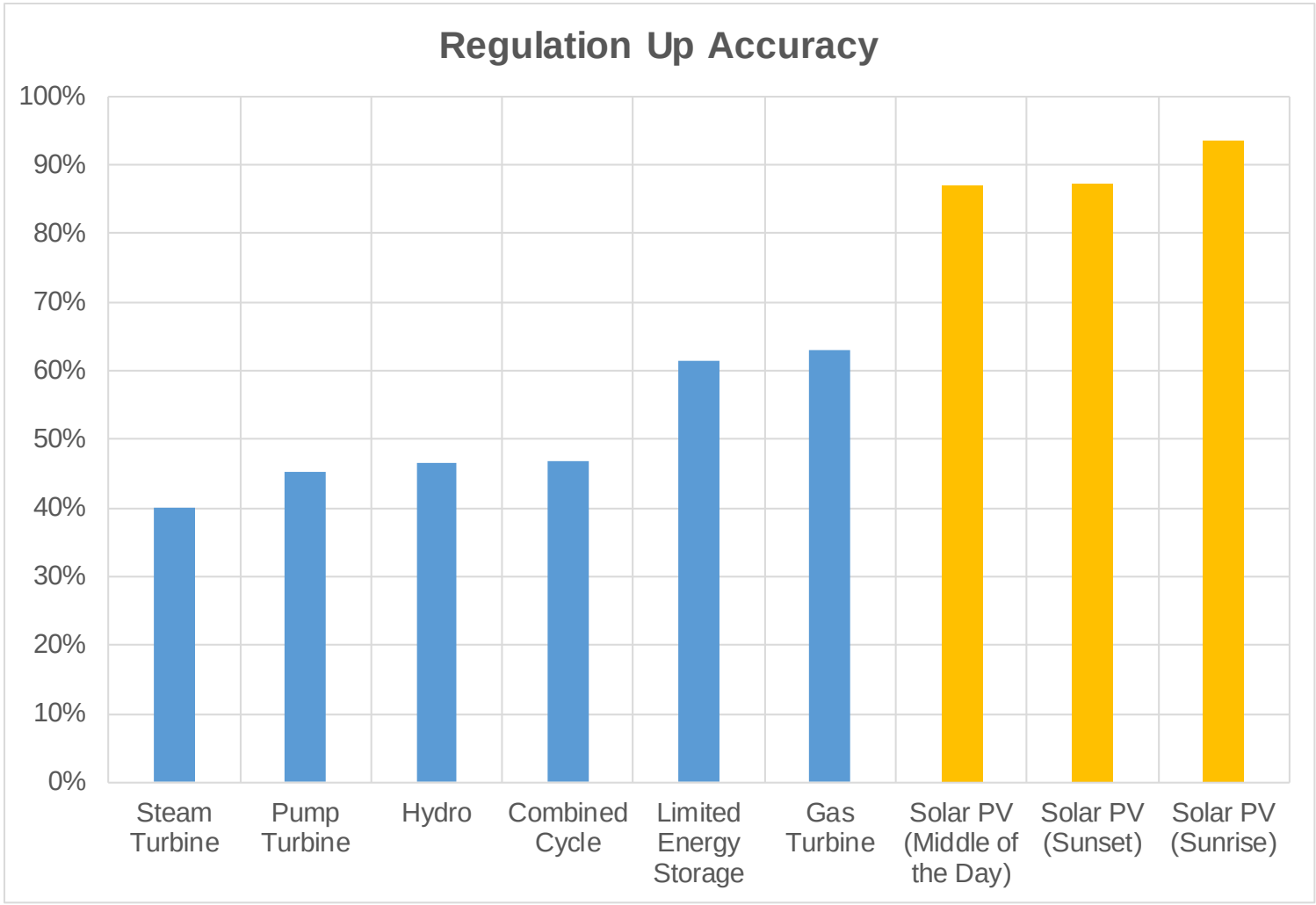
Demonstrated how a solar plant ramping capability can be controlled to a specified ramp rate



Demonstrated that the solar plant was able to accurately follow the 4-second regulation signals

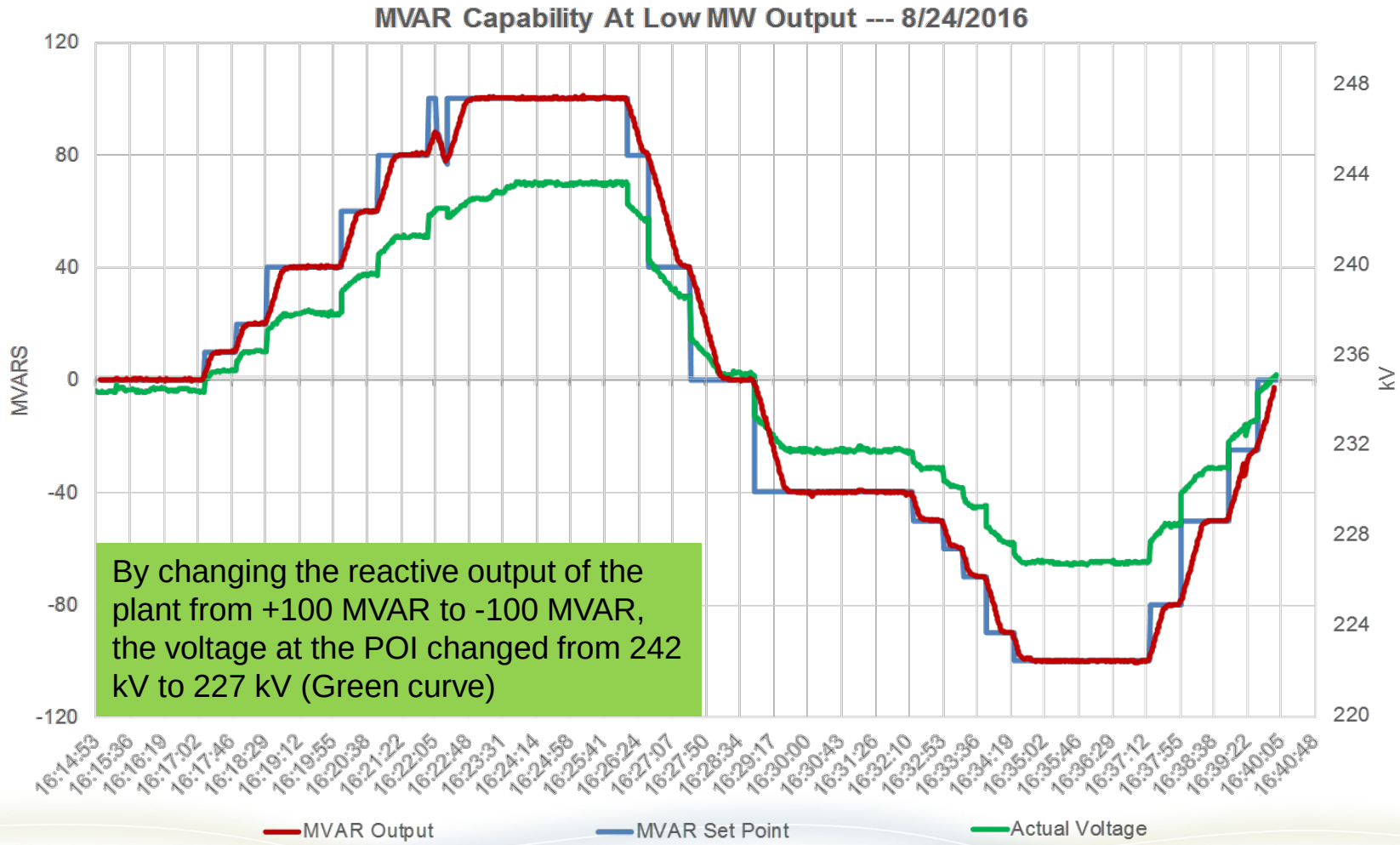


Regulation accuracy of the solar plant demonstration exceeded accuracy of conventional resources



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

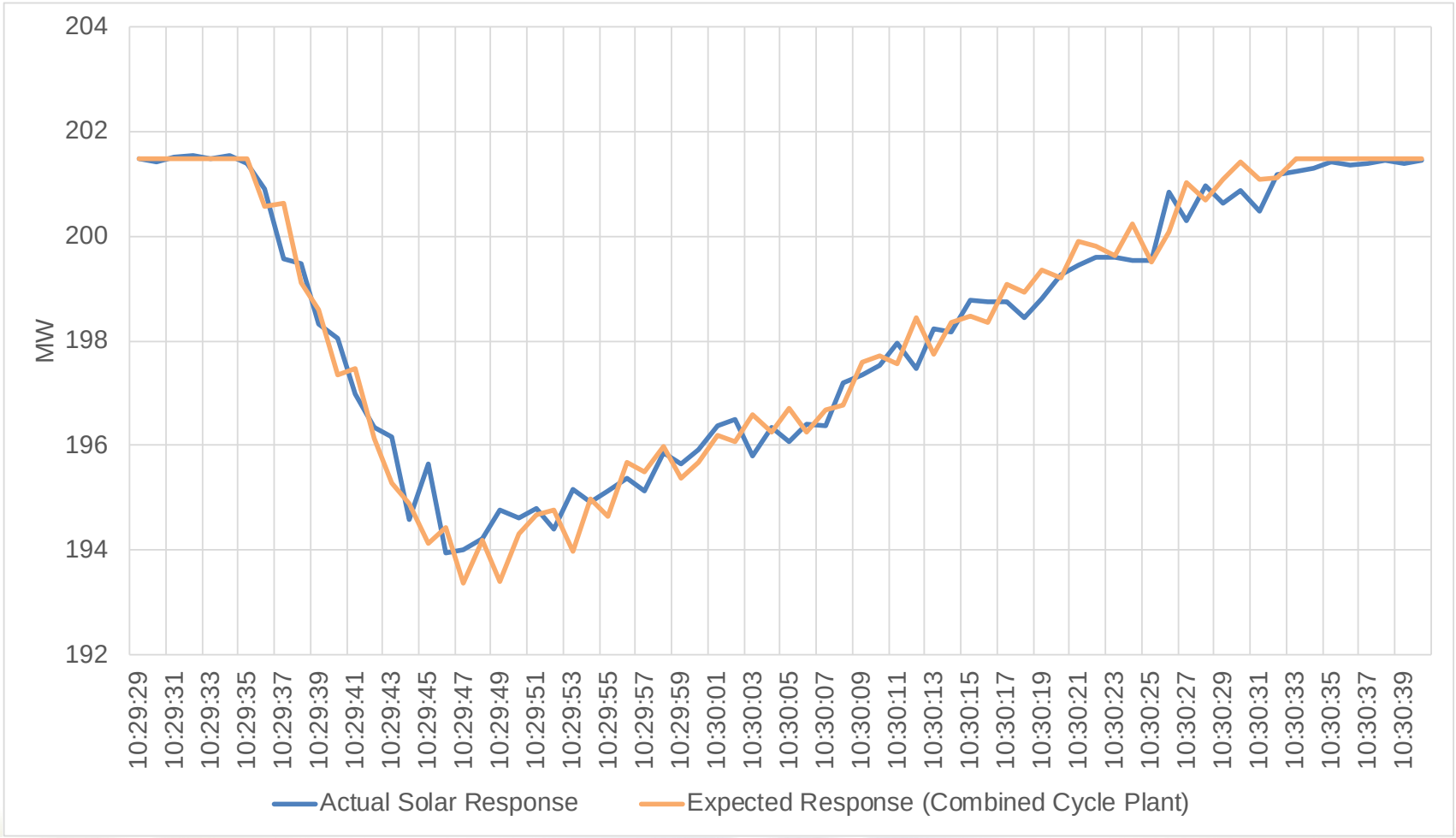
Voltage Control: Test demonstrated the plant's capability to control system voltage at night



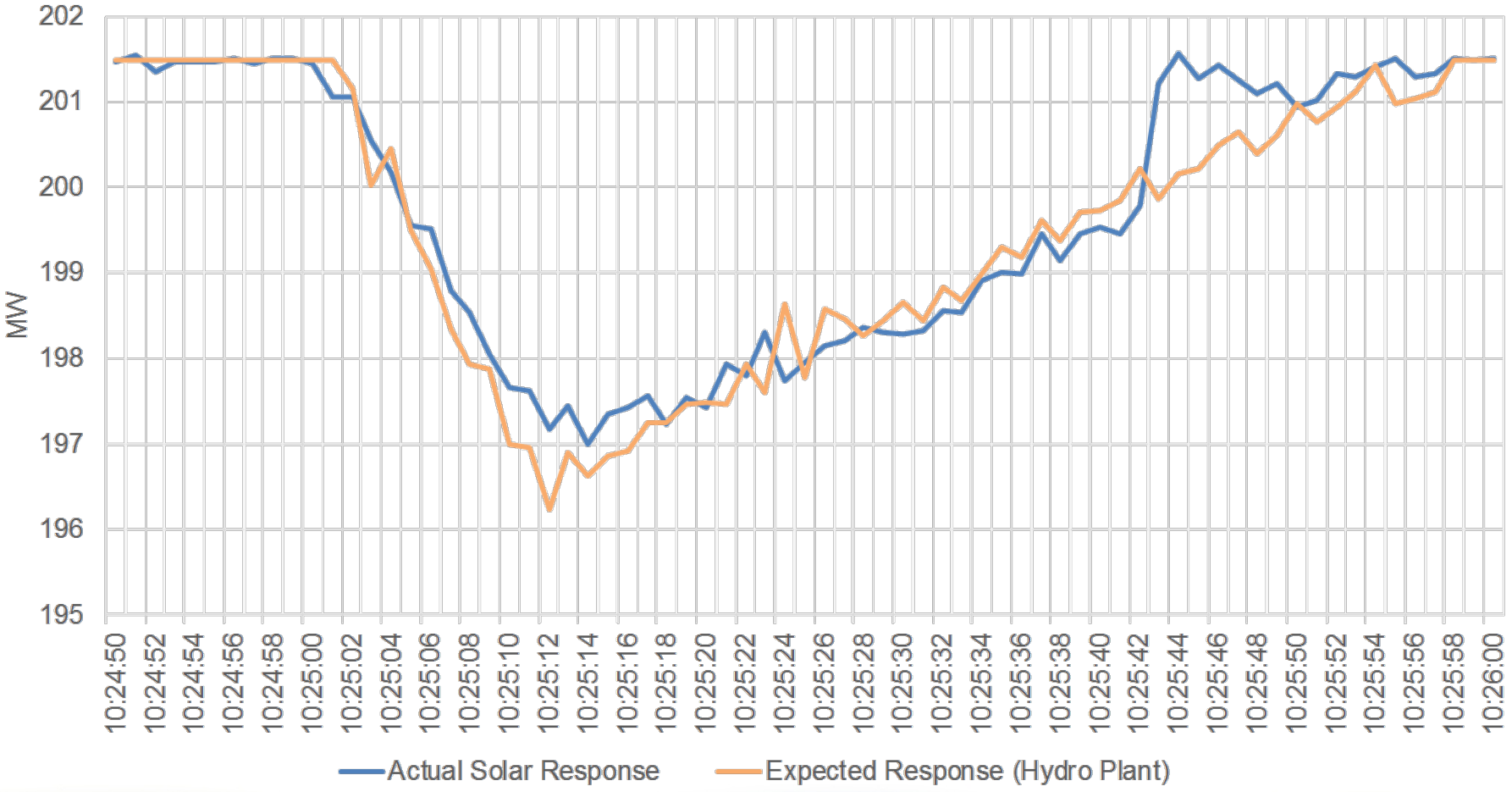
Solar plant frequency responsiveness was similar to or better than conventional resources

Events	Conventional Resource	Performance
Solar PV response to high frequency	Compared to a combined cycle plant	✓
Solar PV response to high frequency	Compared to a hydro plant	✓
Solar PV response to low frequency	Compared to a hydro plant	✓
Solar PV ability to arrest frequency decline within the inertia response timeframe (Fast frequency response)	Compared to a hydro plant	✓

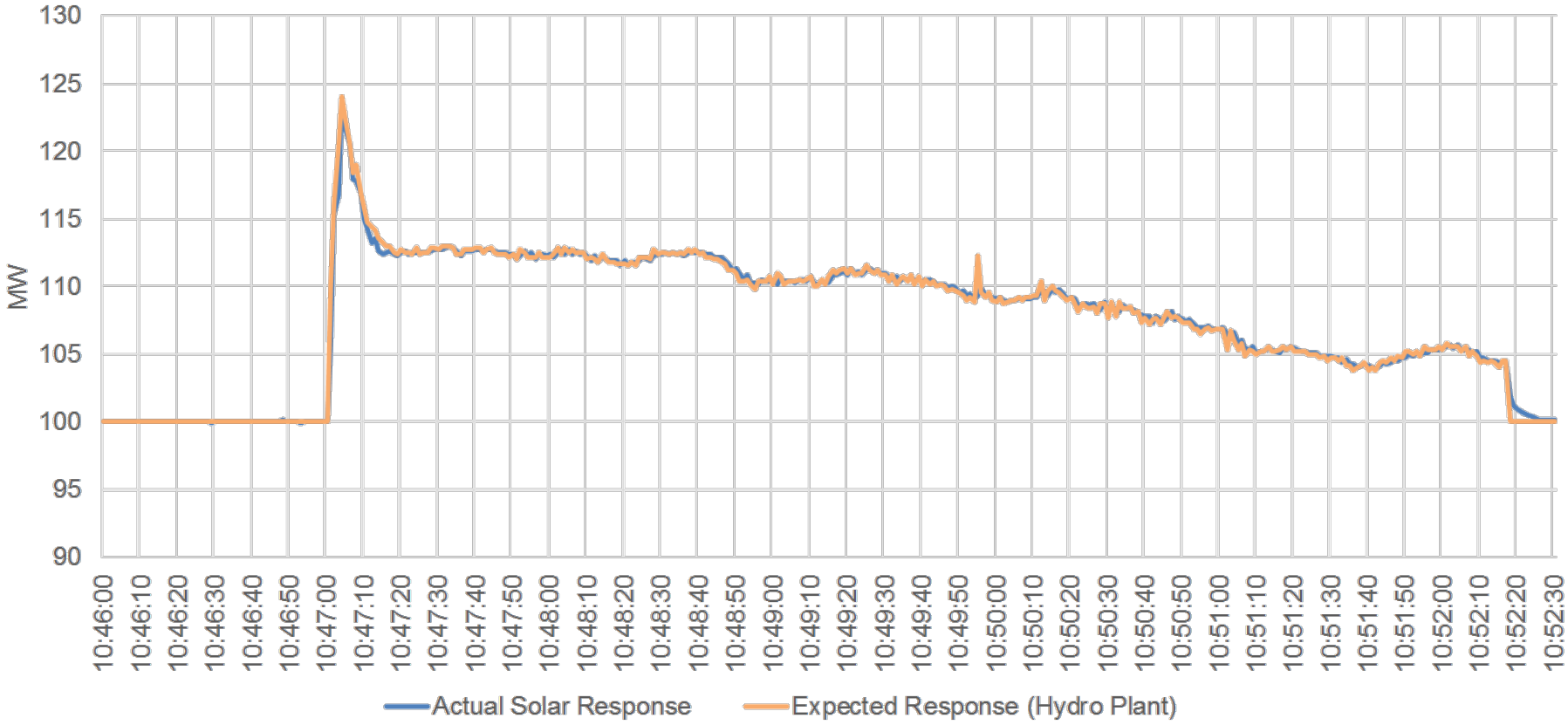
Solar response similar to a combined cycle plant using 3% governor-like droop setting for **high** frequency event



Solar response similar to a hydro plant using 5% governor-like droop setting for **high** frequency event



Ability of solar plant to respond and arrest frequency decline similar to a hydro plant for a **low** frequency event



Next steps

- Continue to share test results:
  - NERC's Essential Reliability Services Task Force
  - NREL & GE Technical Review Committee for the West Wide study on frequency response
  - FERC staff
- Evaluate the existing solar fleet to determine the amount of capacity able to provide essential reliability services
- Further explore additional opportunities for renewable resources to participate in the various markets for energy and ancillary services
- Issue final report in 4th quarter of 2016