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A Review on Energy Efficiency of Microgrid Implementation with Solar Photovoltaic Power Plants

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***Abstract*- The aim of the article is to study of the operating modes basis of distributed solar power plants, power consuming storage and power filtering devices using simulation tools. and energy efficiency assessment of local microgrid on the change of the concept of developing modern power engineering is conditioned by growing interest in renewable energy sources The most rapid pace of the development among low-power distributed renewable energy sources is presented by private solar power plants, which operate both autonomously, and can be integrated into the industrial network which is designed to solve two key tasks – performing the function of the backup power supply in the autonomous operating modes of the system and the alignment of the load profile, that is, the elimination of daily peaks and failures in power consumption. To meet the demand of the next generation power system, renewable energy resources can be the fuel of choice because it is easily available, free of cost, environment-friendly, and the renewable energy-based generation is cost effective in all manners. There are several types of renewable energy resources such as solar, wind, geothermal, tides, and biomass. In this paper, the concentration is limited to the solar energy resources, solar plants, and storage system to provide required power support.**

***Keywords*- Solar, MPPT, ESS, Grid, Battery.DC-DC converter.**

I. INTRODUCTION

The change of the concept of developing modern power engineering is conditioned by growing interest in renewable energy sources. The most rapid pace of the development among low-power distributed renewable energy sources is presented by private solar power plants,which operate both autonomously, and can be integrated into the industrial network. Structural changes in the electricity market, where the consumer acquires additional functionalities and partial energy independence, contributed to the emergence of a new concept of energy development Smart Grid.

The most significant feature of Smart Grid is the presence of a bi-directional energy flow in the elements of the energy supply system (ESS). Operation of the Smart Grid ESS is conditioned by the operation of the industrial network, renewable energy sources and variable load profiles. In the intelligent ESS with small solar power plants, the combination of such modes causes some difficulties in implementing an information management system that would ensure not only high reliability of power supply but also increase its energy efficiency. Photovoltaic Power Station also known as a solar park or solar farm is a large-scale photovoltaic system (PV system) designed for the supply of merchant power into the electricity grid. They are differentiated from most building-mounted and other decentralized solar power applications because they supply power at the utility level, rather than to a local user or users. The generic expression utility-scale solar is sometimes used to describe this type of project. The solar power source is via photovoltaic modules that convert light directly to electricity. However, this differs from, and should not be confused with concentrated solar power, the other large-scale solar generation technology, which uses heat to drive a variety of conventional generator systems.

Both approaches have their own advantages and disadvantages, but to date, for a variety of reasons, photovoltaic technology has seen much wider use in the field.How Does A Solar PV Power Plant Work:Solar PV power plants work in the same manner as small domestic-scale PV panels or the tiny one on your calculator but on steroids. Most solar PV panels are Made from semiconductor materials, usually some form of silicon. When photons from sunlight hit the semiconductor material free electrons are generated which can then flow through the material to produce a direct electrical current. This is known as the photo-effect in physics. The DC current then needs to be converted to alternating current (AC) using an inverter before it can be directly used or fed into the electrical grid..PV panels are distinct from other solar power plants as they use the photo-effect directly without the need for other processes or devices. For example, no liquid heat-carrying agent, like water, is needed as in solar thermal plants. PV panels do not concentrate energy they simply convert photons into electricity that is then transmitted somewhere else.

II. RELATED WORK

Power processing systems will be a key factor of future photovoltaic (PV) applications. They will play a central role in transferring, to the load and/or to the grid, the electric power produced by the high-efficiency PV cells of the next generation. In order to come up the expectations related to the use of solar energy for producing electrical energy, such systems must ensure high efficiency, modularity, and, particularly, high reliability. The goal of this paper is to provide an overview of the open problems related to PV power processing systems and to focus the attention of researchers and industries on present and future challenges in this field.

In addition, the recent research and emerging PV converter technology are discussed, high lighting their possible advantages compared with the present technology. This phenomenon has been possible because of several factors all working together to push the PV energy to cope with one important position today(andpotentially a fundamental position in the near future). Among these factors are the cost reduction and increase in efficiency of the PV modules, the search for alternative clean energy sources (not based on fossil fuels), increased environmental awareness, and favorable political regulations from local governments Grid-connected PV systems account for more than 99% of the PV installed capacity compared to stand-alone systems (which use batteries).

In grid-connected PV systems, batteries are not needed since all of the power generated by the PV plant is uploaded to the grid for direct transmission, distribution, and consumption. Hence, the generated PV power reduces the use of other energy sources feeding the grid, such as hydro or fossil fuels, whose savings act as energy storage in the system, providing the same function of power regulation and backup as a battery would deliver in a stand-alone system. Since grid-connected systems do not need batteries, they are more cost-effective and require less maintenance and reinvestment than stand-alone systems. This concept together with the cost reduction, technology development, environmental awareness, and the right incentives and regulations has unleashed the power of the sun.

III. LITERATURE SURVEY

Solar energy has experienced an impressive technological shift. While early solar technologies consisted of small-scale photovoltaic (PV) cells, recent technologies are represented by solar concentrated power (CSP) and also by large-scale PV systems that feed into electricity grids. The costs of solar energy technologies have dropped substantially over the last 30 years. For example, the cost of high power band solar modules has decreased from about $27,000/kW in 1982to about $4,000/kW in 2006;the installed cost of a PV system declined from $16,000/kW in 1992 to around $6,000/kW in 2008 (IEA-PVPS, 2007;Solarbuzz, 2006, Lazard 2009).

The rapid expansion of the solar energy market can be attributed to a number of supportive policy instruments,the increased volatility of fossil fuel prices and the environmental externalities of fossil fuels, particularly greenhouse gas(GHG) emissions. Theoretically, solar energy has resource potential that far exceeds the entire global energy demand (Kurokawa etal.2007; EPIA, 2007).

Despite this technical potential and the recent growth of the market, the contribution of solar energy to the global energy supply mix is still negligible (IEA, 2009). This study attempts to address why the role of solar energy in meeting the global energy supply mix continues to be so a small. What are the key barriers that prevented large-scale deployment of solar energy in the national energy systems? What types of policy instruments have been introduced to boost the solar energy markets? Have these policies produced desired results? If not, what type of new policy instruments would be needed?

M. Islam et.al. The photovoltaic (PV) stand-alone system requires a battery charger for energy storage. This paper presents the modeling and controller design of the PV charger system implemented with the single-ended primary inductance converter (SEPIC). The designed SEPIC employs the peak-current-mode control with the current command generated from the input PV voltage regulating loop, where the voltage command is determined by both the PV module maximum power point tracking (MPPT) control loop and the battery charging loop. The control objective is to balance the power flow from the PV module to the battery and the load such that the PV power is utilized effectively and the battery is charged with three charging stages. This paper gives a detailed modeling of the SEPIC with the PV module input and peak-current-mode control first. Accordingly, the PV voltage controller, as well as the adaptive MPPT controller, is designed. An 80-W prototype system is built. The effectiveness of the proposed methods is proved with some simulation and experimental results.

A. Kadam et.al. This study first presents an experimental control strategy of photovoltaic (PV) system composed of: PV array,dc–dc power converters, electrolytic storage, and programmable dc electronic load.This control aims to extract maximum power from PV array and manages the power transfer through the dc load,respecting the available storage level.The designed system allows simultaneously the supply of a dc load and the charge or the discharge of the storage during the PV power production.The experimental results obtained with a dSPACE 1103 controller board show that the PV stand-alone system responds within certain limits that appear as soon as one of the storage thresholds is reached: either loss of energy produced, or insufficient energy toward the load. In urban area,it is proposed to overcome these limitations by connecting the utility grid with the PV system while maintaining the priority for self-feeding. The experimental results of this PV semi-isolated system are shown and discussed. For this first approach,the goal was to verify the technical feasibility of the suggested system controls.The final results are energetically relevant.

Romero Cadaval et. al. This paper proposes a power management architecture that utilizes both super capacitor cells and a lithium battery as energy storages for a photovoltaic (PV)-based wireless sensor network. The super capacitor guarantees a longer lifetime in terms of charge cycles and has a large range of operating temperatures, but has the drawback of having low energy density and high cost. The lithium battery has higher energy density but requires an accurate charge profile to increase its lifetime, feature that cannot be easily obtained supplying the wireless node with a fluctuating source as the PV one. Combining the two storages is possible to obtain good compromise in terms of energy density. A statistic analysis is used for sizing the storages and experimental results with a 5-W PV energy source are reported.

T.K. S. Freddy et.al. This control system that coordinates parallel operations of different distributed generation (DG) inverters within a microgrid. The control design for the DG inverters employs a new Model Predictive Control algorithm that allows faster computational time for large power systems by optimizing the steady-state and the transient control problems separately. An overall energy management system is also implemented for the microgrid to coordinate load sharing among different DG units during both grid-connected and islanded operations. The design concept of the proposed control system is evaluated through simulation studies under different test scenarios. The impact of the increased penetration of DG units on the distribution grid is also investigated using the proposed microgrid. The simulation results show that the operations of the DG units within the microgrid can be coordinated effectively under the proposed control system to ensure stable operation of the overall microgrid.

Gonzalez, E.Gubia et.al. In this paper, a new control method for the parallel operation of one or several inverters in an island grid or the mains is described. Frequency and voltage control, including mitigation of voltage harmonics, are achieved without the need for any common control circuitry or communication between the inverters.Each inverter supplies a current that is the result of the voltage difference between a reference AC voltage source and the grid voltage across a virtual impedance with real and/or imaginary parts. The reference AC voltage source is synchronized with the grid,with a phase shift, depending on the difference between nominal and real grid frequency.

A detailed analysis show that this approach has superior behaviour in comparison with the existing droop control methods, considering the mitigation of voltage harmonics, short-circuit behaviour and, in the case of anon-negligible line resistance, the ‘efficient’ control of frequency and voltage. Experiments show the behaviour of the method for an inverter feeding a highly distorted load and during the connection of two parallel inverters in operation.

López, F.D. DC and AC Microgrids are key elements to integrate renewable and distributed energy resources as well as distributed energy storage systems. In the last years, efforts toward the standardization of these Microgrids have been made. In this sense, this paper present the hierarchical control derived from ISA-95 and electrical dispatching standards to endow smartness and flexibility to microgrids.The hierarchical control proposed consist of three levels: the primary control is based on the droop method, including an output impedance virtual loopii) the secondary control allows restoring the deviations produced by the primary control;and iii) the tertiary control manage the power flow between the microgrid and the external electrical distribution system. Results from a hierarchical controlled microgrid are provided to show the feasibility of the proposed approach.

IV. PROPOSED APPROACH

Solar energy is genesis for all forms of energy. This energy can be made use of in Two ways the Thermal route i.e. using heat for drying, heating, cooking or generation of electricity or through the Photovoltaic route which converts solar energy in to electricity that can be used for a myriad purposes such as lighting, pumping and generation of electricity. With its pollution free nature, virtually inexhaustible supply and global distribution- solar energy is very attractive energy resource. Solar Energy can be utilized for varied applications.

1.Photovoltaic Plants: A photovoltaic cell, commonly called a solar cell or PV,is a technology used to convert solar energy directly into electricity.A photovoltaic cell is usually made from silicon alloys. Particles of solar energy, known as photons, strike the surface of a photovoltaic cell between two semiconductors.These semiconductors exh ibit a property known as the photoelectric effect,which causes them to absorb the photons and release electrons. The electrons are captured in the form of an electric current - in other words, electricity.

2.Solar Panel: Standard Solar, Inc.recently completed one of the first solar microgrid systems with a grid interactive battery bank in the country. Being a first was a challenge– it took months of dedication, innovative engineering and coordination with key partners, utilities and government offices to make this project a reality. The first half of this paper will set the stage by explaining how the microgrid is setup, its functionality and what makes it special.Then I will explore what it takes to design and install a solar micro grid system, the lessons learned from this ground breaking project and what technical consi derations should be made when implementing this new technology.

3.Solar Microgrid: The solar microgrid system is designed to operate in two modes; Grid-Interactive and Islanded mode. In grid-interactive mode the battery system operates in parallel with the PV system. The PV system operates normally as a typical grid-tied solar PV system. During peak sun hours of the day the battery system is less active,but when the PV system is not utilizing the majority of the inverter capacity (i.e. at night) it is able to actively participate in fast response frequency regulation.The control system is designed to always prioritize the use of the inverter capacity for the solar PV generation first, and then the remainder is utilized for frequency regulation participation.In full sun the PV system will normally require approximately 325kW of AC capacity, leaving 175 kW of inversion capacity available for participation in the frequency regulation market. When there is a grid outage the micro grid system senses the loss of grid and signals the isolation breaker to open and convert to Islanded mode. The system adjusts automatically from a grid-tied current source to an islanded voltage source in a few cycles.

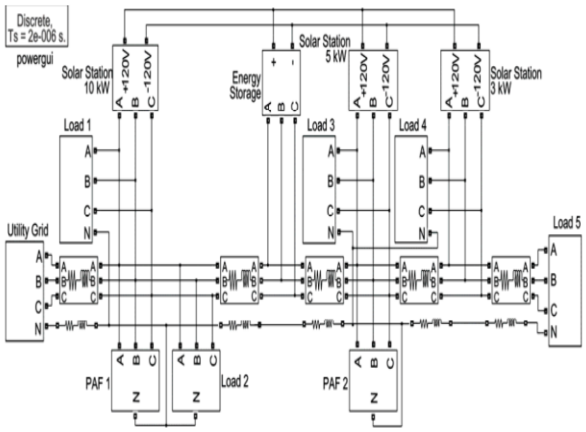

Fig 1. Proposed Block Diagram.

The PV system will continue to produce electricity as long as there is sufficient sunlight to generate and sufficient load or battery capacity to absorb it. The energy storage system acts as a buffer between the PV and the load so that the user doesn't notice any fluctuation in power as a result of unstable sky conditions. The duration that the energy supply will last is difficult to predict because it is a function of the amount of sunlight available, the demand of the selected back-up loads and the state of charge of the battery system at the moment of isolation from the grid.

V. CONCLUSION

Besides the negative impact on both the environmental and geological aspect in the case of fossil fuel combustion-based power generation, the fossil fuels have almost been depleted, and hence an alternative fuel source is required. To meet the next generation power demand, renewable energy sources are the most reasonable fuel-shift taken over the naturally limited conventional fuels. Among all the available renewable energy resources, solar energy has been developing as one of the most significant contributors of the power industry. In this paper, the concentration has been limited to the solar energy resources, solar plants, and storage system to provide required power support. In particular, this letter has been associated with the mathematical modeling of the solar plants and simulation for the different aspects and cases of the systemIn solar energy sector, many large projects have been prop osed in India.Thar Desert has some of India's best solar power projects, estimated to generate 700 to 2,100 GW. The implementation of microgrid with solar power plants allows increasing the efficiency of the ESS. The reserve for increasing the efficiency through the implementation of microgrid has two components, the first one is related to the normalization of the power consumption mode, and the second one to the optimization of the structure of the network, when the distances between energy sources and consumers are reduced, and the density of the network energy flow and trunk line decreases. Moreover, the second component makes a more significant contribution to increasing the efficiency of the energy supply system.

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