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DC Power System with Super Capacitor &Sepic Converter Monitoring Using IOT

P. Anushya, R. Brindha Devi, R. Deepika, P. Jayanthi, Assitant Professor A. Pradeep
Department of Electrical and Electronics Engineering
Vivekananda College of Technology for Women
Namakkal, Tamil Nadu,India

Abstract:-As the conventional energy resources are depleting there is an urgent need for switching to renewable energy resources as well as increasing its functionality. This project proposes a design of solar power system fed by a photovoltaic source with a super capacitor storage system and sepic converter. The super capacitor has the fastest charging time compared to all other storage devices and also 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. The lithium battery has higher energy density but requires an accurate charge profile to increase its lifetime. Combining the two storages is possible to obtain good compromise in terms of energy density. Sepic converters allow output from converters to be higher or lower than its input and allow the output to be non-inverted state with respect to input. It also reduces the amount of harmonics present in the output. A Controller is added between the solar panel and the battery to improve the system performance. The solar power system is controlled and monitored using Arduino microcontroller.

Key words- conventional energy , super capacitor , energy density etc.

I.INTRODUCTION

With the ever-increasing demand for low-cost energy and growing concern about environmental issues, PV based systems are being increasingly employed in diverse applications both at domestic and commercial levels. While a good sort of harvesting modalities are now feasible, solar power harvesting through photovoltaic (PV) conversion provides the very best power density, which makes it the well-liked option to power an embedded system that consumes several mille watt employing a reasonably small harvesting module.

The growing emphasis on energy saving. PV being a serious energy source enables the dc loads to be connected on to the dc bus. Photovoltaic systems are often broadly classified into stand-alone system and grid-connected system. The stand-alone system is widely utilized in foreign places where access to electricity isn't viable.

The stand-alone configuration can provide a well-regulated load voltage, but the reliability of power supply can't be guaranteed. Storage batteries are widely wont to improve the reliability of the stand-alone system. The integration of a PV system to the grid is rapidly increasing thanks to the development within the power electronics technology. In grid-connected PV systems (gcpvs), the generated PV power is fed to the grid, or it supplies the linear and nonlinear loads connected at the ac side. In some hybrid systems [5] battery is employed to compensate the mismatch between the generation and demand.

II. SOLAR PANEL

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (PV) module is a packaged, connected assembly of typically photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 24%.

A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism. The most common application of solar energy collection outside agriculture is solar water heating systems.

Types of Solar Panels

- Mono crystalline Solar Panels
- Polycrystalline Solar Panels
- Thin-Film: Amorphous Silicon Solar Panels.

III. SUPER CAPACITOR

A super capacitor (SC) is a high-capacity capacitor with capacitance values much higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries. They typically store 10 to100 times more energy per unit volume or mass than electrolyticcapacitors, can accept and deliver charge much faster than batteries, and tolerate many more charge and discharge cycles than rechargeable batteries.

Super capacitors are used in applications requiring many rapid charge/discharge cycles rather than long term compact energy storage: within cars, buses, trains, cranes and elevators, where they are used for regenerative braking, short-term energy storage or burst-mode power delivery. Smaller units are used as memory backup for static random-access memory (SRAM).

1. Storage Principle

Electrochemical capacitors use the double-layer effect to store electric energy; however, this double- layer has no conventional solid dielectric to separate the charges. There are two storage principles in the electric double-layer of the electrodes that contribute to the total capacitance of an electrochemical capacitor:

- Double-layer capacitance, electrostatic storage of the electrical energy achieved by separation of charge in a Helmholtz double layer.
- Pseudo capacitance, electrochemical storage of the electrical energy achieved by faradaic redox reactions with charge-transfer.

Both capacitances are only separable by measurement techniques. The amount of charge stored per unit voltage in an electrochemical capacitor is primarily a function of the electrode size, although the amount of capacitance of each storage principle can vary extremely.

2. Construction Details

Super capacitors are constructed with two metal foils (current collectors), each coated with an electrode material such as activated carbon, which serve as the power connection between the electrode material and the external terminals of the capacitor. Specifically, to the electrode material is a very large surface area. In this example the activated carbon is electrochemically etched, so that the surface of the material is about a factor 100,000 larger than the smooth surface. The electrodes are kept apart by an ion permeable membrane (separator) used as an insulator to protect the electrodes against short circuits. This construction is subsequently rolled or folded into a cylindrical or rectangular shape and can be stacked in an aluminium can or an adaptable rectangular housing.

IV. LITERATURE SURVEY

Chen.S.et.al.,[1] Sizing of Energy Storage for Micro grids. 12 August 2017.IEEE.

This paper presents a new method based on the cost-benefit analysis for optimal sizing of an energy storage system in a micro grid (MG). The unit commitment problem with spinning reserve for MG is considered in this method. Time series and feed- forward neural network techniques are used for forecasting the wind speed and solar radiations respectively and the forecasting errors are also considered in this paper.

Two mathematical models have been built for both the islanded and grid- connected modes of MGs. The main problem is formulated as a mixed linear integer problem (MLIP), which is solved in AMPL (A Modelling Language for Mathematical Programming). The effectiveness of the approach is validated by case studies where the optimal system energy storage ratings for the islanded and grid-connected MGs aredetermined. Quantitative results show that the optimal size of BESS exists and differs for both the grid-connected and islanded MGs in this paper.

Daniel.E..,et.al.,[2]Trends in Micro grid Control,. 29 May 2018.IEEE

The increasing interest in integrating intermittent renewable energy sources into micro grids presents major challenges from the viewpoints of reliable operation and control. In this paper, the major issues and challenges in micro grid control are discussed, and a review of state-of-the-art control strategies and trends is presented; a general overview of the main control principles (e.g., droop control, model predictive control, multi-agint systems) is also included. The paper classifies micro grid control strategies into three levels: primary, secondary, and tertiary, where primary and secondary levels are associated with the operation of the micro grid itself, and tertiary level pertains to the coordinated operation of the micro grid and the host grid. Each control level is discussed in detail in view of the relevant existing technical literature.

Daniel.K..,et.al.,[3] A Survey of Distributed Optimization and Control Algorithms for Electric Power Systems,. 25 May 2018. IEEE.

Historically, centrally computed algorithms have been the primary means of power system optimization and control. With increasing penetrations of distributed energy resources requiring optimization and control of power

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systems with many controllable devices, distributed algorithms have been the subject of significant research interest. This paper surveys the literature of distributed algorithmswith applications to optimization and control of power systems. In particular, this paper reviews distributed algorithms for offline solution of optimal power flow (OPF) problems as well as online algorithms for real-time solution of OPF, optimal frequency control, optimal voltage control, and optimal wide-area control problems.

V. EXISTING SYSTEM

By increasing the penetration of grid-connected photovoltaic (PV) units in electrical energy systems, the concern regarding the effect of these units on grid operation increases as well. A considerable proportion of PV units already installed in some countries are residential PVs that are usually connected to low voltage (LV) distribution systems. Since the maximum PV generation happens simultaneously with low residential load consumption, high PV generation may cause reverse power flow in the grid, which can potentially cause overvoltage, especially in weak grids. Different methods have been proposed to mitigate the voltage rise caused by high PV penetration such as grid reinforcement, Demand-Side Management (DSM) and reactive power absorption by PV inverters.

The cost associated with grid reinforcement is high and as the controllable domestic loads are not necessarily used on a daily and continuous basis, DSM cannot be considered as a reliable solution.

Moreover, in some LV grids the R/X ratio is high; as a result, the reactive power absorption by PV inverters is not sufficient to prevent the overvoltage. In recent years, the concept of using electrical energy storage systems (EESS) for overvoltage prevention in high PV generation conditions has been addressed. Although battery technologies have developed in recent years, the main concern about the application of EESS is stillthe initial investment in the system, and a strategy to optimize the size of energy storage units in the distribution system is required.

A sizing strategy for optimizing the size of energy storage units in a distribution system is proposed in and the EESS life time, the effect of energy storage utilization on operation cost of transformer with On-Load-Tap- Changer (OLTC), and the effects of EESS on reduction of peak power generation cost are considered. In a sizing strategy is developed to calculate the EESS capacity required for prevention of voltage rise and voltage drop in LV grids with residential (PVs) and electric vehicles (EVs).

In a method is proposed to determine the minimum EESS required to be installed at different locations of an LVresidential distribution system in order to prevent overvoltage in the network. The uncertainties associated with PV generation and load consumption are modelled for sizing the EESSs in this study.

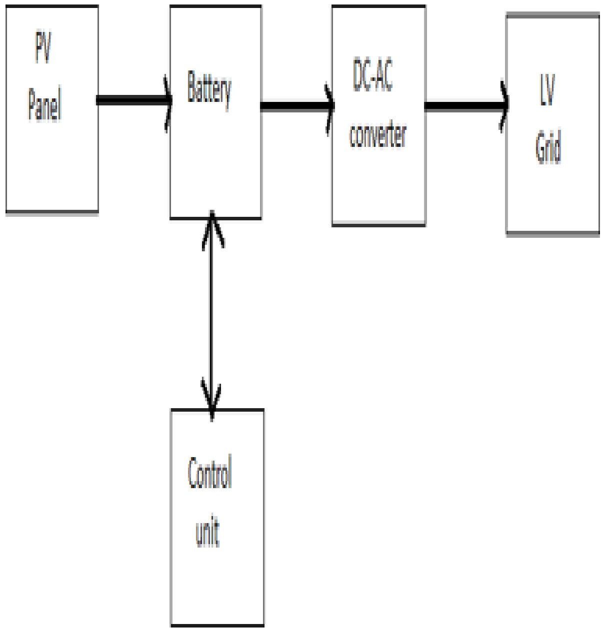

Fig.1 Existing system.

VI. MONOCRYSTALLINE SOLAR PANEL

Monocrystalline silicon (also called "single-crystal silicon", "single-crystal Si", "mono c-Si", or mono- Si) is the base material for silicon-based discrete components and integrated circuits used in virtually all electronic equipment today. Mono-Si also serves as a photovoltaic, light-absorbing material in the manufacture of solar cells.

It consists of silicon in which the crystal lattice of the entire solid is continuous, unbroken to its edges, and free of any grain boundaries. Mono-Si can be prepared as an intrinsic semiconductor that consists only of exceedingly pure silicon, or it can be doped by the addition of other elements such as boron or phosphorus to make ptype or n-type silicon.

Due to its semiconducting properties, single-crystal silicon is perhaps the most important technological material of the last few decades—the "silicon era", because its availability at an affordable cost has been essential for the development of the electronic devices on which the present-day electronics and IT revolution is based.

VII. VOLTAGE ANALYSIS

The voltage sensitivity matrix derived from power flow equations is used for the grid voltage calculation.

Sensitivity analysis can effectively decrease the computational time in optimization problems.

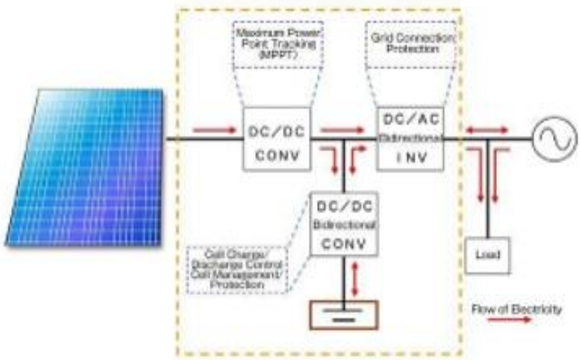

Fig. 2 Voltage Analysis.

The active power feed-in at any location in the grid will increase the voltage in all buses. These increases differ for different locations and depend on the sensitivity of the connection points to the active power. As a result, in order to control the grid voltageefficiently, an advanced method is required for the grid management.

VIII. BATTERY

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower- energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

1. Principle of Operation

Batteries convert chemical energy directly to electrical energy. In many cases, the electrical energy released is the difference in the cohesive or bond energies of the metals, oxides, or molecules undergoing the electrochemical reaction. Forinstance, energy can be stored in Zn or Li, which are high-energy metals because they are not stabilized by d-electron bonding, unlike transition metals. Batteries are designed such that the energetically favorable redox reaction can occur only if electron move through the external part of the circuit.

Fig. 3 Battery.

A battery consists of some number of voltaic cells. Each cell consists of two half-cells connected in series by a conductive electrolyte containing metal cations. One half-cell includes electrolyte and the negative electrode, the electrode to which anions (negatively charged ions) migrate; the other half-cell includes electrolyte and the positive electrode, to which cations (positively charged ions) migrate. Captions are reduced (electrons are added) at the cathode, while metal atoms are oxidized (electrons are removed) at the anode. Some cells use different electrolytes for each halfcell; then a separator is used to prevent mixing of the electrolytes while allowing ions to flow between half-cells to complete the electrical circuit.

2. Disadvantadeof Battery

- It is rechargeable of time is high.
- It is dischargeable of time is low.
- It is easily damaged on high temperature.

IX. DC-AC CONVERTER

DC to AC converters produce an AC output waveform from a DC source. Applications include adjustable speed drives (ASD), uninterruptible power supplies (UPS), Flexible AC transmission systems (FACTS), voltage compensators, and photovoltaic inverters. Topologies for these converters can be separated into two distinct categories: voltage source inverters and current source inverters. As show in figure 2.5. Voltage source inverters (VSIs) are named so because the independently controlled output is a voltage waveform. Similarly, current source inverters (CSIs) are distinct in that the controlled AC output is a current waveform.

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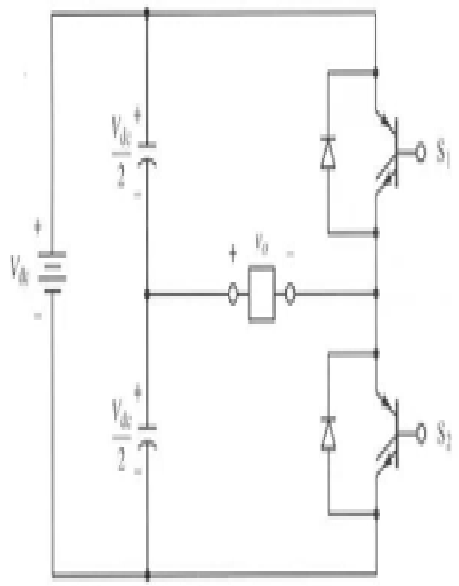

Fig. 4 DC-AC Converter.

DC to AC power conversion is the result of power switching devices, which are commonly fully controllable semiconductor power switches. The output waveforms are therefore made up of discrete values, producing fast transitions rather than smooth ones. For some applications, even a rough approximation of the sinusoidal waveform of AC power is adequate. Where a near sinusoidal waveform is required, the switching devices are operated much faster than the desired output frequency, and the time they spend in either state is controlled so the averaged output is nearly sinusoidal. Common modulation techniques include the carrier-based technique, or Pulse-width modulation, space- vector technique, and the selective-harmonic technique.

X. PROPOSED SYSTEM

As discussed before, the curtailment levels have considerable effects on the need for energy storage, and curtailing the active power at lower levels results in higher EESS need and vice versa. By determining a fixed operating point for controlling EESSs, which has to be determined under worst-case conditions ofmaximum PV generation and no load consumption, the effect of reactive power absorption by PV inverters and the effects of local consumption cannot be considered. This paper proposes a new method to determine dynamic operating points for EESS control in LV grids. Using the proposed method, the effects of reactive power absorption by PV inverters are considered as well as the load consumption.

The cost associated with grid reinforcement is high and as the controllable domestic loads are not necessarily used on a daily and continuous basis, DSM cannot be considered as a reliable solution. Moreover, in some LV grids the R/X ratio is high; as a result, the reactive power absorption by PV inverters is not sufficient to prevent the overvoltage. In recent years, the concept of using electrical energy storage systems (EESS) for overvoltage prevention in high PV generation conditions has been addressed. Although battery technologies have developed in recent years, the main concern about the application of EESS is still the initial investment in the system, and a strategy to optimize the size of energy storage units in the distribution system is required.

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XI. BLOCK DIAGRAM

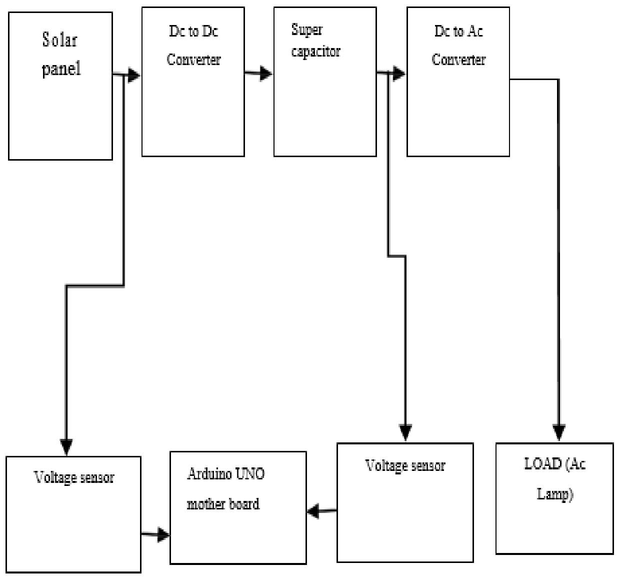

Fig.5 Block Diagram.

XII. EFFICIENCY

Incremental improvements in efficiency began with the invention of the first modern silicon solar cell in 1954. By 2010 these steady improvements had resulted in modules capable of converting 12 to 18 percent of solar radiation into electricity. The improvements to efficiency have continued to accelerate in the years since 2010, as shown in the accompanying chart. The performance and potential of thin-film materials are high, reaching cell efficiencies of 12–20%;

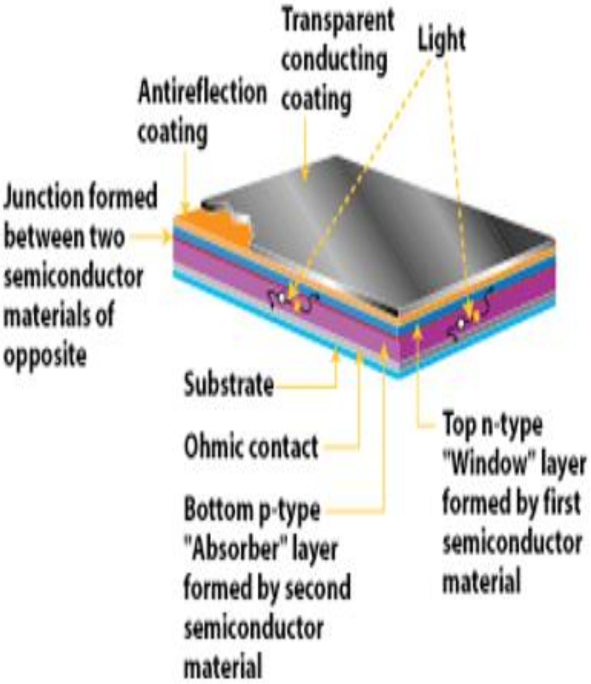

Fig . 5 Efficiencies.

prototype module efficiencies of 7–13%; and production modules in the range of 9%.The thin film cell prototype with the best efficiency yields 20.4% (First Solar), comparable to the best conventional solar cell prototype efficiency of 25.6% from Panasonic. A new record for thin film solar cell efficiency of 22.3% has been achieved by solar frontier the world's largest cis solar energy provider. In joint research with the New Energy and Industrial Technology Development Organization (NEDO) of Japan, Solar Frontier achieved 22.3% conversion efficiency on a 0.5 cm2 cell using its CIS technology. This is an increase of 0.6 percentage points over the industry's previous thin-film record of 21.7%.

XIII. SUPERCAPACITOR

A supercapacitor is a high-capacity capacitor with capacitance values much higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerate many more charge and discharge cycles than rechargeable batteries.

Fig . 6 Super Capacitor.

Supercapacitor are used in applications requiring many rapid charge/discharge cycles rather than long term compact energy storage: within cars, buses, trains, cranes and elevators, where they are used for regenerative braking, short-term energy storage or burst-mode power delivery. Smaller units are used as memory backup for static random-access memory (SRAM).

1. Basic Desing

Electrochemical capacitors (supercapacitor) consist of two electrodes separated by an ion-permeable membrane (separator), and an electrolyte ionically connecting both electrodes. For example, positively polarized electrodes will have a layer of negative ions at the electrode/electrolyte interface along with a charge-balancing layer of positive ions adsorbing onto the negative layer. The opposite is true for the negatively polarized electrode.

XIV. CONCLUSION

In this project, a new control approach was proposed for energy storage management to prevent the overvoltage in load. To this aim, dynamic set points were determined for micro controller control considering the effects of reactive power absorption by PV inverters and the local load consumption. Simulations were performed on a realistic LV feeder to determine the energy storage capacity required to prevent overvoltage in the network considering two reactive power control methods, namely, reactive power as a function of voltage and power factor as a function of injected active power. The results indicated that busing the proposed method, the customers' voltage remained less than the predefined value in all locations of the grid and in all operation modes. In addition, compared to the fixed power threshold method, the energy storage that is required for overvoltage prevention was considerably decreased. Super capacitor use the energy storagesystem is very high efficiency system. It is best energy storage system is better than other storage system. Simulations showed that by considering 5- kWh EESSs and applying the proposed method, the PV penetration in the grid could be increased to around 75%. In the same condition, by using a fixed set point for energy storage control, the PV penetration had to be limited to around 50%. In addition, simulations indicated that in the selected LV grid, the PF method was more efficient in lower PV penetration and the Q (U) method showed better efficiency in higher PV penetration.

FUTURE SCOPE

Supercapacitor is a better storage device in future usage.it is a fast charging energy storage device. Future at device use at low voltage panel will be using at required storage system .it will be added on Buck-boost converter connected between on panel and supercapacitor.

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