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A REVIEW ONMAXIMUM SOLAR PV AND BATTERY STORAGE CAPACITY FOR GRID-CONNECTED HOMES

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***Abstract*-The growing public concern about climate change has resulted in legislative measures such as the Paris Climate Agreement as well as an urgent demand for clean, renewable energy sources. As a result of these and other causes, distributed energy resources, such as photovoltaic (PV) systems, have seen increased market penetration. One of the most major disadvantages of adopting solar systems is the unpredictability of their power generation. Any technique of generating photovoltaic (PV) energy must be able to compensate for the lack of sun irradiation throughout the night. Even more problematic is the fact that electricity consumption is lowest during the day, which is also when solar generators in the majority of houses produce the greatest power. The answer to this dilemma is to install a battery energy storage system (BES), which can then be utilised to store any excess energy generated during the day. This energy might then be used at times of high demand for power in the community's residential sections. This article contains a brief knowledge about the basics of solar system, different battery energy storage system and various optimization techniques for getting maximum output from solar system.**

***Keywords*-Solar system, Battery Energy Storage System, Particle Swarm Optimization, State of Charge.**

I. INTRODUCTION

Solar energy collected by Earth can meet the needs for a year's worth of global electrical demand in just one hour. Even if we just managed to capture a small percentage of this potential energy, it would be enough to power the whole human population. If photovoltaic modules continued to operate at their current efficiency level of 10%, the amount of land required to provide the world's entire energy consumption would be cut to only 0.4 percent of the earth's surface. [2]

It is possible to convert solar energy into electricity in a basic manner by using photovoltaic modules and taking use of a phenomenon known as the photovoltaic effect. Solar heat collectors may be used for a variety of purposes, one of which is the storage of solar energy in the form of heat. The heat may then be converted into electricity using a steam turbine, which can subsequently be utilised to heat dwellings or water (concentrating solar heat collector). This thesis's discussion is confined to photovoltaic modules.

In 1839, Edmond Becquerel made a world-changing discovery when he invented the first functional solar cell. However, prior to the discovery of quantum physics and semiconductor technology in the twentieth century, both this phenomenon and its far-reaching consequences were little understood. [3]

The benefits of photovoltaic systems are as follows, as stated in [2] and as will be discussed here:

- Fuel is present almost everywhere and it is infinite

- Pollution- and radiation-free
- Low operation and maintenance costs
- No moving parts and almost maintenance-free
- Reliable; manufacturers guarantee 25-30 years of operation with at least 80 % of energy yield
- Annual energy yield is predictable
- Modular; can be used in both small and large applications
- Can be easily integrated into both new and existing infrastructures
- Quick installation.

The main disadvantage of photovoltaic systems are:

- The systems are (or used to be) regarded as expensive
- Hourly and daily electricity generation is intermittent and unpredictable
- Generation does not always match demand
- The systems are quite large

The cost of solar panels has consistently decreased. Solar modules accounted for 70% of the whole cost of a PV system ten years ago; however, as the cost of solar modules has decreased, the inverter and other BOS-related equipment now account for 50% of the total cost.

Photovoltaic systems are rapidly nearing the point where they can compete with any other sort of energy generating in terms of cost. This chapter will examine the current status of photovoltaic technology, including the impact of various operating settings, the inclination of solar modules, and the BOS of the technology.

PV Technology

Silicon, both monocrystalline and polycrystalline, is one of the most often used materials in the manufacture of solar cells. Copper indium diselenide (CIS) cells, in addition to CdTe and amorphous silicon cells, are among the several types of solar cells that have been created. However, monocrystalline and polycrystalline silicon-based solar cells will be the major focus of this thesis. Solar cells are devices that convert solar radiation into useable electricity and are utilised in power generation. They are typically made of semiconductors, with dimensions of 156 mm on each side, and produce voltages ranging from 0.5 to 0.6 volts. Figure 1 depicts a typical photovoltaic (PV) cell and all of its constituent elements.

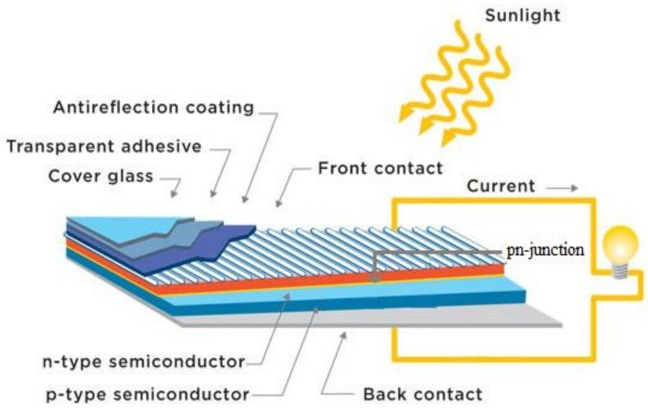

Figure 1. PV cell and components. Adapted from [6].

A PN junction, front and rear collectors, and an anti-reflection layer comprise a solar cell. The underlying notion of how the cell functions is not difficult to grasp. The cell generates an electric current whenever a load is connected to it and when it is exposed to solar radiation.

II. LITERATURE REVIEW

Low and medium energy storage have been related to the creation of new active systems throughout the last decade. Wind turbines, power generators, biomass and geothermal manufacturers, photovoltaic systems, fuel cells, storage, and electricity quality enhancement tools are among them. In this post, we will attempt to build a strategy for dealing with analytical concerns in general.

M. Zeeshan Tariq et al. (2021)In response to the global contribution of renewable energy storage systems (RES), we have noticed an undeniable surge in marine electrical systems. On the other hand, to address the intermittent RES. A battery energy storage system is built into the system. However, the problem is that the energy density is low and the lifespan is short, which increases the space required and increases the cost. To solve this problem, it is recommended to equip an ultra-capacitor battery energy storage device. Therefore, the integrated system provides greater dynamic performance using relatively less space and higher energy. In order to take advantage of these advantages in this integrated system, it is necessary to realize the optimal management of power generation and consumption. This requires the development of accurate and robust control algorithms [1].

Jianlin Wang et al. (2020)The varying dynamic characteristics of different vehicle power sources must be taken into consideration while managing the energy of new energy vehicles. An energy management technique for fuel cell/battery/ultracapacitor hybrid energy storage systems in fuel cell electric vehicles is proposed in this research, which is real-time predictive in nature. To anticipate the future speed of the vehicle and compute future power consumption, LSTM Neural Network Speed Prediction was built[2].

Chung-Hsinz Chao et al. (2019) presents a regulatory architecture developed to steer electric golf cart hybrid power with an extended action of 5 kW. A hybrid power system consists of a fuel cell stack, batteries, ultracapacitor banks and individual power conditioner units. The proposed strategy consisted of three levels with different frequency and duration of use to optimise the overall operation. The power demand of each energy source is determined in real-time according to the frequency distribution and the cutoff frequency defined in the dynamic capacity of the energy source. In this study, to consider the characteristics of each energy source, it is easy to find the optimal set point for them. We have acquired a functional simulation that ensures that the power is in proper battery and supercapacitor charge[3].

K. Nakul Narayanan et al. (2018) provided a hybrid multiport bidirectional converter system for hybrid electric vehicles (HEVs). The proposed hybrid multiport topology consists of an IC engine coupled to an alternator with a battery bank, a supercapacitor bank and shares a common DC link. The topology provided uses a high gain converter as the DCDC converter interface. A new control strategy for the closed-loop operation of the proposed topology is also presented. Control strategies are validated in PSCAD / EMTDC using time-domain simulation. A hardware prototype was created to verify the performance of the high gain DCDC converter [4].

Lai, et al., (2017)that this high penetration may provide economic and technological challenges to grid operators, energy storage facilities would be necessary to meet the non-dispatchable nature and inability to manage this energy source. These researchers hypothesised that energy storage facilities will be needed to suit these qualities[5].

Wang et al. (2014) had presented a charge pump control converter that proficiently gives electrical power powerfully controlling a switch lattice of the charge pump that incorporates a flying ultra-capacitor. Rather than open-circle oscillator-based control, a dynamic controller gives control upon request by detecting the yield voltage and changing the working recurrence of the charge direct accordingly. In addition, this shut circle dynamic control inherently voltage directs the yield voltage of the charge pump control converter without the wasteful expansion of a stage down voltage controller downstream of the power converter [6].

III. BENEFITS OF BATTERY ENERGY STORAGE SYSTEM

The financial benefits that a BES system provides to its clients are the primary focus of this study's efforts. [Citation required] BES systems, on the other hand, provide a variety of extra benefits in addition to financial ones, all of which will be considered in this research. A BES system allows the customer to become more energy self-sufficient, allowing them to depend more heavily on solar electricity. From the customer's perspective, this is favourable. Even if the power supply is disrupted, the BES system's UPS capability ensures that power distribution continues uninterrupted.

The ability to store surplus photovoltaic (PV) energy for later use is the key source of financial advantage. Following that, BES may be compared to the amount of money necessary without the system. Any additional photovoltaic (PV) power you sell to the grid must be valued at its selling price, which is the amount of money you would make if you did so. Although the cost of power is reflected into the grid's selling price, it is not included in the selling price paid to individual users, which includes energy transmission costs as well as taxes. As a result, the cost of the customer's BES electricity is much cheaper than the cost of electrical energy obtained from the grid. This isn't only because the electrical provider has to take its own portion of the earnings. Time-of-use (TOU) shifting is another financial benefit provided by BES. Batteries may be charged at one time of day and discharged at another via TOU-shifting. The owner of a PV-BES system is also entitled for numerous benefits as a consequence of the system's installation. When doing either of these two analyses, it is critical to consider not just the average system losses but also the system's round-trip efficiency.

IV. OPTIMIZATION PROCEDURE

The answers provided by MATLAB can be used to solve the stated optimization model. Because of its efficient use of computer resources, ease of implementation, ability to uncover global optima, adequate convergence rate, and low dependency on starting locations, the optimization approach known as particle swarm optimization, or PSO, was used in this work. The PSO technique has long been regarded standard practise for optimising the scale of power systems.

Figure 2.displays a flowchart for optimising the size of rooftop PV and BESS systems. The operation began with the data entered into the system.

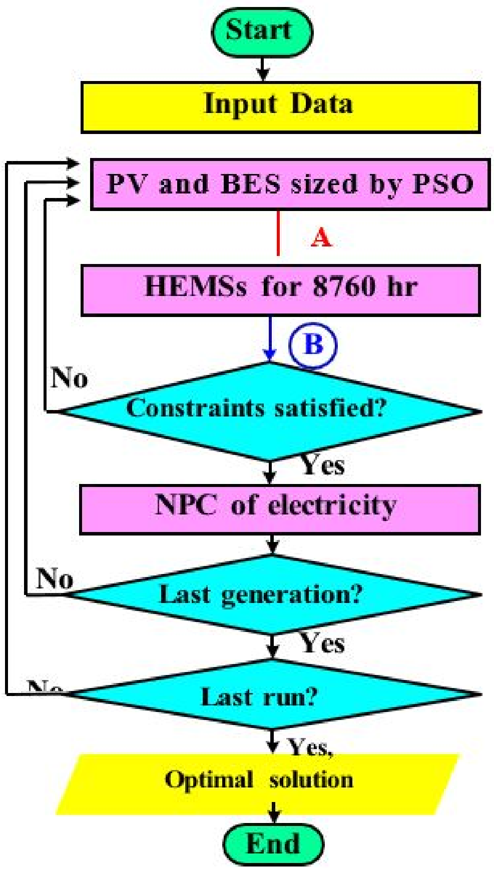

Figure 2. Optimization flowchart for sizing of PV and BESS.

These included data on the GCH's power use, weather data, energy rate information, grid data, and component data. A year later, the PV and BESS were scaled using PSO, and the system's performance was reviewed (8760 h).

Figures show the HEMSs in action, with points A and B acting as the system's starting and ending locations. After the operation is completed, the algorithm checks to see if it meets the design criteria. The entire number of system generations and runs were then counted, and it was determined whether or not the system's NPC had been satisfied. Finally, it was concluded that the alternative with the lowest NPC would be the best choice.

V. DISCUSSION &CONCLUSION

This article contains a brief knowledge about the basics of solar system, different battery energy storage system and various optimization techniques for getting maximum output from solar system. After a detailed study about the optimization technique, we have concluded that Particle Swarm Optimization technique is one of the best method to get maximum output from solar system and maximum storage capacity of the battery system.

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