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SOLAR ENERGY GRID INTEGRATION SYSTEMS

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ABSTRACT Solar Energy Grid Integration Systems (SEGIS) concept helps in achieving high penetration of photovoltaic (PV) systems into the utility grid. Advanced, integrated inverter/controllers will be the enabling technology to maximize the benefits of residential and commercial solar energy systems, both to the systems owners and to the utility distribution network as a whole. Advanced integrated inverters/controllers may incorporate energy management functions and/or may communicate with separate-alone energy management systems as well with utility energy portals, such as smart metering systems. The value of the energy provided by these solar systems will in turn be increased through advanced communication interfaces and controls.

KEYWORDS : Solar Energy Grid Integration Systems, Solar Energy, integrated inverter/controllers

INTRODUCTION

Solar-grid integration is a network allowing substantial penetration of Photovoltaic (PV) power into the national utility grid. This is an important technology as the integration of standardized PV systems into grids optimizes the building energy balance, improves the economics of the PV system, reduces operational costs, and provides added value to the consumer and the utility.¹

Integration technology has become important due to the world's energy requirements which imposed significant need for different methods by which energy can be produced or integrated, in addition to the fact that integration of solar energy into non-renewable sources is important as it reduces the rates of consuming of non-renewable resources hence reduce dependence of fossil fuels. Photovoltaic or PV system are leading this revolution by utilizing the available power of the sun and transforming it from DC to AC power. Integrating renewable energy of this source into grids has become prominent amongst researchers and scientists due to the current energy demand together with depletion of fossil-fuel reserves and environmental impacts.²

How Is Solar Power Generated

All solar power systems work on the same basic principles. Solar panels first convert solar energy or sunlight into DC power using what is known as the photovoltaic (PV) effect. The DC power can then be stored in a battery or converted by a solar inverter into AC power which can be used to run home appliances. Depending on the type of system, excess solar energy can either be fed into the electricity grid for credits, or stored in a variety of different battery storage systems.³

Solar Power Is Generated In Two Main Ways:

Photovoltaics (PV), also called solar cells, are electronic devices that convert sunlight directly into electricity. Solar cells were invented in 1954 at Bell Telephone Laboratories in the United States. Today, PV is one of the fastest-growing renewable energy technologies, and is ready to play a major role in the future global electricity generation mix.

Solar PV installations can be combined to provide electricity on a commercial scale, or can be arranged in smaller configurations for mini-grids or personal use.

Concentrated solar power (CSP), uses mirrors to concentrate solar rays. These rays heat fluid, which creates steam to drive a turbine and generate electricity. CSP is used to generate electricity in large-scale power plants.

A CSP power plant usually features a field of mirrors that redirect rays to a tall thin tower. One of the main advantages of a CSP power plant over a solar PV power plant is that it can be equipped with molten salts in which heat can be stored, allowing electricity to be generated after the sun has set. $^{\rm 4}$

Solar Panel Grid

A grid-connected photovoltaic system, or grid-connected PV system is an electricity generating solar PV power system that is connected to the utility grid. A grid-connected PV system consists of solar panels, one or several inverters, a power conditioning unit and grid connection equipment. They range from small residential and commercial rooftop systems to large utility-scale solar power stations.

When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load, to the utility grid.^s

The arrangement of solar modules absorbs the sunlight on them and convert them into electricity. The current generated here is Direct Current (DC). The solar inverter then converts the DC to Alternating Current (AC), thus making it power the electrical items.

This electricity is then routed to the grid where it is supplied for day to day use. An important feature is a net meter. It is a device that records the energy supplied to the grid and the energy consumed. At the end of each month, the outstanding is recorded and the consumer is provided with a bill.

The solar systems can be classified into 3 different categories based on their grid-connectivity. They are on-grid solar, off-grid solar and hybrid systems which are a combination of both.

Types of Solar Systems⁵

On-grid Solar Power System:

On-grid solar power system is a solar power generation system where it is connected to the utility grid. The electricity produced by the system is routed to the grid from where it is used to run the various appliances.

Benefits:

- Zero Electricity Bills
- Easy maintenance
- Passive income generation

Off-grid Solar Power System:

In off-grid solar system, one is completely dependent on sun and energy stored in batteries for the power.

Benefits:

Most off-grid solar systems are designed to produce a certain amount of "extra" electricity in the daytime, which is sent to batteries for storage. The energy stored in those batteries can then be accessed when the system is not producing, like at night or during cloudy weather.

Hybrid Systems:

The hybrid solar energy system is a combination of On-Grid and Off-Grid based solar energy systems. In simple terms, it is a grid connected solar power system with a battery backup added.

Benefits:

- The best thing about hybrid solar systems is that they store solar energy and low-cost electricity.
- Use of solar energy at peak usage times is made possible.
- They can be used for advanced energy management.
- Enables energy independence.

CONCLUSION

Integrating PV system into national grids can reduce transmission and distribution line losses, increases grid resilience, lower generation costs, and reduce requirements to invest in new utility generation capacity. Thus, this system proves to be very resourceful in future.

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