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Management Hybrid System PV Energy with Fuel Cells Energy

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Abstract
Fuel cell power systems employing renewable energy to reduce power outages and problems is affecting the network and their are generation systems. Many researches has been to integrate photovoltaic energy with other sources contributes a lot in the field of electrical energy. High efficiency, high quality, and decrease fuel consumption . We its noted that the development of renewable energy means finding a new source of energy, a safe environment, and economic factors. On the other hand, the development of battery technology with solar cells and other sources is sufficient for our need for energy. The integration of the solar cell with fuel cells and batteries will obtain an uninterrupted source of energy. This study aims to find and design efficient and hybrid energy systems according to the hybrid energy system strategy. The results were obtained through simulation using the Matlab program.

Keywords: solar cell, fuel cells, storage energy, hybrid power systems.

1. INTRODUCTION
Renewable energy has become a source (solar / wind/ tidal / etc) are of great importance as they are power source that replace traditional fuels. The worldwide environmental damage is global warming. Solar (PV) energy systems are widely used as sources and are a door for studies and research and are widely used because they are low cost and easy to maintain. This system can be applied in homes, projects, etc., communications and others, in military missions, cars and even drones [1] - [3]. On the other hand, in

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the operation of solar energy, photovoltaic panels have great applications in energy production despite the changing weather conditions and technical problems they are exposed to. To overcome these problems, energy sources and solar energy can be combined in; Examples include machine generators [4] .

Electromagnetic energy storage unit [5], battery storage unit [6] - [8] and fuel cells systems [9] - [10]. It is possible to provide 24 hour diesel sources with capable, highly efficient and less efficient photovoltaic power at the output. The the energy generated by diesel is very harmful to the environment. We note that the magnetic energy storage technology has a wide field, and has also been associated with great risks due to the exchange of magnetic fields of high strength. Fuel cell sources are one of the good sources available and can be used with solar cells because of the low fuel and high efficiency. Therefore, one of the weaknesses of fuel cells is their slow dynamics, which we note is limited by the slow dynamics due to the water pump and valve systems and their maintenance. The increase in the electrical load decreases the voltage supplied by the fuel cell, and this causes the power to fluctuate or cause it to stop at low temperatures. The fuel cell system must be large enough to meet the energy needs. To increase its response and give maximum energy output, there must be an energy storage system. On the other hand, despite the use of batteries as an energy storage system, renewable energy systems employ enough electrical energy to prepare to meet our energy needs and to prepare heavy loads, batteries are not sufficient to meet the need for electrical energy due to demand and increased loads. Therefore, hybrid systems must be found to meet the need for energy, which are batteries and fuel cells, which integrate energy for fuel cells and batteries [11], with solar energy systems through power controls to ensure quality and efficiency. The fuel cells can be combined into a solar energy system in two ways: first, an independent source of energy, or a coordinated storage system by feeding them hydrogen from a dedicated electrolyze [12] - [13]. This paper discusses the independent or central power unit. In this case, it is possible to find ways to control energy that save from energy sources and the difficulty of controlling branched energy systems and what is represented by a problem. Hybrid power systems require an effective scheme for controlling power from sources without any risks and increasing efficiency and reliability by addressing the problem of low voltage conditions. Therefore, instead of finding a system

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for regulating the voltage and current at the output . generation, there should be a system that controls the transducers. This method ensures the supply of power to the load while ensuring that the batteries are not overcharged, the processing of the power supply, the protection of the fuel cell, etc. The aim of this study is to design a system.

2. Scheme of The Hybrid System

The hybrid power unit, consisting of renewable energy sources, solar cells, fuel cells, and batteries, is connected through appropriate inverters (DC-DC). As shown in Figure 1, which shows the shape of the hybrid system and its components. We also note that there are two types of energy sources, namely solar cells, and fuel cells. Although batteries store energy, they are also a source of electrical energy, to fill the shortage of supplied energy. Solar cells provide the largest energy for the load, while fuel cells are supportive of electrical energy in the event of an increase in the load when the solar cells are unable to supply the electrical load. The batteries store electrical energy and supply it at a specific time. The voltage, current, and capacity are measured. The measurement is carried out for the voltage, current, and capacity supplied from hybrid energy sources. Then the electrical energy is prepared to ensure quality, which is treated by adding filters resistor and capacitor (RC), in the sub-systems and according to the power system, and then it is done Format transducers. The supply of energy from the sources is controlled through special transformers for each source.

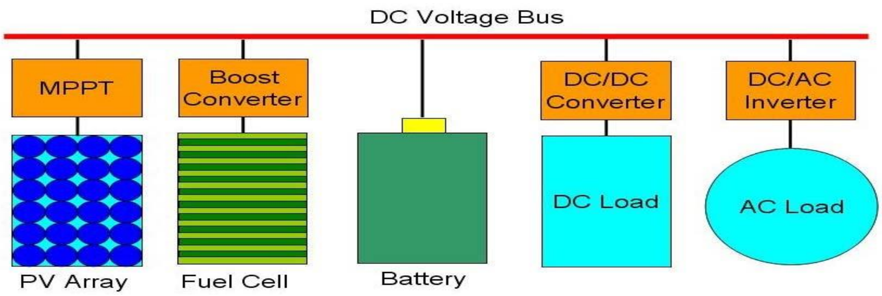

Fig. 1 Hybrid solar cell - fuel cells system.

subsystem . The solar cells power of the load and the battery cross a controller which operation as ((a max power - point tracker)). A diode D_1 is function to prevent the current from flowing back to the solar cell ,

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the reverse current may be causes problem in the solar cell. The converter is operation by a plus with modulation generator is control by the digital logic controller.

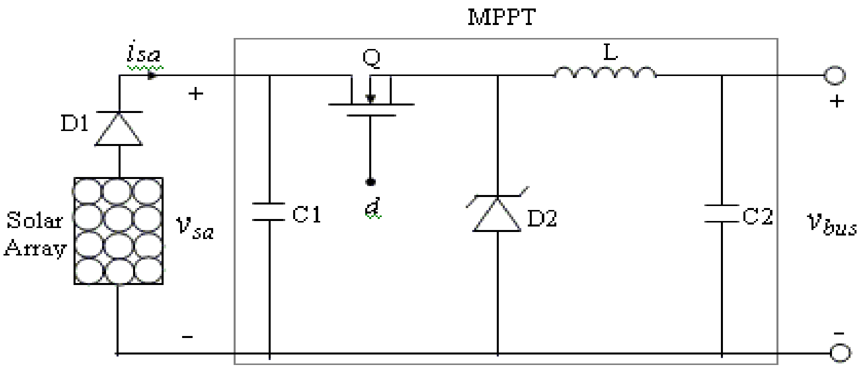

Fig. 2. Circuit diagram of solar cell

A boost converter, as shown in Figure 3, is specified to regulate the output voltage from the fuel cells to the regulator voltage. The power circuit components of the fuel cell converter are from the switch (S1), the Schottky diode D1, the high-frequency inductors L1, and the capacitor C1. Diode D0 is used to prevent the current from returning to the fuel cells to protect them because the reverse current causes damage to the cell. The boost converter is powered by a PWM generator. For low operation, a boost transformer MOSFET switch is used. converter S2 is for a safe shutdown in the event of a sudden circuit fault .

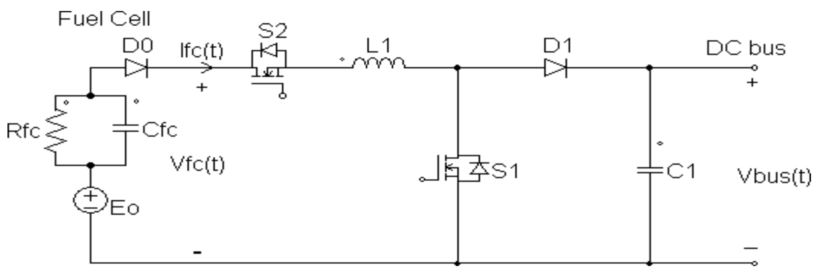

Fig (3) Diagram of the FC

A batteries are connect to the Dc potential parte . Energy is flowing in both paths . The are charging current is regulated by controlling the voltage from the source. Voltage regulation is done for the power source for solar cells and fuel cells.

3. Power control of solar cell

Due to the changes in solar radiation according to the time and seasons.The potential cell includes non-linear currents [14], which changes whenever the conditions change. Solar radiation activates and generates an electric current, as well as temperature, electrical loads, wind, etc. Therefore, the system must be the regulator for solar energy to obtain the max the power (maximum power point M.P.P) by control the DC Inverter - DC interfering current through solar cells & voltage transmitter to ensure quality and efficiency. The energy generated by the solar cells charges the batteries and in addition, is associated with the fuel cells. When we consider the design of the solar energy subset of the system, the necessary to reflect the protection the batteries. The potential of the batteries must be regulated and protected from the bus voltage, that's are means that the supplied potential does not override the rated voltage. Here, we notice a concern when the battery is filled with electric energy when charging, so the control of solar cells has a strategy and there are two modes, the mode of obtaining the maximum electrical power point maximum power point tracking (M.P.P.T) and the other mode is the bus voltage supplied from the batteries.

In the circuit shown in Figure 2, the transducer is the only source of power supply. The current provide from solar cells is output of the battery its regulated by regulating conductor voltage. when the battery voltage override the rated voltages, a control system is triggered to protection the battery when be overcharging . By this model, so current from solar cells are far from (M.P.P). If the voltage of the batteries are less than rated potential , here is M.P.P.T operation. Here we notice the largest possible capacity draw.

Figure 4 shows the voltage regulation. The arrows here indicate the extent of changes to the system

4. The Hybrid System

the rules that is unique to the current rated mode (state). Since the solar cells panel voltages is positive, that mean could get the We need a suitable hybrid system that contains more than one source, this system always works in (M.P.P.T) mode. When a rated potential of a battery reaches, regulation is applied to avoid overcharging. According to the circuit strategy, the load is disconnected if the battery is discharged Safe operation (eg 5 times the specified to charge the current), who is appropriate for a load position , or when the battery voltage less than a lower voltage. It can be adapted to any time, only one regulation is used, and the unit is controlled by a power transformer. Here the work of the transducer is regulated according to the intended purpose. When there is a change in solar radiation, batteries, or electrical loads to suit the work, the control strategy puts another regulating device and here the voltages are measured and calculated. The power transformer has a role in transferring energy according to the new goal, to suit the control instead of using several controllers, only one controller is used.

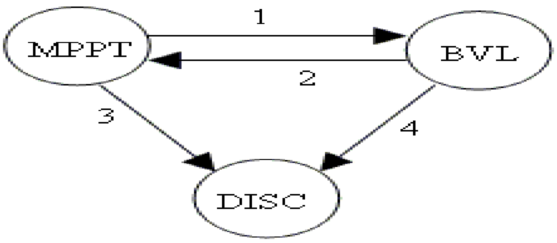

Fig. 4. Control strategy for the photovoltaic subsystem.

case 1:
$MPPT$: $Max\ Power\ Point\ Tracking\ result$: $Bus\ of\ (battery)\ Voltage\ Limit\ mode\ DISC$: $Disconnecting\ the\ Load$
$Conditions\ of\ Events$

$$1: Vb > Vref$$
$$2: Vb < Vref$$

$$3 - 4: |Ib| > Idisc\ (for\ part, Idisc = 4\ x\ Iref.)$$

The main goal of tracking the maximum power point by (MPPT) is to ensure that the energy is supplied with high efficiency where that is take the max energy from the solar cells and takes into account the weather and weather conditions. Several phase algorithms for MPPT, for example, the observer and perturbation method [15], the gradually conduction mode [16], the fault a short circuit current [17], cutting circuit methods [18], the fuzzy system of logical control [19]. Modules use intelligent Neural network techniques system [20] . The additive methods of connection that are widely used in this system will be used and applied. As shown in Figure 2, solar cells are

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described by (1).

where Vsa potential and Isa current a solar cells

$$\frac{1}{V_{sa}}\frac{\partial p_{sa}}{\partial V_{sa}} = \frac{I_{sa}}{V_{sa}} + \frac{dI_{sa}}{dV_{sa}} \qquad (1)$$

Let's define immediate connections and additional connections as follows:-

$$G = \frac{I_{sa}}{V_{sa}} \qquad (2)$$

$$\Delta G = \frac{dI_{sa}}{dV_{sa}} \qquad (3)$$

where the solar cell voltage is positive are getting :-

$$\begin{aligned} &\frac{dP_{sa}}{dV_{sa}} > 0 \; if \; g > \Delta g \\ &\frac{dP_{sa}}{dV_{sa}} = 0 \; if \; g = \Delta g \qquad (4) \\ &\frac{dP_{sa}}{dV_{sa}} < 0 \; if \; g < \Delta g \end{aligned}$$

Eq (5) suggest that management the voltages is little the potential in the M.P.P if the instant conduct is greatest than the increase reliability, and if little that means opposite. The M.P.P.T algorithms are search to find the voltages are functionality point at point the prompt conductance's is equal to the incrementally contact. M.P.P.T algorithm is useful in Fig. 5

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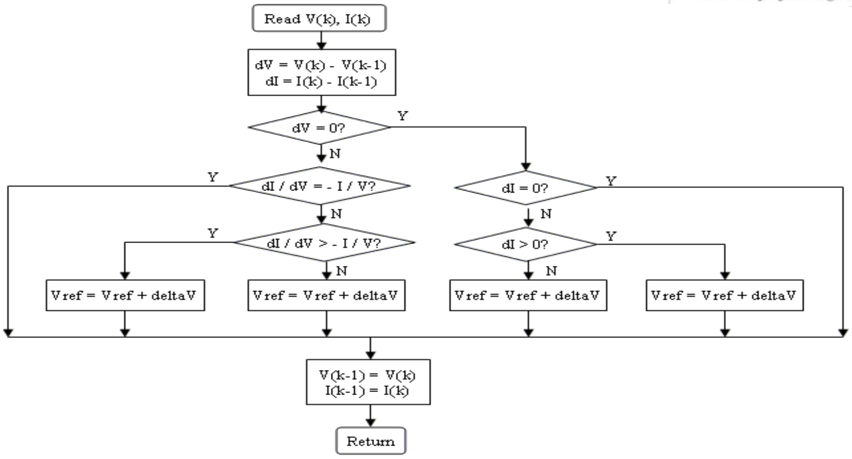


fig .5 .Diagram of the MPPT algorithm.

Using the proportional–integral–derivative controller PID to the regulation of voltage at the system is operating in B.V.L mode. The voltage is regulated as series.

Note $d(n)$ & $d(n-1)$ mention to the frequency respectively, $V\,(n)$ is the battery voltage when the current provide , $Vref$ is mention to the battery, ((kp)) its gain, ki its integral - gain, and ((kd)) mention to derivative gain .

5. Fuel cell control.

Since the fuel cells is supplied with fuel and air by pumps, valves and compressors, it has excellent time stability, if compared to the stationary electrical time. Therefore, the fuel cell system cannot respond to the change of electrical load, and the system may suffer from the change in energy consumption. Therefore, the fuel cell operates in a hybrid system smoothly in stable conditions, while the battery function supplies temporary power. The fuel cell must be suitable for supplying energy to replace the solar cells and charge the battery. have to responsible for operating the fuel cell and be voltage regulated. In order to achieve the condition of supplying the required current, to maintain the battery it is possible to control a converter connected to the fuel cell to a certain extent of charging. To achieve the desired response, a current regulating loop controls the transformer. As in Figure 6, the selection of a PID regulator is associated with a PWM signal generator to systematically control the current of the fuel cell.

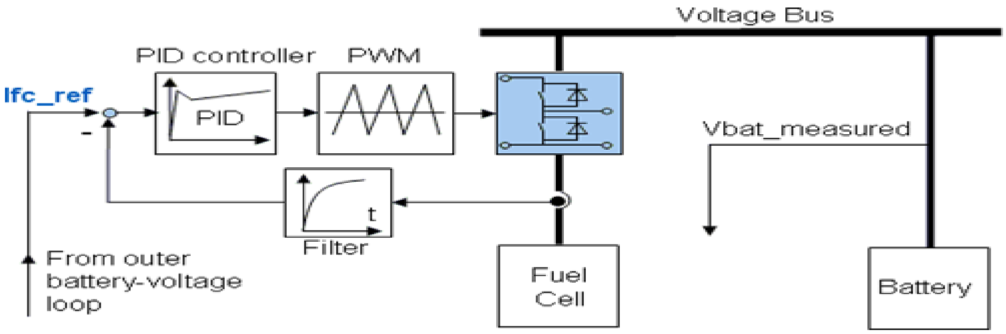
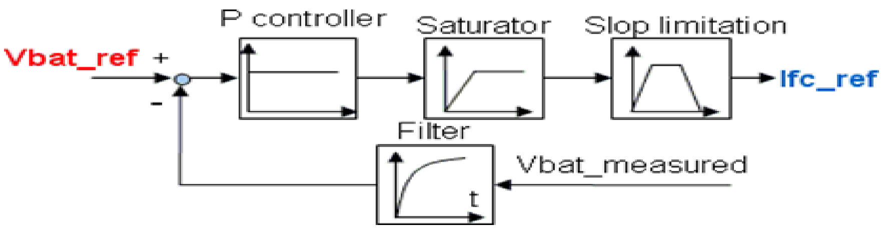


Figure 6. Regulation of the internal current of the boost converter .



Fig(7) the loop of the regulation potential to the converter

This current of fuel cell have supplied to the reference of signals, current fuel cell source – reference , its create through loop of voltages there is present in Fig 7 The batteries series of voltages , result the $IRefe$ current to fuel cells, included a PI regulation at gather of the algorithms indicates the fuel cell and the proved currents that arose due to the voltage drop of the battery, and we note those fuel cells currents have started to work to fully charge the battery. This control method, in addition to the solar cell controller. When the battery is fully charged, the fuel cell stops operating . Here we note, the solar cells and the battery will be in the working range. This mode of work saves us fuel.

Obtaining a reference current for fuel cells is an important matter that activates the working system of fuel cells for the purpose of conducting the necessary regulation of the flow of hydrogen gas and oxygen's to get the output current required for charging.

6. Discussion a& Result

Test the management of the hybrid Solar cells and Fuel cells electrical system, Simulink represent were connected in the bus of voltage It is an advanced power systems simulation design [21].. Figure (8) shows the power in the bus voltage of a hybrid system with a capacity of 2 kilowatts. The power system is supposed to be located at line 33 in the north direction and 81 degrees in the west direction. The symmetrical figure was transformed from 7 am to 12 pm, 13 April, 2020. We assume that the sky was clear and the ambient temperature was equal at 28 ° C during the process. Figure (9) shows the incident solar radiation that was sent from the sun at 7 am and was observed It maxed out at 12:35 p.m. The solar radiation decreased to zero at 5:35 pm.

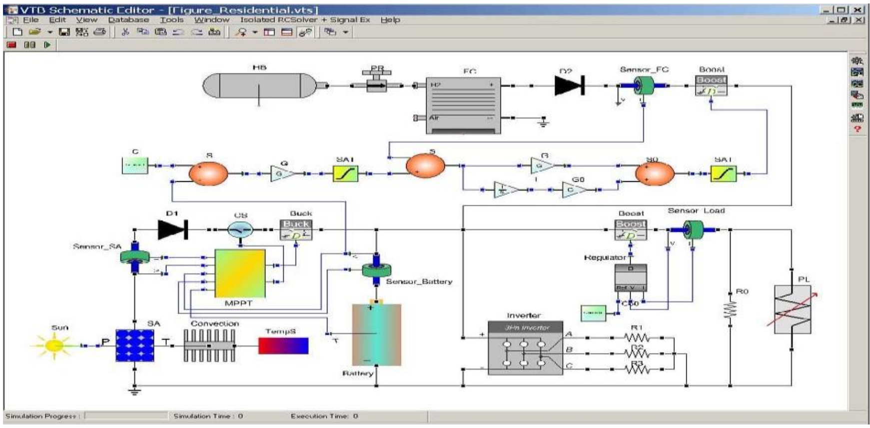


Fig (8) V-T- hybrid system of solar - fuel cells power system.

A solar cells panels have included to the array of 141 * 100 cell all those panels connected as series by parallel connection every pare of cells have area (2) * (3.6) cm^2. The response value 0.306 A/W. The source unit 2 of power has 41-cells P.E.M fuel cells stack . The operation region of any cell has 291cm^2. The battery has arrangement as an array of 13 x 25 part . Any cell have energy 1.6Ah. The priority was to charge the battery 0.4. this load included to a fix alternating load , so a fix powers – direct load as will as pwm energy . Electrical loads have observed around 1.6kW in period of peak period power 2kW rated of the energy. The power boost converter have shown by pwm models .Indicated to the area operating rules ,rated

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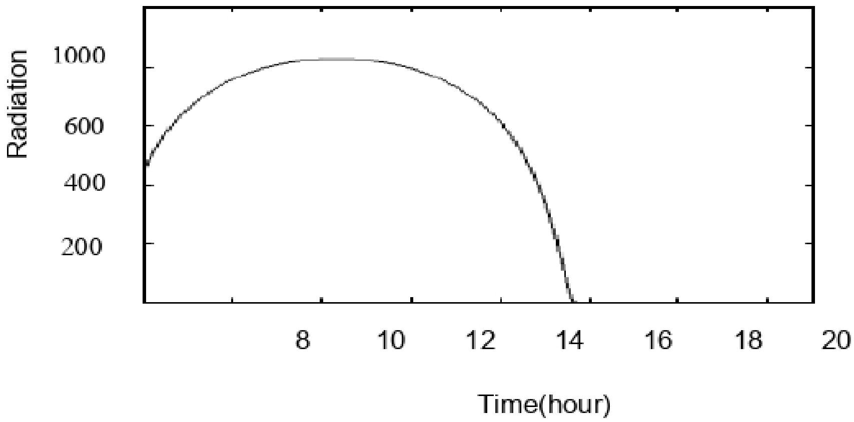
voltage from source battery have rated to 50.5V. Current proved from fuel cells rate set 32A. The reference battery voltage was previously regulated as a reference for the fuel cell current to 51 volts. The results indicate Simulink in Figs. From 10 to 14. Figure 10 has shown the supply current from solar cells and fuel cells as well as the battery. Figure 11 has shown the voltage value of solar cells, fuel cells and battery. Have noted the bus the voltage is equally to the voltage at the battery. Each of the sources is shown in the drawing for the energy produced. The check state-of-charges of the battery is plotting in Fig 13 & Fig 14 represent the modification of arrange mode.



At start-up, the maximum output current of the fuel cell is 35 amperes due to the low charge of the battery. Solar cells and fuel cells provide energy to prepare the electrical load. As the solar cell controller, it works in MPPT mode, to get the maximum PowerPoint. The energy is gradually increasing. The battery is charged gradually to supply loads requires low power consumption. The battery charges , as plot in Figure (13) is speedily increasing. When the battery charge reaches the rated value for pre-charging (50 volts), the fuel cells begins gradually decreasing, as shown in Figure (10) shown supply of the solar cells giving the largest amount of energy. We notice a slight increase in the voltage of the fuel cell. The fuel cell ran out at 9:30 am because the battery is fully charged at this moment. Between 10 AM and 2 PM, the load attracted a peak of 2.5 kW power. The battery here begins to supply for enhancement the peak load, the current of the fc growth by about 10 amps due to the discharge of the battery. After running for two hours, the battery is recharged again and the fuel cell is closed due to the lack of demand for the load.

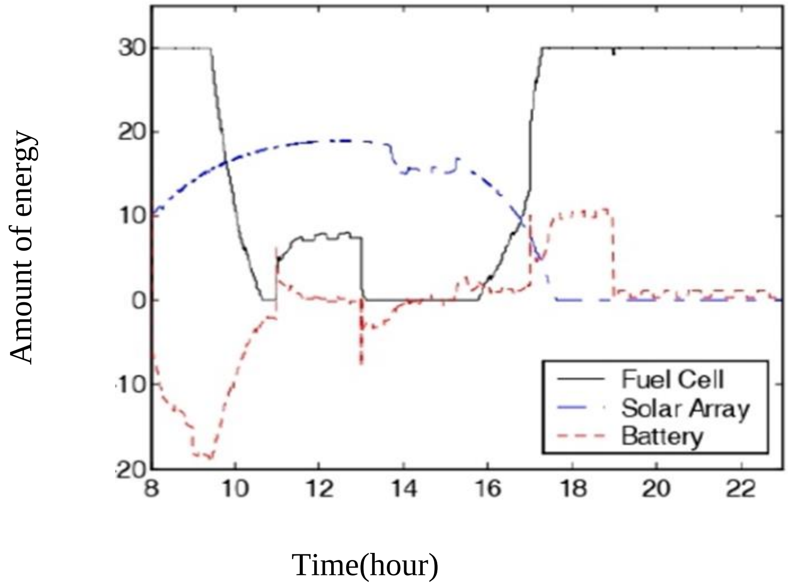


Fig.10 Current provide from three sources shown (fc ,solar cell battery)

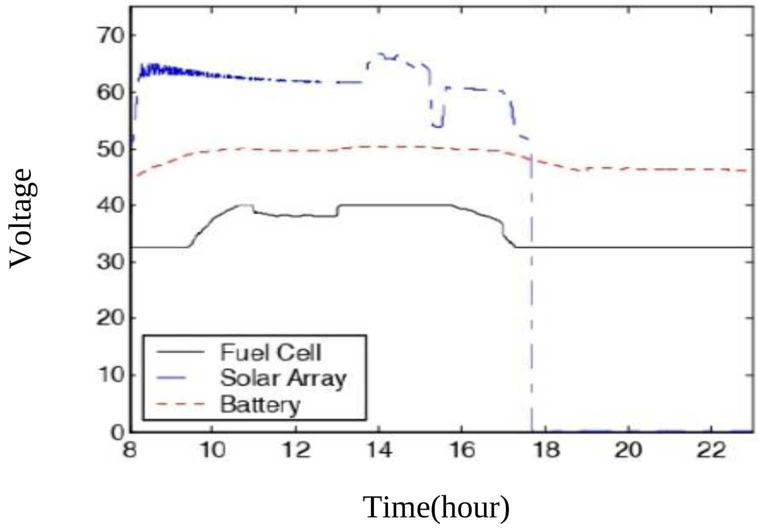


Fig . 11 A voltage of the (solar cells) ,the (fc) ,and battries.

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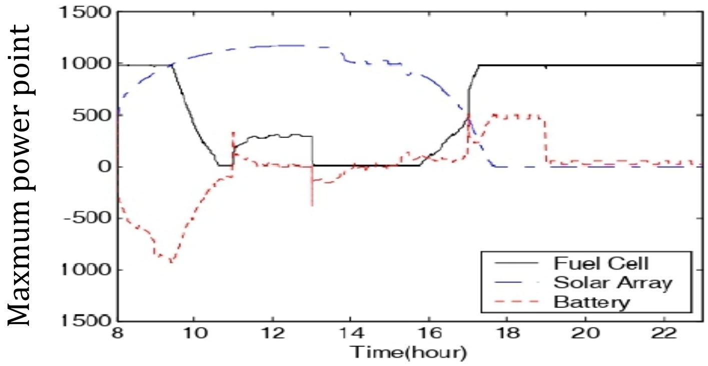
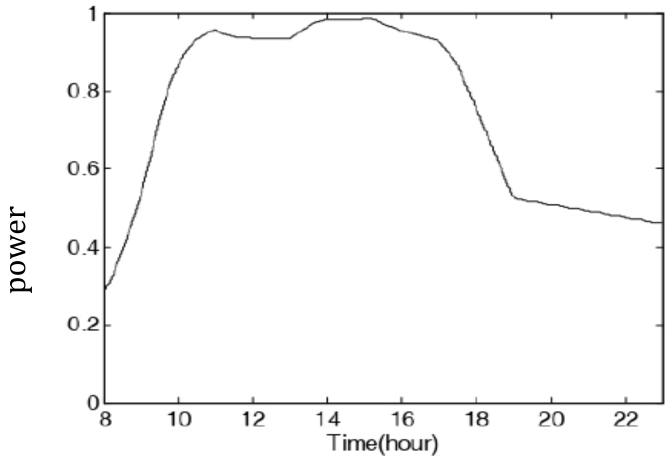
By 3:00 pm, the battery voltage reached its maximum charge, BVL mode was turned on and the battery voltages were set at 50.5 volts. A little current leaks to the battery and here we notice that the output current of the solar cells has decreased, and this leads to an increase in the output voltage of the fuel cells. What is interesting to note is that when the solar cells are operating in B.V.L mode, the (fc) is blocked to store fuel



Time(hour)

Fig. (12) three source supply energy.



Time(hour)

Fig .13 calculated charge of battery

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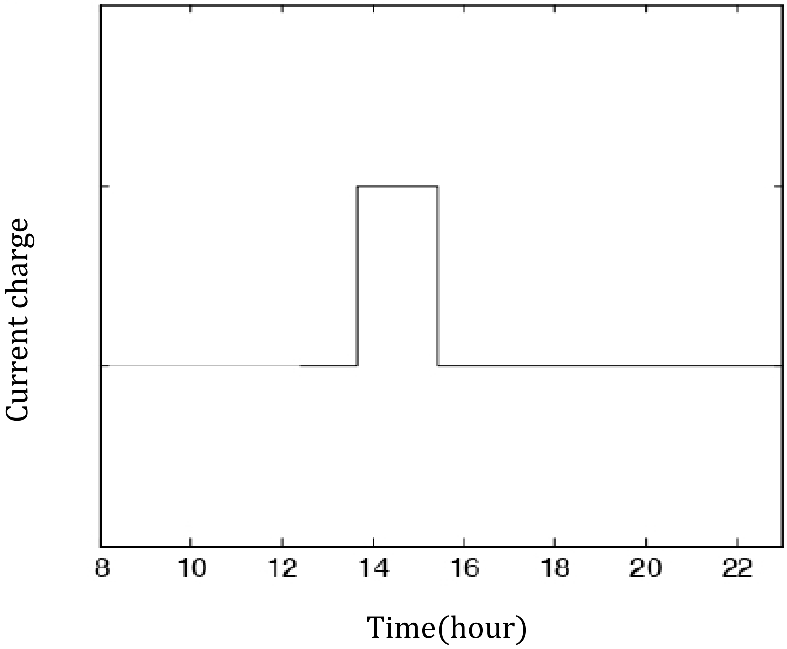

Fig. (14) system mode of the solar cells controls system.

Theoretical research in energy handling is through controlling each energy source accurately and that the hybrid energy system is a reliable system.Simulink results exhibit that the control strategy is more Effective in supplying electric power.

6. Conclusion.

the paper represented the efficient energy handling systems for solar energy and fuel cells (FC) hybrid mode so that a reliable system. The hybrid power system consists of solar cells, PEM fuel cells, and batteries, which are connected by a DC bus and controlled by suitable DC-DC converters. Solar cells operate to supply the electrical load with energy and charge the battery appropriately, which works to prepare the charging energy. Its determined the converter to regulate the low direct current is any potential supply from the fuel cells to the controlled busbar voltage. The batteries are connected to a direct current busbar. Energy flows through the battery in both directions. Control the system on the end of the solar cells on the operating sample. (M.P.P.T) and ((battery)) voltage tracking mode. Control the fuel cell supply transformer to conserve the battery. To verify the hybrid module that was shown, the scheme studies were carried out in a Matlab environment. The study showed the power management system to control each power source and that the hybrid system to work reliably. Simulation results of hybrid energy efficiency. From this we conclude that employing the appropriate control helps a lot in producing energy from solar cells and improves efficiency very significantly. From this we conclude that the greater the accuracy of control, the greater the energy production and obtaining the maximum possible capacity despite the fluctuations of the climate

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