Power Plant Controller - Putting the Power back Into the hands of the Developer

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Abstract

The solar PV and Wind plants are assets which needs to consistently produce power with maximum control and predictability. This dynamic control of grid parameters is necessary in accordance with government guidelines which can be achieved using a power plant controller. The Power Plant Controller (PPC) controls individual inverters to maintain specified active power, reactive power, voltage, power factor and frequency at the Point of Interconnection (POI). Most of the grid codes worldwide mandate use of PPC for any renewable plant over 10 MW in capacity.

Problem Statement

A system that provides the ability to control different parameters in a solar PV plant to achieve utility grid requirements is now necessary for grid stability. The power plant should be able to maintain its performance even with voltage variation subject to availability of solar insolation data.

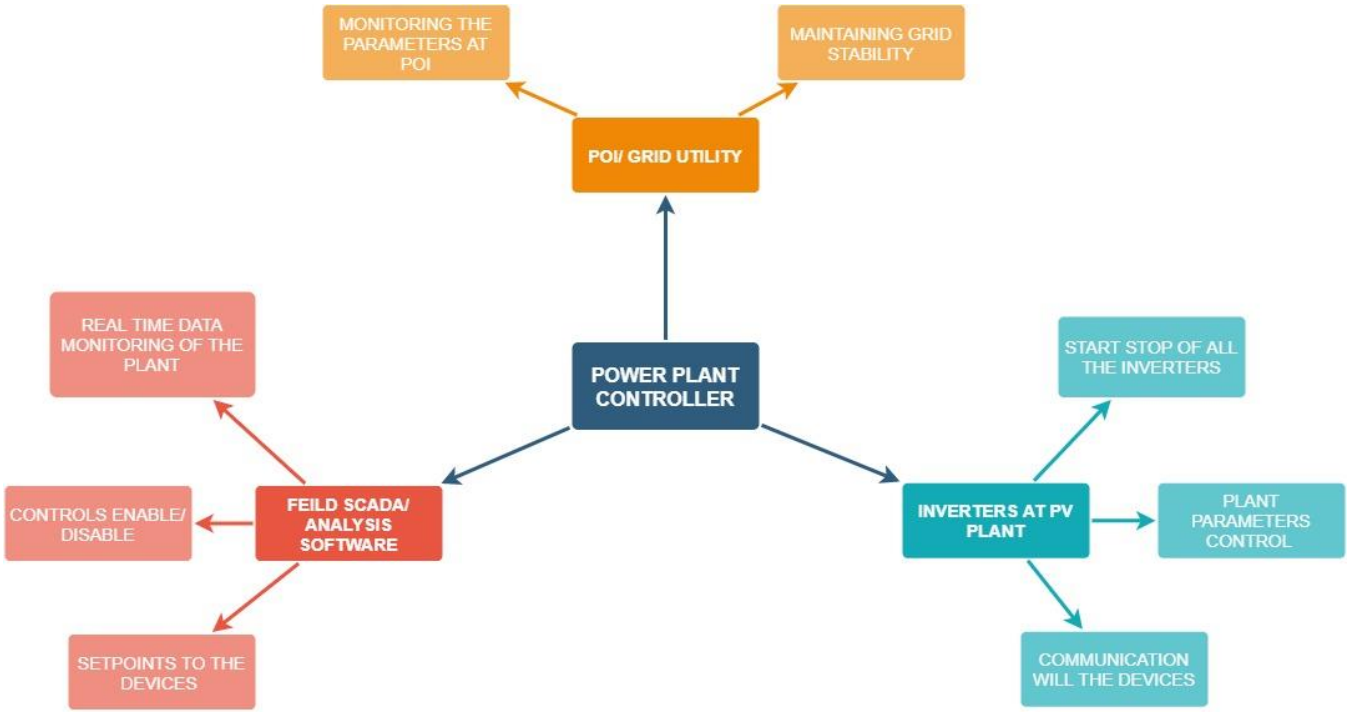
Background

Power Plant Controller

Power plant controller (PPC) is a reliable and flexible solution that can control different parameters present in Solar PV plants to achieve Utility grid requirements at POI (Point of interconnection). Power Plant Controller assurances PV system developer's maximum yields and contributes to the stability of public utility grids.

PPC works in integration with high accuracy power quality analyser, which records all grid parameters at POI during operation for dynamic control of grid parameters in accordance with Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations recommendations for grid connectivity of generating stations. PPC can also integrate with plant SCADA system and can communicate with inverters/power conditioning units directly or through SCADA.

Control behaviour for solar generating stations are amended as The generating unit shall be capable of operating in the frequency range 47.5 to 52 Hz and be able to deliver rated output in the frequency range of 49.5 Hz to 50.5 Hz: Provided that in the frequency range below 49.90 Hz and above 50.05 Hz, or, as prescribed by the Central Commission, from time to time, it shall be possible to activate the control system to regulate the output of the generating unit as per frequency response requirement Provided further that the generating unit shall be able to maintain its performance contained in this sub-clause even with voltage variation of up to + 5% subject to availability of commensurate wind speed in case of wind generating stations and solar insolation in case of solar generating stations.



Solution

PPC systems are capable of meeting the national/international grid operator's requirements for grid stability management with its ability to fixed/variable control the following parameters/functionalities:

- **Active Power Control:**

  Limits the active power injected into grid to a certain limit recommended by utility grid operator based on contracted nominal power or capacity utilization factor (CUF) as per power purchase agreement.

- **Reactive Power Control:**

  Maintains fixed reactive power at POI by controlling the inverters or capacitor banks, whatever be the voltage and power production from PV plant. PPC helps PV plant developer for reactive power settings desired by POI.

- **Voltage Control:**

  Maintains the grid voltage to the reference voltage at point of interconnection by supplying or absorbing reactive power.

- **Frequency Control:**

  Variation in frequency shall be controlled by adjusting (increase/decrease) active power to get desired frequency at POI.

- **Power Factor Control:**

  Maintains constant power factor at POI whatever be the voltage and losses of PV plant.

- **Ramp Rate Control:**

  It limits the increase/decrease of active (MW/min) and reactive power (MVAr/min) value caused by fluctuations in irradiance.

  - Power Oscillation Damping Control

    PPC should provide auxiliary control signal to damp low frequency power system oscillation as asked by the grid code of different countries.

  - Artificial Inertia

    PPC should also provide Artificial Inertial response to frequency deviation in the system. This auxiliary control signal is added to the active power control loop.

1. Why is control of parameters required at point of interconnection (Grid connection point) for solar PV plants?

Distributed bulk solar PV plants feed electricity into grid which originally was designed for centralized. Distributed solar PV plant connects with distribution substations at medium voltages and Transmission substations at medium/high voltage levels, which further connected with overall utility grid.

Grid parameters at solar PV plant point of interconnection (POI) may surpass the acceptable tolerance limits of respective utility grid code norms owing to various reasons, which are listed below.

- Solar PV plants injects fluctuating energy into grid owing to variable solar irradiation.
- Load profile of solar PV plants vary during day and night.
- Irregular energy injection and energy extraction from the grid.
- Variation in grid parameters at point of interconnection due to variation in power injection caused by plant internal faults/outages.
- Variation in active power and reactive power ramp rate due to fluctuations in solar irradiation.
- Sudden increase of load, load shedding and outage of any grid feeder owing to faults.
- Limited capabilities of conventional power plants to balance out fluctuations in utility grid.

Due to variation in grid parameters at POI, Solar PV plant developer shall control the Grid parameters due to following reasons of utility grid operator norms and Central Electricity Authority

(Technical Standards for Connectivity to the Grid) Regulations recommendations for grid connectivity of generating stations.

- Active power at POI shall be controlled due to legal/technical limitations (like contracted nominal power or capacity utilization factor (CUF) as per power purchase agreement) on energy evacuation into grid as per power purchase agreement and grid power transmission feasibility/capability.
- Generating stations more than 10MW installed capacity shall have equipped with active power control facility as per CEA amendment regulations, 2019. As well, PV plant developer shall control the active power injection as per directions of state or regional load dispatch centres for ensuring grid stability.
- For frequency variation of more than 0.3Hz, generating stations shall have facility to provide real power frequency response of at least 10% of the active power capacity as per CEA amendment regulations, 2019.
- Generating stations shall be equipped with rate of change of power (active/reactive power ramp rate) controllers at a rate not more than ±10% per minute as per CEA amendment regulations, 2019.
- Generating stations shall capable to supply varying reactive power to maintain power factor within the limits of 0.95 lagging to 0.95 leading as per CEA amendment regulations, 2013.
- Reactive power withdrawal or return to utility grid as per PPA and respective grid operator grid codes.

2. Advantages of power plant controller compared to SCADA

Power plant controller performs following additional functionality when compared to SCADA.

The main functionality and backbone of PPC is Power Systems Logics which cannot be found in a conventional SCADA or PLC/RTU. These fundamentals are foundations of Power Plant Controller.

- Real-time control of active power curtailment at POI
- Real-time control of reactive power compensation at POI
- Real-time control of voltage at POI
- Real-time control of power factor at POI
- Frequency control at POI
- Ramp rate control of active and reactive power
- Data integration from SCADA and WMS data loggers
- PPC can be controlled from SLDC, RLDC or utility substation as per utility requirements.

Conclusion

Power plant controller helps to dynamically control various grid parameters and provide better grid stability management. Performance of the power plant can be regulated to meet the necessary government guidelines. The power generation over the lifetime of the plant can be assured to a great extent with better equipment safety, greater performance, accurate data analysis and integration in real time, which cannot be achieved using SCADA alone. This gives the solar PV plant developer control over the power generation and the revenue from the plant.

References

- Section B. Connectivity standards applicable to the wind generating stations, generating stations using inverters, wind - solar photo voltaic hybrid systems and energy storage systems. As described in **CENTRAL ELECTRICITY ZUTHORITY, NOTIFICATION. New Delhi, the 6th February, 2019**.
- 08a Guidelines for Collection of Modelling data from solar generation-R1 1 as described in **Power System Operation Corporation Limited.**