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# A Review on Power Management and Power Quality for Islanded PV Microgrid in Smart Village

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## Abstract

**Objective:** To review the challenges of Power management and Power quality for islanded Photo-Voltaic (PV) microgrid for smart village electrification. **Method:** From different reviews, we understand the challenges and facts of power management and power quality for islanded PV Microgrid. The power management solutions are proposed based on smart management system w.r.t load demand and for improving the power quality intelligent Flexible AC Transmission Systems (FACTS) devices are proposed. **Findings:** The islanded PV microgrid a transformative solution to meet the energy demands for smart village or smart city. The intelligent control for power management and power quality will improve the reliability of islanded PV Microgrid in smart village. **Applications:** The smart village or smart city concept bring up by government of India for implement the modern services and modern electrification of rural area, which is the control pillar of Indian development.

**Keywords:** Electrification, Intelligent, Power Management, Power Quality, PV Microgrid, Smart Village

## 1. Introduction

In India more than 70% population is based in villages and it has major contribution for development. The government of India introduce Smart village concept for improving the village life hood, which is helping people lift out of rural poverty from the bottom up with modern energy services. On other side Indian government is promoting solar energy to fulfill the electric demands for present and future. The electrification of rural area is the control pillar for the development of the country. To fulfill the electric demand in villages the solar power is one of the best solution. A recent concept from different non-conventional sources form a distributed power generation systems and it associated with local area load, which is forming a small power grid in the village that is called microgrid as shown in Figure 1. The microgrid will play the main role in future power demands in India. The PV microgrid is a transformative solution to meet growing energy needs in India and its act as a catalyst for rural development. The Photo-Voltaic (PV) microgrid consists of load and distributed generators in same cluster, which are operating as a single controllable system. The microgrid increased the reliability and efficiency of power system and also brings environmental and economic benefits. At same time there are some issues in microgrid like improvement of Power Management, Power Quality, active and reactive power flow control and fault ride through etc.

Among these issues, the power management and power quality has gained more attention. As the load in microgrid does not constant all the time in villages, during peak hours demand is higher than off peak hours. The synchronization of loads and source in isolated mode as well as islanded mode in smart village is main challenge. The Power quality also gained more attention in microgrid due to excessive non-linear and unbalanced loads, which are over-stressing the distribution system and causing system failure in microgrid. The power management and power quality of microgrid is the main concern in Smart

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village. In this paper we are reviewing the challenges Power management and power quality for PV microgrid.

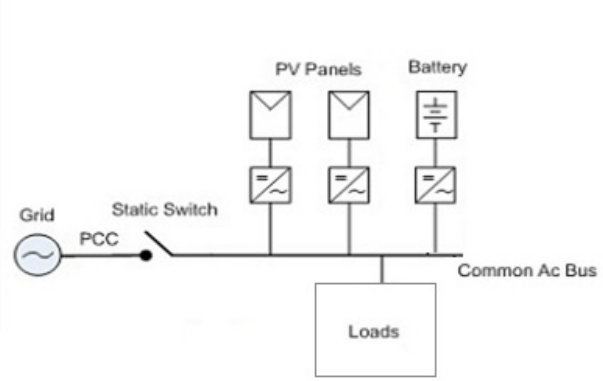


**Figure 1.** Grid connected PV micro-grid for smart village.

In this paper we are briefly present the Power management microgrid Section-1.2. In Section 1.3 describes the factor of Power quality. In Section –1.4, solution for Power management and Power quality. Finally, we conclude this paper in section 1.5.

## 1.1 Power Management Microgrid

The Power management of microgrid has gained more attention. As the load in microgrid does not constant all the time in villages, during peak hour's demand is higher than other demand. So, in peak hours demand microgrid will take the access power from main grid and in off-peak hours demand microgrid feed the access energy to Main grid. On other side, in microgrid power will flow in both the directions from Main grid to load as well as from PV Plant to Main grid based on load demand. Due to main grid connectivity the excess reverse power flow from PV grid, this is causing of instability in Power system. The Power management system improve the stability of the microgrid, by synchronize the loads and source in isolated mode as well as islanded mode in smart village. The following reviews are defining the power management for microgrid.

- In[1] explain about the injection of current control from PV sources to main grid based on direct control method, the current injection affecting the performance of PV grid and its presenting PV microgrid as current sources. Due to lack of control voltage and current regulate and frequency control in PV grid, it cannot operate in island mode[1].
- In[2] explain about Power management strategies and real-time control for direct drive Permanent Magnet Synchronous Generator (PMSG) based variable speed wind turbine. The PMSG is operating as grid-connected and islanded mode. The main focus in islanded mode, on current control method for microgrid. In case of grid-connected mode, he consider the mitigation of voltage sags at the Point of Common Coupling (PCC)[2].
- In[3] explain about necessity of power management for some of the sophisticated and sensitive loads in industries based on semiconductor manufacturing, textile mills, paper mills and plastic injection molding, etc. whereas smaller commercial sensitive loads such as modern digital appliances, VCRs, microwave ovens, computers, electronic data processing equipment, and so on, are all demanding a stable and reliable power supply. Therefore, even a standalone or hybrid RESs based power system requires a proper power management control strategy to meet the load demand.
- In[4] explain power management system for renewable energy source, such as a wind source, cannot operate satisfactorily within the operating limits and meet the load demand due to its intermittent nature. Some additional sources and sinks are required in order to counterbalance the fluctuating nature of the wind. With fast development in renewable energy and Power electronics technology, cost reduction in energy storage and wider applications of the microgrid system, different control strategies and power management systems have been proposed for wind integration.

## 1.2 The Factor for Power Quality

The power quality gain more attention due to use of excessive non-linear and unbalanced loads, which are causing over-stress on distribution network and casing the failure of microgrid. The non-linear or unbalanced loads are representing a high proportion of total load in small-scale network, due to that power quality Problem is particular concern in microgrid. Due to power quality problems a wide range of disturbance like harmonic distortion, voltage sags/swells and interruptions are occurring in microgrid. Voltage sag can cause fail or shut down effect on the sensitive equipments and it's creating a unbalance in current, which will casing trip of circuit breakers. The

following reviews are defining the Power quality challenge for microgrid:

- They explain the effect of voltage Sag on performance of power converters and electrical machines, which are connected to same ac network. How the voltage sag causes the reduction of power quality and increase the current harmonic distortion[5].
- They explain the power quality in PV grid. Generation of PV grid is depends on atmospheric conditions. So, the generation is not constant all the time. For improving the efficiency of PV Grid, efficient control scheme are required to deliver the maximum power. The selection of proper controlling method with grid connected PV system for stable operation under disturbances such as changes in atmospheric conditions change in load and due to faults, which will cause the poor power quality[6].
- It expresses the Power Quality of a system in a practical supply system resembles with the ideal supply system. Due to poor power quality a wide range of disturbance like harmonic distortion, voltage sags/swells and interruptions are occurring in PV microgrid. Voltage sag can cause fail or shut down effect on the sensitive equipments and it is cause a unbalance in current, which will trip the circuit breakers[7].
- The main cause of power quality problem is power electronic components, which required in microgrid to convert DC to AC. The output of inverter in micro-grid should compatible in voltage and frequency with load[8].
- Micro-grid is different from the main grid, in case of microgrid large and sudden changes in load may results voltage transient with large magnitudes in ac bus. The non-linear loads and switching power converters are decreasing the power quality in microgrid[9].

## 1.3 Solution for Power Management and Power Quality

### *1.3.1 Power Management*

To achieve high reliability of PV microgrid in Smart village be need to designed the power management system for synchronize the loads by Smart grid. The Smart grid is providing flexible energy demand according to load in Smart village. It's helping to segregate the sensitive load and normal load in Smart village and providing high priority for sensitive loads, when main grid is outage. The real time power management system will provide reliability of PV microgrid in Smart village[10]. The smart power management system importing and exporting the power from main grid based in following conditions.

Assume Pvgrid= Power from microgrid

Pmain= Power from Main grid

Pvload= Total load in microgrid

If Pvload = Pvgrid ( No power import or export to Main grid)

If Pvload > Pvgrid (Power import from Main grid)

If Pvload < Pvgrid ( Power export to Main grid)

### *1.3.2 Solution for Power Quality*

For improving the power quality in PV microgrid, there are mainly two approaches in Smart village. The first approach is Village side or from utility side based on the load conditions; this approach is called load conditioning. In this case we will ensure that load equipment is less sensitive to power disturbances, and they are operating even under significant voltage distortion also. The second approach is based on external equipment installation near the load or source for improving the power quality. The installation of equipments is line conditioning systems that suppress or counteracts power system disturbances. Some of effective and economic measures can be identified as following for power quality improvement in Smart village[10-13].

- Installation Lightening and Surge Arresters with PV grid.
- Connect the Thyristor Based Static Switches at load side and sources side.
- Energy Storage Systems for PV grid.
- FACTS devices.

# 2. Conclusion

We review the challenges and solutions of Power management and power quality in PV microgrid for Smart village. From different reviews, we understand the instability problem is occurring due the atmospheric conditions for PV grid in islanded mode. To improve the stability of PV

microgrid the Power management is required. On other side, PV microgrid is using the power electronics devices for energy convection and due to unbalance non linear loads the power quality problem is occurring, which is cause of power reliability of PV grid. As name indicate Smart, the real time or Smart control are implement for improving reliability, power quality and stability of PV microgrid in Smart village. In future the PV microgrid with grid connected will be implemented by using FACTS or Artificial *Neural Network* (ANN) control to achieve the high stability and reliability of the system in Smart village electrification.

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