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# Review : Efficient Integration of Solar Energy with Conventional Grid

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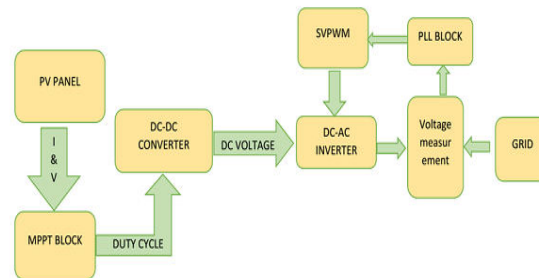
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**ABSTRACT:** A work on the review of efficient integration of solar energy with conventional grid is presented. Integration technology has become essential due to the world's energy requirements which put important need for different methods by which energy can be generate or penetrated, in addition to the fact penetration of solar energy into non-renewable sources is important as it decreases the rates of consuming of non-renewable resources hence reduce dependence of fossil fuel. Photovoltaic or PV system are leading this revolution by use the available power of the sun and convert it from DC to AC power. Integrating renewable energy of this source into grids has become outstanding amongst researchers and scientists due to the current energy demand together with reduction of fossil-fuel preserve and environmental effect .In this review, current solar-grid integration technologies are identified, benefits of solar-grid integration are focused, Wavect controller uses for analyses the solar system penetration to grid , Integration issues and well suited of both systems (i.e. solar and grid generations) are briefed from both the solar system side and from utility side. This review will help in the implementation of solar-grid integration in new projects without repeating apparent challenges happened in existing projects, and provide data for researchers and scientists on the possibility of solar-grid integration.

**KEYWORDS:** Solar Photovoltaic (PV), Grid-tied PV system, Wavect controller, Inverter, MPPT and PLL

## I. INTRODUCTION

Renewable energy is increasingly considered important for meeting current and future energy requirements. Photovoltaic (PV) power, as it is clean and unlimited source of energy is in most likely the best technology amongst all renewable energy sources and therefore an appreciable amount of research has been conducted recently in this field. To better use the PV power, grid interconnection of PV system is required. It is normally accepted in the scientific community that human activities actively contributing in climate change and that a most of this effect comes from fossil fuel combustion originate by the electric utility industry. Conventional fossil-fuel producing facilities have in past met the majority of global electrical energy inquire however, environmental and climate change implications of fossil fuel-based producing present serious challenges to society and the environment. Distributed Generation (DG), specially Photovoltaic (PV) systems, provides a means of mitigating these challenges by producing electricity directly from sunlight. Unlike off-grid PV systems, Grid-Connected Photovoltaic Systems (GCPVS) manage in parallel with the electric utility grid and as a result they need no storage systems. Since GCPVS supply power back to the grid when generating excess electricity (i.e., when produced power is greater than the local load demand), GCPVS help offset greenhouse gas emissions by displacing the power required by the connected (local) load and giving additional electricity to the grid. As such, during peak solar hours (maximum solar irradiance), fewer conventional generation plants are required. In addition, GCPVS decrease Transmission and Distribution (T&D) losses. In this paper, we focus our attention on the growing adoption of GCPVS and the technical challenges produce by the mass addition of these DG systems on the overall performance and reliability of the electric grid. A review of the standards governing the safe installation, operation and maintenance of GCPVS, and the known methods of refine efficiency of PV systems are presented. We are focusing on the role of the wavect controller as an active grid participant. It is software that is used to analyse the solar power system .



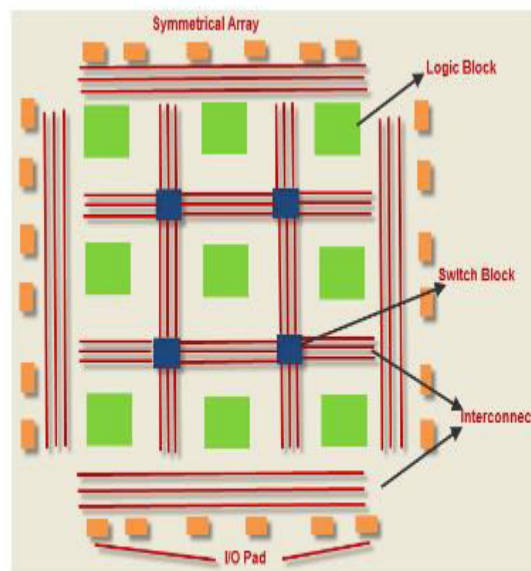
**Figure 1.** Solar Energy module with grid synchronization

## II. WAVECT CONTROLLER

WAVECT Controller is a compact, flexible actual time manage prototyping system. Comprising of excessive stop FPGA for instant computing and I O (input output) dual core processor for manage and communication, scalable embedded voltage and current sensors, huge wide variety of PWM outputs and excessive pace IO's, it's far designed to cope with present day complicated problems. Coupled with an smooth and effective model based improvement environment, push button tool binary and configuration generation and a devoted instrumentation software, its paperwork a entire manage prototyping solution.

### II (a).Field Programmable Gate Arrays

Field Programmable Gate Arrays (FPGAs) are integrated circuits that are based mostly around a matrix of configurable logic blocks (CLBs) connected via programmable interconnect. FPGAs may be reprogrammed to desired application or practicality needs once manufacturing. FPGAs has some applications such as: Medical,Industrial, wired communication, wireless communication, Consumer electronics.

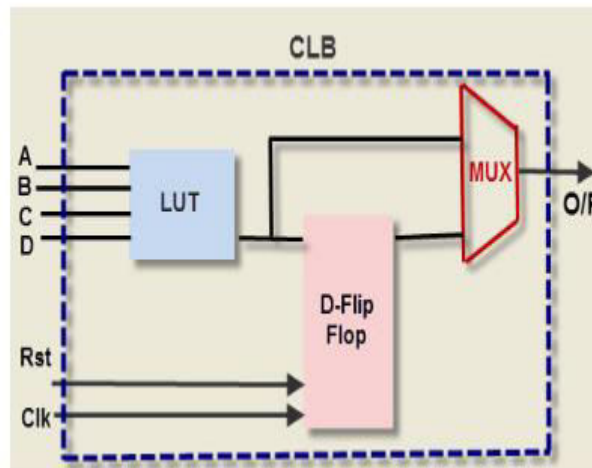


FPGA Architecture

**Figure 2** FGPA Architecture

### II(b) Configurable Logic Blocks

A CLB is that the elementary element of an FPGA, permitting the user to implement just out any logical practicality among the chip. It will be achieved by the usage of 2 sets of similar parts within a block, called slices. There are two differing kinds of slices, said as SLICEM and SLICEL, and every CLB can contain either a SLICEM and SLICEL or two SLICELs. There are roughly doubly as several SLICELs than SLICEMs on a chip, although the precise numbers vary by device. These slices contain four look-up-tables (LUTs), eight flip-flops (FF), a network of carry logic, and 3 types of multiplexers.



**Figure 3** Configurable Logic Blocks Architecture

### II(c) .Slice

Slices exist in CLB. Every slice contains 2 lookup tables and two registers. There are different logics in each slice, such as: electronic device (F5, F6, F7 and F8 multiplexer), wiring and carry logic. it's the fundamental logical unit outlined by Xilinx. A slice consists of two 4-input functions, carry logic, arithmetic logic, storage logic, and performance multiplexer.

### II (d). Lookup table in FPGA

Image result for search table in CLB search table is actual made-to-order truth table that is loaded with values that are relevant to FPGA, supported specific wants and instructions. We will even think about our custom search Table or LUT as a tiny low piece of RAM that's loaded whenever we tend to power up FPGA chip.

### II (e). Flip-Flop

A flip-flop is the smallest storage useful resource at the FPGA. Each flip-flop in a CLB is a binary register used to store logic states among clock cycles on an FPGA circuit.

### II(f) Advantages of Wavect Controller

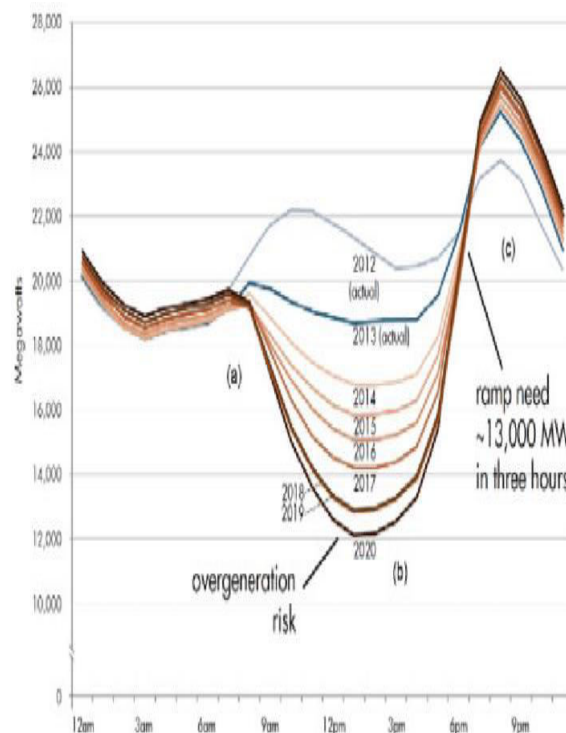
It makes easy to analyze the solar power system.

- .Less time consuming
- .More accuracy
- .More compatibility
- .To detect fault easily
- .Measurements of voltage , currents and power becomes easily



### III. ISSUES CAUSED IN GRID-CONNECTED PV SYSTEMS

As the overall costs of installing and owning GCPVS systems are fall off, residential, commercial and utility scale assumption of this technology is on the rise. While there are many benefits of GCPVS, such as its long working life (25–30 years), low operations and maintenance costs and apparent environmental advantages over fossil-fuel power plants, while, GCPVS have their own set of challenges. A number of professional works have advise that the mass assumption and expansion of GCPVS could create vast stress on the electric grid. The root of problem is the built in functional nature of GCPVS, primarily because their output production decreases as the sun goes down. Accordingly, they are unable to sufficiently give to the grid when demand escalation in the hours following sunset (when demand for electricity is greatest). During this period, electric utilities ramp their generation from traditional generation plants to meet this rise in demand.



**Figure 4.** CAISO's duck curve[10]

Zones (a) and (b) in the duck curve constitutes the morning and mid-day net demand loads respectively. Zone (b) has the least regularity because the increase in the generation from renewables (mostly) (c) is conventional plants will look the most stress. The in-secureness of DG resources (especially solar and wind) means that utility providers may not be able to properly control and plan for the fluctuating system electricity requirement.

According to CAISO, ramps, over-generation and the resulting effect on frequency response will require to be rapidly addressed as more GCPVS are installed, commissioned and connected to the grid. There are a number of solutions to these problems. Because traditional generation resources (steam combustion turbines and nuclear plants) take hours to start and upgrade investment in generation plants able of quick ramping, especially gas compensation engines and simple-cycle combustion turbines, can help reduce the effects of the pressure on the grid.

### IV. GRID CONNECTED PV INVERTER

In the grid-connected PV system, the DC power of the PV array need to be converted into the AC power with proper voltage magnitude, frequency and phase to be connected to the utility grid in these circumstances, DC-to-AC converter

which is better known as is needed. here are many kinds of grid PV inverters . The line inverter, in which the utility grid dictates the commutation process (the commutation process initiated by reversal of AC voltage polarity) power switching devices like commutating thyristors. The turn-on operation of this device can be controlled by the gate terminal of the device while the turn off cannot be controlled by the identical.

Turn off device is performed with the help of an add on circuit to the device. on the other hand, the self inverter, where the current is shifted from one switching device to another in a controlled manner, is characterized in that it utilize such a power switching device, the potential at the gate terminal of which can control both the turn-on and the turn such as Insulated Gate Bipolar Transistor (IGBT) and Metal Oxide Semiconductor Field Effect Transistor (MOSFET). Power MOSFETs are utilized for low power typically less than 10 kW and high switching working (20–800 kHz) and IGBTs are utilized for medium-to-high power exceeding 100 kW, but very high-frequency switching is impossible utilizing IGBTs as the switching frequency is limited to 20 kHz. In case of grid-connected frequency switching is needed to decrease an inverter's output-current harmonics, size of the magnetic (filter) utilized and weight of the inverter. The self inverter utilizes a pulse width modulation (PWM) switching techniques to generate the output. The self-commutated inverter can control both voltage waveform besides current waveform at the output side of inverter, and adjust or correct the power factor and suppress the harmonics in the current waveform which is requires for grid connected PV system, and is highly resistant to utility grid disturbances. In present days, due to evolution of advanced switching devices like Power MOSFETs and IGBTs, most inverters .Distributed power systems such as PV systems now employ self commutated inverters rather than line commutated inverters.In the self-commutated inverters may be voltage source inverter or current source inverter established on voltage or current waveforms at their input DC side. In VSI, the input side is a DC voltage source, the input voltage holds the same polarity, the average power flow direction across the inverter is resolved by the polarity of the input DC current, and at the output side, an AC voltage waveform of the stable amplitude and variable width might be acquire. To limit current flow from the inverter to the utility grid a tie line inductor is utilized along with VSI. The input DC side terminals of a VSI are typically connected in parallel with a relatively wide capacitor that resembles a voltage source.

## **V .PHASE LOCKED LOOP**

A phase-locked loop or phase lock loop (PLL) is a system that generates, stabilize, modulate, demodulate, filter or recover a signal. There are many totally different types; the best is an electronic circuit consisting of a variable frequency generator and a phase detector in an exceedingly feedback loop. The oscillator generates a periodic signal, and phase detector compares the phase of that signal with the phase of the input periodic signal, adjusting the oscillator to stay the phases matched. Keeping the input and output establish lock step also implies keeping the input and output frequencies the same. Accordingly, in addition to synchronizing signals, a phase-locked loop can track an input frequency, or it can generate a frequency that's a multiple of the input frequency. These properties are used for laptop clock synchronization, demodulation, and frequency synthesis. Phase-locked loops are wide utilized in radio, telecommunications, computers and alternative electronic applications. they'll be accustomed pull out a sign, recover a signal from a loud communication channel, generate a stable frequency at multiples of an input frequency (frequency synthesis), or distribute exactly regular clock pulses in digital logic circuits such as microprocessors. In solar power system PLL is used as voltage or current driven oscillator that is constantly adjusted to match in phase with the frequency of an input signal.

## **VI. MPPT (Maximum power point tracker)**

Maximum power point tracker is an electronic DC to DC converter that optimizes the match between the solar array (PV panels), and the battery bank or utility grid. To put it simply, they convert a higher voltage DC output from solar panels and to the lower voltage needed to charge batteries. The main purpose of MPPT is to ensure fast, precise maximum power tracking and reduce fluctuations. Voltage, current and duty cycle are control variable that can be used in the MPPT technique. The P and O's most important feature of PV array, high accuracy and easy to use both analog and digital formats.

## **VII. CONCLUSIONS**

Although the solar PV market has knowledgeable massive levels of growth and cost depletion many in recent years, there are numerous technical challenges and economic actuality that require to be resolve in order for DG resources like GCPVS to be at equality with conventional generation. For successful mass acceptance of GCPVs, new technologies must be developed that will permit the inverter to do more than just give DC/AC conversions. Modern grid interactive

inverters will require to give Volt/VAR control (power factor and voltage stabilization), frequency regulation, enable storage and use modern communications protocols, all at a suitable cost. This new generation of inverters has been rightly termed “smart inverters”. Future GCPVS design will need inverters to monitor, react to and adjust their output based on instantaneous feedback from the grid. The inverter will also be capable to save and share data with the skill management system for trending, guessing, protective and corrective maintenance. These new variety of smart inverters will be able to log several data like available battery storage hours and capacity information, alarm on external events and give day to day power management information. Rethinking the role and capability of the inverters can promote the mass adaption of GCPVS and equally help to generate and support a more reliable grid.

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