RESEARCH ARTICLE OPEN ACCESS

# Design Utilisation Of Battery Bank Fuel Cell In Case Of Solar Pv System

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**Abstract-**From the perspective of global warming containment and depletion of energy resources, renewable energy such as wind generation (WG), photovoltaic facility (PV) and fuel cells (FC), and batteries are getting attention in distribution systems. The usage of all-electrification houses is growing in the world. So convenient loads such as electric water heaters, heat pumps, and electric vehicles are introduced to the power system. In addition, the controllable load could shift the peak demand in the daytime to the low demand,and it is an effective method for leveling the load and upgrading the load factor. This paper illustrates solar-fueland solar battery hybrid organizations for supplying electricity to the power grid. In this paper, the solar power module and their modeling are also simulated through MATLAB.

**Keywords**: Smart grid, Fuel cell, Renewable energy power, battery

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Date of Submission: 03-04-2023 Date of acceptance: 15-04-2023

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## I. INTRODUCTION

This document explores the viability and responses of a PV, battery, and fuel cell-based hybrid microgrid model for intermittent Level 3 EV charging services. This concept differs from other microgrid models in that the system remains grid-tied with limited autonomy, striving to reduce strain on the central grid when power is at a premium and reduce the community's carbon footprint. This concept is unique because it proposes that each home is equipped with a generating capacity greater than its need, and this excess generated power is shared within the footprint of the microgrid community. They usually use renewable technologies such as solar photovoltaic (PV) and fuel cells. Non - Renewable energy sources are fast-depleting and unsustainable sources. Apart from that, topographical India doesn't have grid connectivity everywhere. This thesis introduces a hybrid sustainable system comprisinga solar power and fuel cell system connected to a feeder.

Although photovoltaic panels are popular renewable energy sources, the major problems they encounter depending onpower production are with solar irradiation.The connected central grid is treated as an optional power source—the escalation in cost and environmentalconcerns involving conventional electrical energy. Authorities have increased interest in renewable energy sources. Many societies across the world in which we live have developed an enormous appetite for electrical power. This appetite has been stimulated by the relative ease with which electricity can be generated, distributed, and utilized and by the great variety of its applications. It is arguable whether the consumption of electricity should be allowed to grow unchecked, but the fact is that there is an ever-increasing demand for this energy form. If this demand is to be met, then the world's electricity-generating capacity will have to continue to grow. Almost all the electricity generation occurs at the central power station, which utilizes coal, oil, gas, water, or fissile nuclear material as the primary fuel source. There are problems facing the further development of generating methods based on conventional fuels‖. Hydro-power generation is restricted to geographically suitable areas and reserves of coal. To achieve this and also to aid in the management of the existing fossil-fuel resources, some part, and an increasing part, of future electrical energy research and development must be concerned with so-called non-conventional methods of generation Wind- solar PV and fuel cell power generation are visible options for future power generation. Besides being free, they are free of recurring costs.

## II. RELATED WORK

As mentioned, combining solar PV and wind sources improves overall energy output [13],[14]. However, the energy storage system must have a continuous power supply and cover any deficiency in power generation from renewable energy sources. The storage system can be battery banks, fuel cells, etc.,focusing here on battery banks. Various optimization techniques have been reported which could be applied to reach a techno-economically optimum hybrid renewable energy system [1], [7]. A comparison was made for many optimization techniques of hybrid systems in [8]. For remote areas representing most standalone applications for hybrid solar PV and wind systems, it is not always easy to find long-term weather data, such as solar radiation and wind speed used for sizing purposes. Hence, more artificial intelligence techniques such as fuzzy logic, genetic algorithms, and artificial neural networks are used for sizing standalone systems than traditional methods based on long-term weather data. We did EDA using analysis techniques widely used in solar and wind energy data analysis [

Variations in solar radiation and wind speed with time can cause voltage fluctuation. The characteristics of voltage fluctuation depend mainly on the load type and size, the strength of the connected electrical grid, and its size. Active power filters such as dynamic voltage regulators, static synchronous compensators, and unified power quality conditioners can resolve voltage fluctuation [1],[7]. Similarly, power compensators such as fixed or switched capacitors can be used to determine reactive power issues [6][5]. They are the latest interfacing devices between grids and consumer appliances. Sudden changes in active power drawn by a load could cause system frequency fluctuation in AC grids. These changes represent unbalance situations between load and generation. Because of the above, designing control loops for power and frequency control is essential to mitigate quality issues [1]. Bae and **Kwasinski [5]** highlighted that a primary goal of a pulse width modulation (PWM) inverter controller was to regulate three-phase local AC bus voltage and frequency in a microgrid. Power electronics devices and non-linear appliances typically cause harmonics. Appropriate filters and PWM switching converters can be used to mitigate harmonic distortion [49-50]. Integrating renewable energy with battery storage and diesel generator backup systems is becoming cost-effective for resolving less usable renewable energy during the year. [9-6]. However, if storage runs out, there is no way of importing power. Therefore, integrating PV and wind energy sources with fuel cells is a promising alternative backup energy source for hybrid generation systems [11-14]. Distributed generators can help with fluctuations in power supply since generations' units will be close to the loads. However, introducing distributed generators will require upgrading the existing protection schemes [65].

## III. III SOLAR ENERGY SYSTEM

Solar Energy is the most readily available source of energy. It is free. It is also the most important of the non-conventional sources of energy because it is non-polluting. Fuel cells, magnetohydrodynamic systems, and devices based on thermoelectric, thermo ionic, and solar-electric conversion are all potentially useful non-conventional electricity sources. Each of these sources has its advocates for further development, but none more so than solar energy, which capitalizes, perhaps, on the deep-rooted associations between man and the sun to foster an image of bountiful power from a no dependable, non-polluting, and benign source. The potential of a solar-electric conversion is immense, and the current research seeking to realize it involves studies on bioconversion, the wind, photovoltaic, ocean currents, and photoelectrochemical. List all these methods that can be designed to yield electricity as the end product, if so desired.Only through the photovoltaic effect can sunlight be converted directly into electricity. This feature of the directness of conversion has been primarily responsible for making photovoltaic such a popular mode of electricity generation.

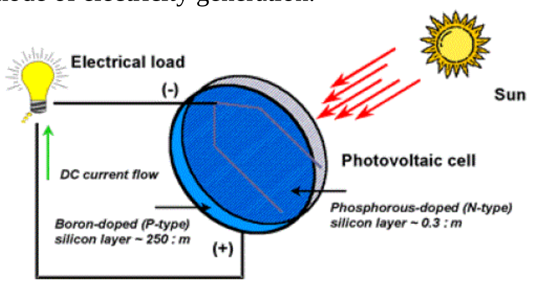


Fig. 1 Generation of electricity through solar cell

**FUEL CELL -**Efficiency Power generation in fuel cells directly convert available chemical-free energy to electrical energy rather than going through heat exchange processes. Thus, it can be said that fuel cells are a more efficient power conversion technology than conventional steam-applying power generation. Figure 2 illustrates energy conversion processes for a traditional power generator and a fuel cell. Fuel Cells, first developed in 1839 by William Grove, work by combining oxygen and hydrogen to create water, extracting electrons to do work (Figure 2). The advantage of using this technology is its use of non-hydrocarbon fuel to produce clean power. In addition, hydrogen fuel can be generated on-site through an electrolyzer. The fuel cells used in the simulation are composed of 21 kW stacks with 10,000 hours of operation life at an efficiency of 52 percent. They are modeled after the Ballard FCvelocity-9SSL [12]. These models are Proton Exchange Membrane (PEM) fuel cells and were selected because they are powered by pure hydrogen.

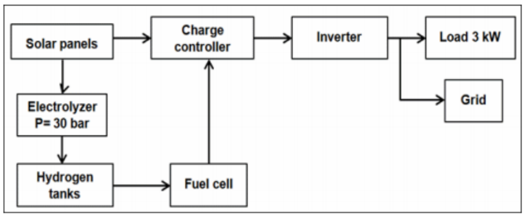


Fig.2 Fuel cell diagram

**A-Batteries-** use a chemical process to store electricity. A chief advantage is that power access is instantaneous. A drawback is the limited duration of energy output. A Zinc Bromide Flow Battery (FB) is selected for this experiment. Unlike conventional batteries, the electrolytes are stored in separate tanks and pumped to the cell stack (Figure 15). The batteries used in the simulation are modeled after the ZBB Overstore for the ZEISS battery. Capacities are 8.75, 12.5, 25, and 50 kWh [30]. The electrolyte solutions are pumped through the battery stack and reconstituted through a chemical process. Thesebatteries can be fully discharged without capacity degradation with cycling. Only the cell stack needs replacing every 4 to 5 years. The replacement cost of the cell stack is roughly 18% of the battery cost and has been incorporated into the model over five years as the yearly O&M cost.

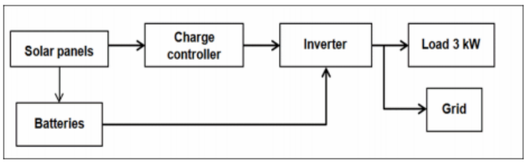


Fig.3Battery diagram

Classical PV battery system Inthe first approach, the classical case using only PV and battery can be studied. The system is presented in Fig. 2 1. In this configuration, PV charges the battery during the day and then supplies the street lights at night.

Battery The lead-acid battery is commonly associated with stationary solar systems. This type fits well with the system in this application: a speedy response time is unnecessary since the load is always constant, and the critical weight of this battery has no influence on stationary applications. Furthermore, its efficiency is at least hb¼ 80%.

**B-Lights -**Nowadays, moststreet lamps are from gas-filled technology and last an average of 12,000 h (less than three years). With 50,000 light hours, LED lamps do not have to be changed for 12 years. Therefore, LED street lamps are twice as expensive as current street lighting with a similar design. However, this is compensated by the longer lifespan and the low consumption, which is around 60W in this case (lifetime is given as an indication from Ref. and LED manufacturers). Currently, the price of LEDs is decreasing because the production capacity has increased. This price is assumed to be around 10V/W. changing two times the LED, the cost of this device will be1200V. Electrical converters ThreeDC to DC converters are needed. The first one is used to obtain the PV maximum power using an MPPT (Maximum Power Point Tracking) algorithm because of the non-linear nature of this source. The second converter controls the current flowing through the load, and the third contains the FC current. A direct connection between the PV and the battery also works. However, there are no guarantees that the PV would supply the maximum power. For the street lighting application, it should be remarked that a direct connection between PV and LEDs would be needed. However, they will never be required, as they will not operate simultaneously. The efficiency of each electrical converter is assumed to be 100%.

**Photovoltaic cells-**Three commercialized silicon technologies are currently available: the amorphous, the polycrystalline, and the monocrystalline. The first one cannot be used because of its low efficiency (about 6%). The monocrystalline technology reaches 15% against 10% for the polycrystalline. However, polycrystalline technology is often preferred for its lower cost, 4V/ W. Finally, the production of monocrystalline cells needs three times more energy than polycrystalline cells,which cannot be ignored from an environmental standpoint. Considering a European region like Geneva, Switzerland, where the annual solar insolation is 1.2 MWh/m2, approximately300 PW polycrystalline cells must be used. Such PV represents a massive surface of 3 m2 for only one street light. To reduce this surface, the only solution is adding another energy source. It is also essential to notice that this simple case assumes a large enough battery capacity. Indeed, due to the seasons, it is considered that a necessary part of solar energy has to be stored during summer to be used in winter.

*ISSN: 2248-9622, Vol. 13, Issue 4, April 2023, pp. 155-160*

## IV. PROPOSED MODEL

The purpose of DC to DC converter is required for the PV system for proper voltage level at the DC bus. It consists of MPPT with a boost converter, providingthe correct voltage and power at the output. To integrate the utility grid and microgrid, a power inverter is needed, which can be inserted in between these two. The kinetic energy of the turbine is converted to mechanical energy, and the turbine shaft is connected to the generator, which converts it finally to electrical energy.

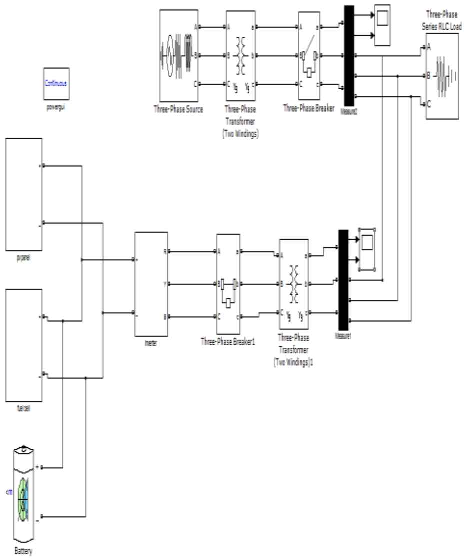


Fig. 4 Proposed simulation model

**C- Power inverter/converter**

connected to the rotor shaft of the generator. The power is transmitted from the turbine to the generator with the help of a shaft. The generator rotor winding is known as armature, which rotates between the stationary magnetic field and produces electrical voltage according to the general generator principle. The fuel cell system considered in this paper consists of a fuel cell reformer and stack, which generates electricity due to the electrochemical reaction of hydrogen and oxygen, as shown in Figure 11. The fuel cell is a device that produces electricity from the chemical reaction of hydrogen and oxygen where the microgrid is designed with solar PV/wind energy /Fuel cell and battery system, which is connected to a common DC bus through a switch

**D-Maximum power point tracking (MPPT)**

The solar panel efficiency is increased by the use MPP technique. This is because the MPPT applies the maximum power transfer theorem, which says that the load will receive full power when the source impedance equalsthe load impedance. Therefore, the MPPT is a device that extracts maximum power from the solar cell and changes the DC/DC converter's duty ratio to match the load impedance to the source.

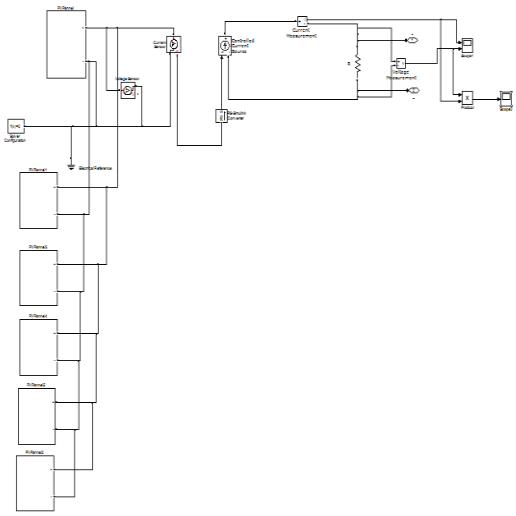

Fig. PV battery model

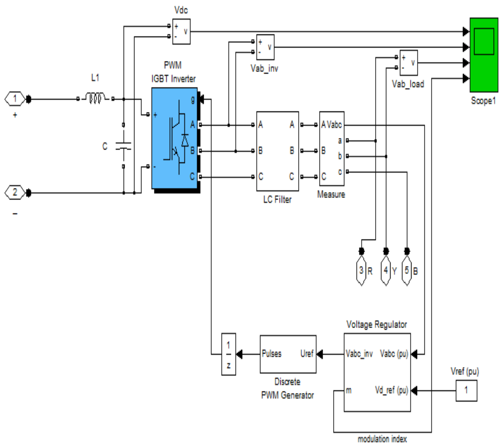


fig. 5 Simulation sub-model

With the developed model, PV module characteristics and Hybrid system load characteristics are estimated as follows: I-V and P-V characteristics for the PV module are shown as follows.

## V. SIMULATION AND RESULT

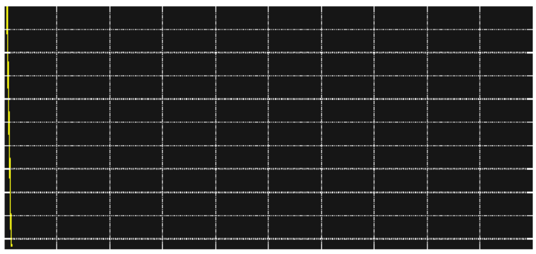

Figure 6: Power delivered PV-FC

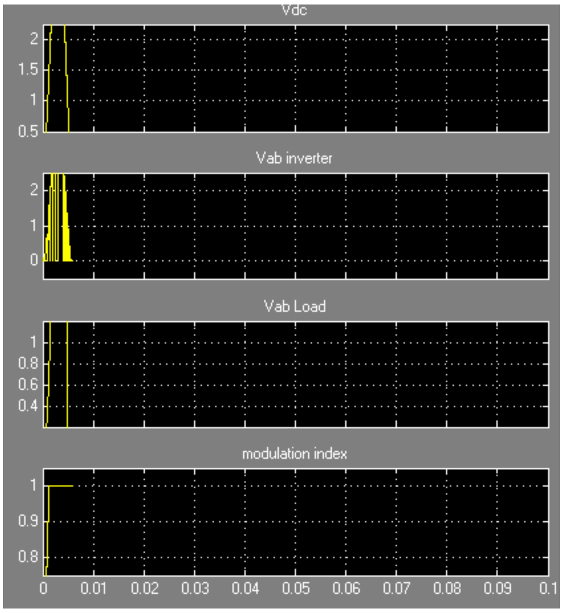


Fig.7 Power delivered by Fuel Cell voltage and current waveform

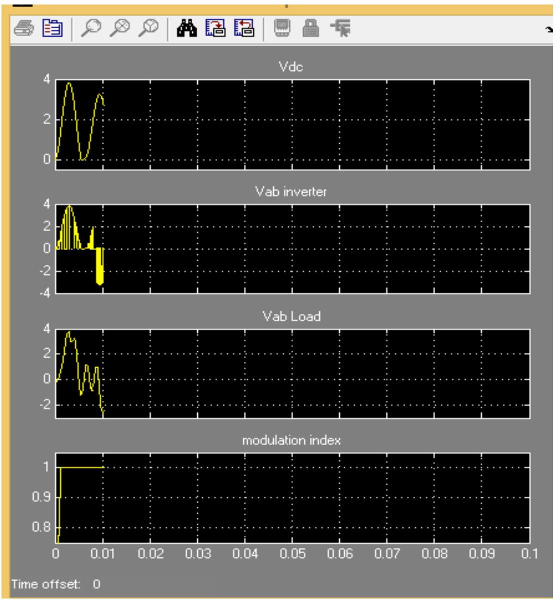


Fig. 8 Simulation wave of load

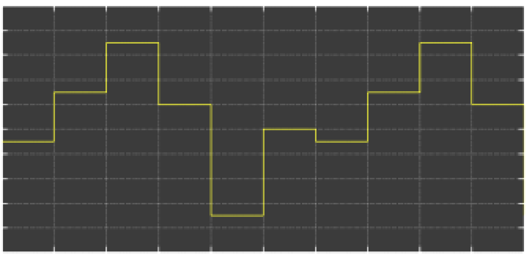

Fig. 9 PV load curve

## VI. CONCLUSION

The step-by-step procedure for modeling of PV module is presented. As well as hybrid system load sharing is introduced.This paper of the simulation of a hybrid Photovoltaic (PV)- fuel cell generation system employing an electrolyzer for hydrogen generation is designed and simulated. The system is applicable for remote areas or isolated loads and maximum power point tracking to extract full available solar power from PV arrays under variable insolation conditions. The system incorporates a controller designed to achieve a permanent power supply to the load via the PV array, fuel cell, and battery.Various resultswere obtained through simulation in terms of current, voltage, load, and power.

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