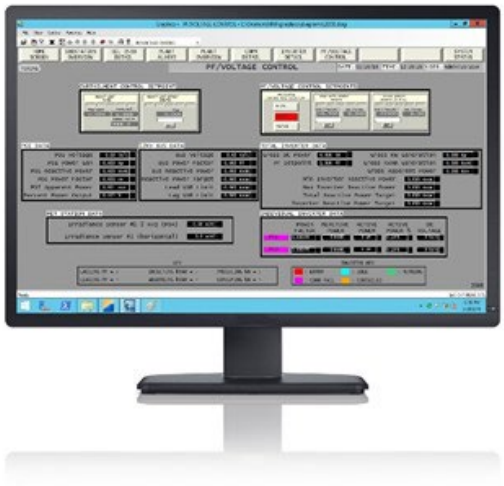
Ovation™ Green for Solar Photovoltaic Plant Grid Interface Control

Features

- Individually adjusts inverters to automatically maximize output
- Controls ramp rates between curtailment setpoints
- Automatically regulates voltage at the point of interconnect (POI)
- Controls POI power factor
- Automatically responds to grid frequency events
- Local and remote control options



Introduction

Solar photovoltaic (PV) plant operators face increased pressure to not only curtail plant output, but also provide controls that support the stability and security of the grids they serve.

Emerson understands these challenges and has optimized its automation technology to meet the unique needs of the solar PV industry. Ovation™ Green full suite of grid interface control features provide stable and secure output control at the plant's point of interconnect (POI) with the grid.

Control features of this solution include:

- Steady state real power output level
- Real power output ramp rate
- Frequency response
- Power factor/reactive power control
- Automatic voltage regulation

Applications

Steady State Real Power Output

Grid operators avoid line overloads and other problems by requiring power plants to adhere to output limits. Sometimes, solar PV plants must adjust to meet the requirements by curtailing the real power output below the

rated limit. However, poor control techniques can result in an inability to achieve the curtailment setpoint, thus reducing revenue.

Ovation Green technology solves this challenge by constantly monitoring and accurately controlling the solar plant's output. Through steady state real power output level control, Ovation Green provides the most constant and highest plant output possible while observing the plant's curtailment setpoint, optimizing the plant's revenue stream.

When the plant array is partially shaded, Ovation Green adjusts inverter setpoints so that inverters connected to sub-arrays exposed to full sunshine can compensate for the shaded sub-arrays, maximizing plant output at the POI and reaching the desired plant output level, whether curtailed or not.

The challenge is in maintaining the desired output level as clouds move across the area, changing the shading pattern on the array. To account for moving shading patterns, Ovation Green continually monitors plant output and the output of each inverter and dynamically adjusts each inverter's curtailment setpoint in real time.

Real Power Output Ramp Rate

Ovation Green allows the plant operator to input a setpoint that limits the ramp rate of the solar plant in either the up or down ramp direction.

Ovation Green's real power output ramp rate control helps grid operators manage system frequency by limiting the aggregate ramps of the 'intermittent resources' (mostly wind and solar generators). This makes it possible for the grid operator to use the aggregate ramping capability of the continuously controllable resources like fossil and hydroelectric generators to keep up with the ramps of the intermittent resources.

Ovation will slow the PV plant's ramp up as the sun rises or anticipating the sunset, begin a ramp down early enough to maintain the ramp at the desired rate.

Ovation also accounts for the variability of PV output caused by intermittent cloudiness. By monitoring the output rate-of-change, Ovation can slow a sudden increase in output to the ramp-up setpoint if the solar resource suddenly increases. However, controlling to a given ramp-down rate when the solar resource decreases unexpectedly is not possible unless the PV facility is paired with a supplemental energy system such as a battery energy storage system, diesel generator, fuel cell or the like, in a hybrid system.

In a hybrid system, which pairs a solar PV plant with a battery energy storage system, Ovation Green manages the output of the facility by directing battery charging and discharging. Ovation maintains the desired ramp rates by either charging the battery with the excess energy when the PV output rises suddenly or supplementing the PV output when it suddenly decreases.

Frequency Response

Solar PV plants must participate in maintaining grid stability by responding as specified to grid frequency events.

Most modern inverters on utility-scale PV plants have on-board controllers that respond to grid over-frequency events by ramping real power downward on an inverter-by-inverter basis. However, some grid operators require the entire plant to respond at a defined ramp rate and/or respond to under-frequency events by increasing output by a defined amount at a defined ramp rate.

Emerson has successfully configured Ovation to satisfy both requirements, resulting in an immediate plant response that mimics an adjustable droop characteristic, similar to a single rotating generator.

Power Factor/Reactive Power Control

Ovation Green's control features include the ability to enter a power factor or reactive power setpoint. It controls either element as measured at the POI.

The control logic includes the ability to specify limits to prevent exceeding any reactive capability limit that might be imposed by the inverters.

Capabilities include switching capacitor banks as needed to maintain the goal at the POI while respecting inverter limits.

Automatic Voltage Regulation

Ovation Green's automatic voltage regulation control option enables input of the target voltage as measured at the POI. These technology adjusts the reactive power setpoints of each inverter to drive toward the target voltage. This is accomplished by accounting for varying impedance between the inverters and the POI.

Ovation Green power factor and voltage regulator control panel

Ovation Green's logic includes the ability to specify power factor limits to prevent exceeding any reactive capability limit that might be imposed by the inverters.

Emerson has also devised Ovation Green's logic that drives power factor to unity when the voltage is within a defined deadband around the target voltage, helping to maximize real power output.

Additional Control Options

Ovation Green's grid interface control for solar PV plants can also be configured to include the following options:

- Plant operator control of breaker opening and closing.
- Interface to solar tracking mechanism controllers (supplied by other vendors), enabling plant operators to change tracking modes of operation from the Ovation operator workstation.