International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Grid Integration of Solar Photo Voltaic System

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ABSTRACT

To overcome the disadvantages due to the usage of fossil fuels, using renewable energy sources (RES) is an alternative solution. Among the available RES, solar energy has better edge. Solar photovoltaic (PV) sources are becoming more and more prevalent in the energy market. When compared to other energy sources, solar energy has a cheaper production cost. Due to aggressive goals established by various countries to integrate PV sources into the electrical grid, the cost of solar panels is falling, solar panel efficiency is increasing, and power electronic gadgets are becoming more common. The technology that enables solar power generated on a big scale from PV systems to the power grid is known as solar grid integration. The energy source can help to keep a power grid's voltage stable. Proper sizing and location of the PV system on the grid should be done to avoid negative impact on system parameters, leading to grid voltage instability

Keywords: grid integration, photovoltaic, electricity grid

INTRODUCTION

The smart grid's bidirectional data flow identifies it as a distributed, automated energy delivery system requires both energy and data. It includes various DER, to balance power, communications and distributed computing are used. The power system must remain operational to work properly, isolate problems, and provide faster service restoration. Supply and demand equilibrium demand, a suitable network architecture, backup strategy analysis, short-circuit testing, and relay safety coordination all require extensive research. The advanced grid features necessary for system operation, monitoring, pricing, and security necessitate communication networks. Connecting different power system stakeholders digitally through communication and information flow is essential. The smart grid initiative's core objective is economics, which aims to preserve quality while reducing overall production costs. Various rules and regulations are in place to support and advance the transfer of power. Numerous technoeconomic analyses will need to be conducted as a result of this new endeavour. The energy industry is rapidly growing. The cost of producing solar energy is less than that of traditional energy sources. Utility-scale PV's levelized cost of power (36–44 USD/MWH) is comparable to onshore wind's (29–56 USD/MWH), and in some cases even less expensive depending on where the installation is located. The cost of solar panels has been steadily declining, panel efficiency has grown due to technological advancements in power electronics related to tics, and most crucially, PV sources are being incorporated into the current electrical grid in order to meet ambitious national targets. The PV system can be separated, from the utility's point of view stand-alone system and grid feeding system, respectively, into two categories. The independent PV system can be separated further into two categories: PV systems with storage and those without in the gathered energy from a stand-alone PV system with storage assists in supplying the load while recharging a battery. When the PV system is utilised without storage, the energy harvested is lost.

To lessen the need for bulky, costly, and temporary technologies Grid-connected mode should ideally be used while using PVs. The main objective of every PV plant is to maximise the amount of power generated by the solar panel. But the ability of the PV plants to operate depends on the load required also o-MPP. MPP is therefore a preferred but not required option condition.

System architecture for power:

The whole network of the electricity system, as depicted, can be separated essentially into three sections. In general, power is produced at multiple power plants with a varied voltage level ranging from 1.5 to 25kv. The voltage and wattage are increased which is sent across the transmission network. The transmission network's voltage ranges from a 220 to 765kv. The subtransmission further transmits this power 66 or 132kv network, then to the distribution network, then to the distribution system. There are two categories for the distribution network: primary/medium voltage (MV) distributed network (11 KV), and low voltage secondary distribution network. The MV and LV distribution networks are connected to respectively, industrial and residential loads. Every rooftop PV system is linked to the second distribution system the focus of this piece roof-top PV grid integration is the sole topic of discussion in this material is solely intended for secondary dissemination.

Architecture of PV plants:

Three categories of grid-connected PV systems exist categories based on installation capacity, which include the following:

1. 1.Utility scale (1-10MW)
2. Huge scale (10-1000KW)
3. Small-scale (10KW or less).

The tiny PVs only cover 12% of the roof. India has a 1247 MW total PV capacity. India is planned to construct rooftop PV systems total in 40 additional GW by 2022. Despite the fact that roof-top PV has a lower relative wattage than the utiliy-scale PVs, installations are automatically increasing higher. A small-scale grid's numerous modules supplying a PV plant. transfer of energy from the PV panel to the grid via a power converter. The corresponding regulates both the kind and volume of electricity sent. While supplying electricity to the grid, there are rules that both the power stage and the control stage must abide by as minimum requirements. Regarding the utility's integration of PVs, numerous national and international standards have been developed. These standards specify fundamental operating guidelines and power quality recommendations, security precautions, and the PV's response to ensure adequate grid integration, take into account atypical grid conditions, etc.

Fig 1: Different components of a small-scale grid-feeding PV system

System of Distribution:

The primary focus of study in the field of PV grid integration is micro grids. The MICROGRID is defined by the U.S. Department of Energy as "a group of interconnected loads and DERs that operate in both grid connected and island modes and have clearly defined electrical boundaries that work as a single controllable entity with respect to the grid and can connect to and disengage from it."

1) A distinctive electrical barrier.
2) A controller that controls the DERs and loads to function as one, controllable unit.

Numerous active sources are immediately connected to the distribution network thanks to the rooftop PV integration.

1) There isn't just one relationship.
2) There isn't a switch that can be turned on or off to connect it to the main grid.

Smaller installations that fit the bill, like a fresh apartment, a commercial structure, or a tiny island, can be categorised as micro grids. Only a neighbourhood of rooftop solar systems with a single point of coupling to the distribution network can ensure the first criteria, which is a clearly defined electrical boundary.

Contribution and Article Organization

This article's contributions can be summed up as follows.

1) Attempts to integrate roof-top PV into the existing distribution network by using small-scale single-phase inverters to satisfy a number of technical requirements.

2) To bridge the gap between the study of micro grids and the integration of PV into the existing distribution system, emphasises various aspects of micro grid research that may be immediately applied in a grid-feeding PV plant. gives a visual representation of this idea.

3) Gives a summary of the standards, power interface architectures, grid synchronisation techniques, and control methodologies for grid-connected, low-voltage PV systems that should respond in a reasonable amount of time.

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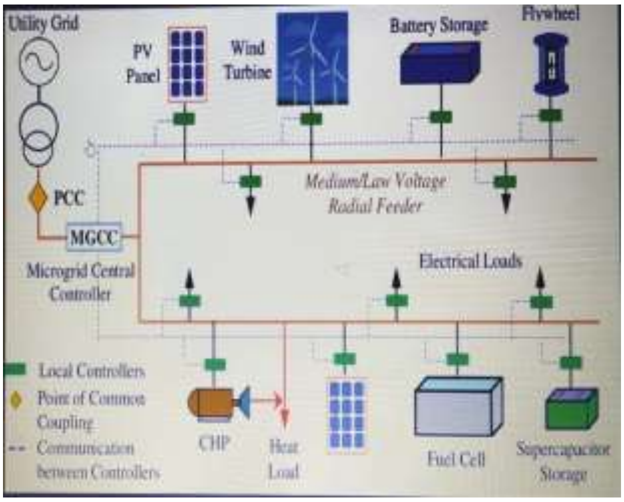

Fig 2: From micro grid to active distribution network

Voltage Variability:

Voltage quality in the distribution network is impacted by PV's intermittent nature. Contrary to the advice of other standards (IEC 61727 and IEEE 1547), which state that the PV should not actively manage the PCC voltage, other standards (IEEE 1547 a) imply that the PV may control the PCC voltage by controlling the active and reactive power input. Voltage fluctuation is defined as a series of erratic voltage fluctuations or a regular alteration of the voltage envelope, whose magnitude normally falls within the set voltage range. A similar scenario could take place when a PV plant is connected to the grid, which could raise the voltage at the point of common connection. Various standards have limits on voltage fluctuation. Alternatively, if a PV plant is linked to the grid at time t = 0, the voltage will be zero.

Cdc = Grid Ppv 2 Vdc Vdc

Three categories can be used to group PV plants:

1) Plants with low-frequency transformers, high-frequency transformers, and plants without isolation are listed in order

2) Without an isolation transformer, the grid integration of PV plants is prohibited in many nations. However, these non isolated PV inverters are continuously receiving study attention because of their superior efficiency, power density, and lower price.

3) The following discusses two key problems with transformer-free PV inverters, and alternative topologies are developed to solve these problems.

Based on a decoupling network, also known as a DC decoupling network, established between the converter and the dc link. The technique known as b) AC decoupling network based on adding a decoupling network between the converter and the filter network. Therefore, it is essential to precisely and quickly identify the grid voltage's amplitude, phase, and frequency. There is a significant demand for proper synchronisation units since grid regulations and standards are becoming more stringent. There are numerous grid synchronisation methods suggested in the literature that use zero crossing detection, Kalman filtering, artificial neural networks, frequency locked loops, and PLL. There are often two types of PLLs, as seen in: PLL

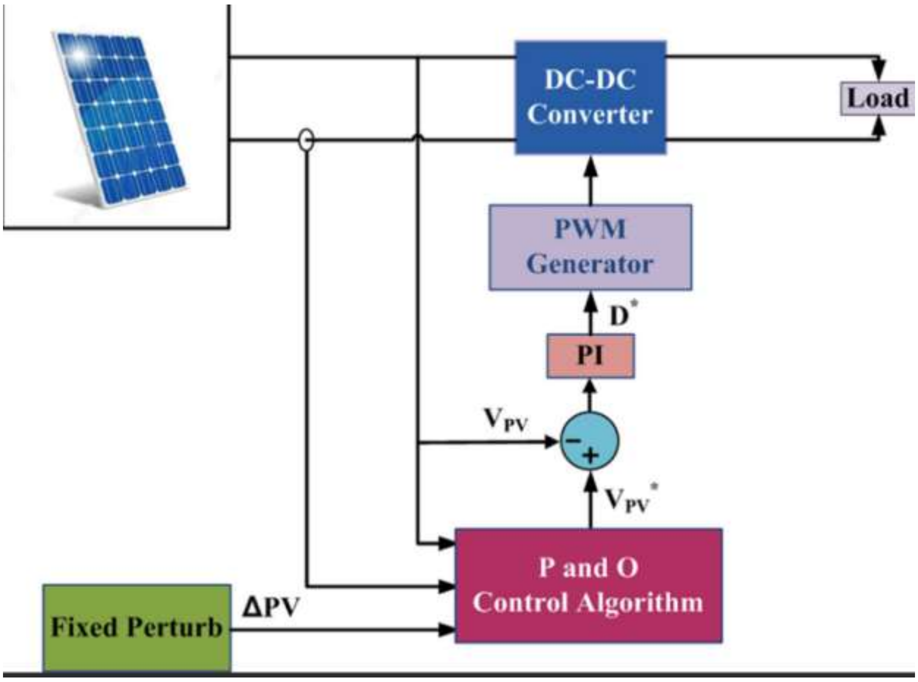

Fig 3: A PV plant's block diagram displaying its location

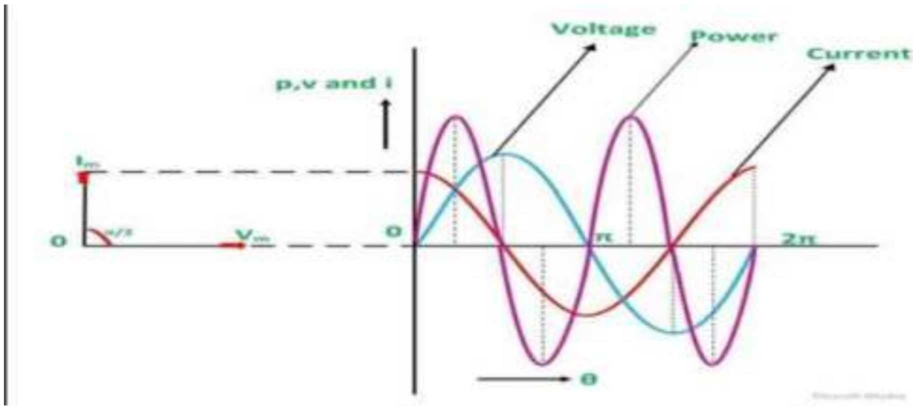

Fig 4: waveform of the decoupling capacitor's voltage

Using OSG. PLLs are extensively used in the communication sector as well as in power electronic systems. The PLL's basic working idea is to multiply the estimated voltage by the sensed grid voltage grid. The literature investigates several filtering methods to address these shortcomings. Depending on the filter that was used, the PLL is further separated into LPF-based PLL, NF-based PLL, MAF-based PLL, DFAC-based PLL, etc. To reject the double frequency disturbance, the LPF requires a low cutoff frequency. This low cut off frequency leads to a laggy transient behaviour of the PLL loop. The projected shift in the grid frequency affects the notch bandwidth in the case of NF-based PLL.

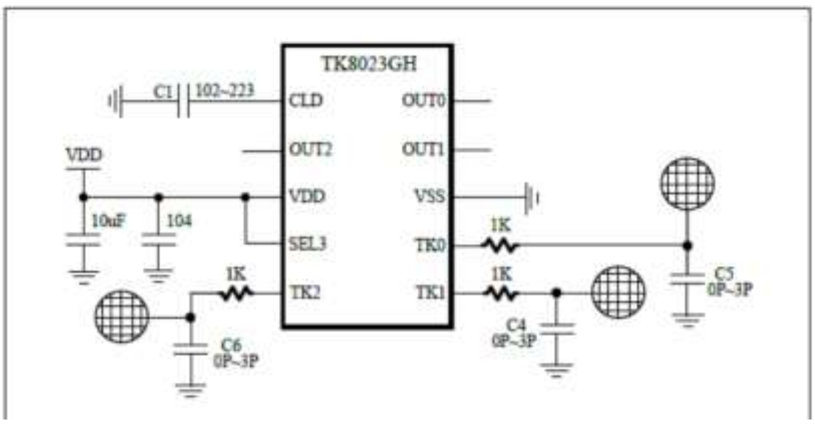

Fig 5: An example of a block diagram for a PLL product;

Conclusion:

Several aspects of a grid serving a small PV installation are covered in this article. There is a summary of the different grid integration regulations. The configuration of the power stages in the grid-connected PV system can change. Also included are in-depth reviews of several control theories and grid synchronisation strategies. When reviewing the numerous technological requirements for integrating the roof-top PV into the current low voltage distribution network, the essay discovers some substantial research gaps. The article's introduction to some of the primary issues faced in this field and familiarisation with the subject matter would be helpful to beginning researchers.

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