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Solar Energy Grid Integration Systems "Segis" Using Photovoltaic System

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***Abstract* – Solar Energy Grid Integration Systems (SEGIS) concept will be key to 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. It can be used with low power as well as high power photo-voltaic system. Efficiency of the proposed architecture is demonstrated for the photo-voltaic system installed in educational institution. The value of the energy provided by these solar systems will increase through advanced communication interfaces and controls, while the reliability of electrical service, both for solar and non-solar customers, will also increase 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. Products will be developed for the utility grid of today, which was designed for one-way power flow, for intermediate grid scenarios, and for the grid of tomorrow, which will seamlessly accommodate two-way power flows as required by wide-scale deployment of solar and other distributed.**

Keywords *– power monitoring device, renewable source, solar panel, Field Programmable Gate Array, Photo-voltaic system efficient energy distribution system.*

I INTRODUCTION

The SEGIS program is an aggressive effort to enable substantial penetration of PV into today's grid, into intermediate grid scenarios, and into the smart grid of the future, which will be characterized by a significantly larger amount of distributed generation, much of it from intermittent sources. To achieve optimum value and to enhance the reliability of power for solar systems owners and the grid as a whole, these systems will require advanced controls that can integrate energy management and energy storage.

The SEGIS program is intended to provide the impetus for improving the methodologies and hardware for increasing the penetration of PV systems into the utility grid. The development of advanced, integrated inverter/controllers and associated energy management functions is a critical part of the SEGIS program. The focus of Stage 1 for this SEGIS project was to evaluate the feasibility of utility controlled inverters with advanced power management functionality and improved island detection via Permissive Signal Anti Islanding (PSAI).

The primary objective of the FSEC team in the SEGIS project was to develop and demonstrate at least three innovations of great interest to utilities and the renewable energy industry A novel approach to protection from islanding during utility feeder outages, which allows the operation of the PV generation during all other grid disturbances without risk to personnel or public safety.

Utility control of inverters in distributed systems to produce leading VArs as needed to replace or supplement dedicated power factor correction capacitors or distribution static VAr compensators (D-STATCOMs).A novel ―shared‖ inverter architecture featuring a Smart Sub combiner to improve safety, provide diagnostics/prognostics of individual module strings, and enhance energy yield for rage roof-top arrays, central-station PV farms, and linear PV farms along rights-of-way But why are these innovations important? These advances can transform the way PV is utilized in today‘s energy generation, transmission, and distribution (T&D), and transform the use paradigm in America and elsewhere. It supports plug and play mechanism.

System capacity can be easily extended by including new solar panels without affecting existing modules. Modular implementation of the architecture enables faster fault identification and isolation. Figure 1 shows the interfacing signals of proposed controller.

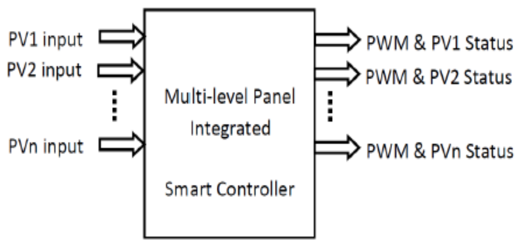

Figure 1: Modular Multi-level controller interface

Typical modern grid-connected inverters that tie clean energy systems such as PV to utility grids are essentially high-bandwidth amplifiers connected to the grid, so there is no requirement that they mimic the functionality and response time of thermal or hydropower plants with large synchronous generators.

Advanced inverter/controllers and energy management systems will need to include sophisticated interfaces and controls to be able to integrate with emerging "Smart Grid" technology, and as such, must be compatible with communication protocols utilized by established and emerging energy management and utility distribution level communication systems. Finally, these systems must meet the performance and reliability targets consistent with achieving leveled cost of energy that will be competitive in future energy markets.

These inverters are typically configured and controlled as current sources to put energy onto the grid, synchronized with the grid's voltage waveform. They do not, typically, supply reactive power to the grid and, in the few cases where reactive power is supplied to correct the power factor of adjacent loads on the same low voltage bus; the inverter typically only follows a fixed preset VAr supply reference. They are also capable, if additionally powered from an energy storage device and fast grid connect device, of acting in a voltage source mode and powering local loads in a load-following manner. In addition to the development and demonstration of these three technical innovations, other indirect goals for this this project included:

- Provide pathway to significant cost reduction in utility scale PV.
- Promote interest in PV for utilities by making them aware of the added value potential of many DERs on their network with a power electronics interface that can be controlled remotely.
- Develop new interconnection standards that allow safe ride-through operation of grid-tied inverters and permit the supply of ancillary services.

Now a day many companies are seeing that to increase the efforts on development of renewable sources by constructing smart grids having sustainable growth and connecting those smart grids to the commercial electricity grids. The renewable energy sources are of different forms like solar, wind, tidal ect. But the problems with this technology are that the energy generated from renewable sources may vary with time and climatic conditions, means these generate indefinite amount of energy but hard expect the constant generation.

Energy management of the future may

1.Be integrated within inverters or

2.Be connected via ancillary equipment (portals) that contain the necessary two-way communications to monitor, control and optimize the value of energy produced by PV installations. Building integration is an important feature of new designs since the complete integration of standardized PV systems with buildings optimizes the building energy balance, improves the economics of the PV system, and provides value added to the consumer and the utility. The emphasis of the program is on developing inverter/controllers that enable integration of large amounts of PV into the electric utility distribution system. The scope of the program includes development of inverters/controllers for grid-interactive solar distributed generation systems that either: incorporate energy management functions and/or power control and conversion for energy storage, or include the ability to interface with energy management and energy storage systems, smart appliances, and utility portals, including adaptation of these systems to communicate with and/or control the inverter/controller.

Features of the smart distribution system may include but are not limited to:

1. Automation for power flow and energy management.
2. Management of the interface between the utility, distributed resources, and micro-grids.
3. Management of all power flow transitions.
4. Real time pricing and analysis for the connected community.
5. Management of the intermittency of renewable solar resources.

While replacement of the nation's entire distribution system will take many years, advanced distribution system technology and micro-grids will occur as new communities and developments are built and as the technology matures. Micro-grids are especially likely to be deployed where there are critical loads, such as high-technology business parks and/or critical infrastructures such as police and fire departments, hospitals, and water-treatment facilities.

II LITERATURE SURVEY

A SEGIS concept paper was written as a progressive outline of needs and priorities for initiating a systems level approach to PV systems with "value added" as a primary theme.[1] The SEGIS Concept Paper was used as a guideline initiating innovative solutions for inroads for high-penetration PV applications. A continuing requirement for SEGIS is improved lifetimes and mean-time-between-failure for PV systems. Communications advantages and disadvantages are presented.

Figure 2 shows one example of an advanced SEGIS system as being pursued in the SEGIS program. Next generation SEGIS systems will include energy storage, energy management and interactive communications, which is new to PV systems. Early SEGIS work has determined that communications for more intelligent utility interconnections will likely have to be a combination of physical link topologies. SEGIS-related communications developments are already being used in micro-grid support and with utility-owned micro-inverter based installations on utility poles with direct utility monitoring and control.

The innovative SEGIS work is addressing the complex interconnect standards barriers to progressive "value added" support for the utility grid or for economic benefits of intelligent distributed PV grid-tied systems. The IEEE Std1547 does not allow for deployment of several progressive SEGIS developments such as 1) Intentional islanding to support stressed grids that results in low-voltage ride through that may last only a few seconds but that disrupts the stability of the grid support, 2) Volt-ampere reactive (VAR) production by PV inverters that has the potential to be a very dynamic and fine-grained aid in voltage support of stressed grids, and 3) Low frequency ride through.[3] Each of these features is best accomplished with communications between the PV system and the interconnected utility. All of these features are best accomplished with energy storage in order to be dispatch able and independent of PV system intermittency. The energy storage must be optimized to obtain the most economically beneficial "value added" per individual installations. SEGIS developments are addressing the array of communications methodologies. The universal concepts that include the utility controlled functionality will be discussed along with impacts for PV applications, the utilities and owners of PV systems. Other important standards and codes directly affecting SEGIS developments include applicable compatibilities with IEC61850 and the National Electrical Code.[4][5] The IEC standard 61850 for communications includes data modeling, reporting schemes, fast transfer of events for peer-to-peer communication modes, setting groups to control blocks protocol, sampled data transfer, commands and data storage protocols.

Renewable sources are also called Echo friendly technologies are very important due to their pollution free energy generation and having sustainable growth. There are many sources of energy that are renewable and considered to be environmentally friendly and harmless natural processes [4]. These sources of energy provide an alternate „cleaner" source of energy, helping to negate the effects of certain forms of pollution. All of these power generation techniques can be described as renewable since they are not depleting any resource to create the energy. While there are many large-scale renewable energy projects and production, renewable technologies are also suited to small off-grid applications, sometimes in rural and remote areas, where energy is often crucial in human development. But the disadvantage with the renewable sources is that their power generation varies with climatic condition and hourly based. To store this unsteady generated energy from renewable sources required a huge, efficient battery and inverter [5], and these are necessary to connect to the power grid. In case of solar power systems variation in the power generation is largely depends on weather and season. Hence every renewable energy system requires storage systems. However the storage systems also have some limitations in the point of installation and return of investment. So to avoid this, in this paper we propose a management system that effectively distributes the energy generated from renewable sources and maximize the efficiency. As the cost of PV modules and panels decrease, the contribution of inverter and balance-of-system cost and replacement are becoming more significant. Reducing system costs through SEGIS improvements and improving the lifetime and reliability are continuing goals and it is estimated to reduce the cost of electricity from PV inverter systems from $.083 to $.022/ kWh.[6] This, along with adding to the value of a PV installation will result in benefits beyond that of just displacing the cost of electricity. The economic benefits will be further assessed and discussed.

III DESIGN CONCEPTS FOR INTEGRATED INVERTERS, CONTROLLERS, BOS AND ENERGY MANAGEMENT

The system decides when to use the energy stored in the battery, that is whenever the power generated from the commercial electricity grid is very low then the switching action takes place, switches to the solar grid. If the energy generated from the solar panel is sufficient then power supplied as usual as the commercial grid otherwise controlling action takes place. The energy stored in the battery is always compared with the preset levels and if it is low then it communicates with control room to take necessary steps. According to the energy levels in the stored battery the controlling of devices takes place.

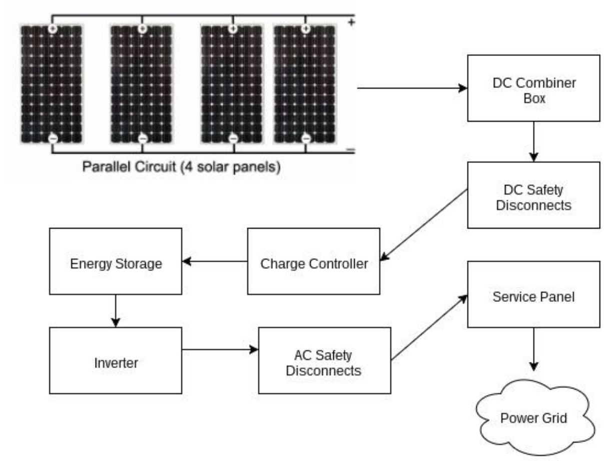

Figure 2: Block Diagram of SEGIS

If the energy level is below the first preset level then the power that goes to the least priority devices are automatically shut off and the high priority devices are run and if the energy is below that then the next priority devices are shut off and allows to run only the highest priority devices giving a signal to take the necessary actions.

The power monitoring device has three power sockets to measure the power consumption of devices and Zigbee network module, that can transmit the status of the battery and receives the control signals to control the power through the devices. Fig.2 shows the basic block diagram for intelligent and efficient distribution system consisting of microcontroller unit, relay control unit; Zigbee communication; user interface, power sensing unit (energy meter) and power supply exist in the system. The energy meter measure the power consumption, consisting of a CT sensor converted to a current value which can handled in the MCU. The renewable energy management system manages the generated power and battery charging conditions in the solar power generator.

The power management methods are of two types, efficiency oriented and user oriented. In the efficient method the generated power and the battery charging conditions are transmitted to the smart power management system and it is compared with the power consumption data stored in the MCU. But the problem with this technique is that it finds only the optimal time to use the charging battery for decreasing power consumption and electric charges.

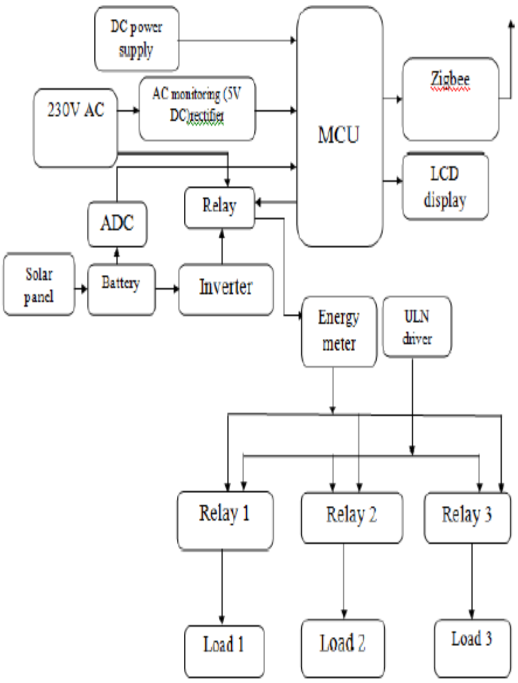

Figure 3: Architecture of SEGIS

In this section, design concepts are presented for enabling increasing value and reliability for solar energy systems assuming a high level of penetration into the electrical distribution system. A possible scenario for evolution of distributed solar energy systems and the electrical grid is outlined in Figure 2. Currently, PV penetration is small, and most residential customers are net-metered under flat rates. PV inverters detect out-of-spec or loss-of-utility power and automatically disconnect from the grid. Distributed generation systems are locally-controlled and provide combined heat and power, usually with no delivery of excess power to the grid or are used for stand-alone power generation. Some utilities are able to dispatch customer loads, such as air-conditioning and electric hot water heating, during periods of high demand.

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In this paper we proposed a user oriented method to run the devices by setting the priorities and run the device having highest priority for a long time compared to the devices having least priority, which increases the efficiency in the point of user. The block diagram in fig.2 having three sockets is nothing but three loads. The intelligent system efficiently distributes the power generated from the solar panel to these prioritized loads depending upon the status of the battery.

IV EXPECTED EXPERIMENT RESULTS

We are showing result as expecting to get this is survey paper and this types of result are obtain in previous paper so our work are progressing on this topic ,Single stage prototype model is developed using Spartan 3E FPGA. Oscilloscope captured signals of inverter. The results shows that, when the power from both power plant and solar system are present then the efficient distribution system connects the energy meter to power line generated from power plant and runs all the devices. Otherwise the remote control station sends the command signal to connect the solar system to the energy meter and compares the battery status continuously to run the prioritized devices. Output and PWM signal for battery charging are Peak to peak amplitude of inverter output is 24V. Control signal generation is independent of the capacity of PV module.

Therefore solar panel of 100 WP with 12V, 42Ah sealed lead acid battery is used to generate various control signals Vertex 6 FPGA device XC6VLX240T-1FFG1156 is chosen for this modular multi-level controller implementation. Major functional modules and their interconnectivity of the proposed controller are ML605 evaluation kit with the FPGA is Implementation of proposed controller architecture utilizes maximum 37% of hardware.

V CONCLUSION

In this paper we proposed a system to distribute the power generated from renewable sources efficiently. The SEGIS program is intended to provide the impetus for improving the methodologies and hardware for increasing the penetration of PV systems into the utility grid. The development of advanced, integrated inverter/controllers and associated energy management functions is a critical part of the SEGIS program.By increasing the capacity of solar panel and efficiency of the battery it is possible to construct a solar gridparallel to the commercial grid which solves the problems of electricity in future and it can be distributed effectively to the rural and urban areas which solves the problems of electricity. But the problem with this system is that to require huge inverter to store the largely variable solar energy and its maintenance. This can be overcome by constructing solar grids parallel to the existed grids by the government. Finally, these systems must meet the performance and reliability targets consistent with achieving levelized cost of energy that will be competitive in future energy markets.

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