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Grid Tied Smart Solar Energy Management System

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Abstract: Grid Tied Smart Solar Energy Management System (SEMS) is a combination of solar power, grid power, energy software and power storage. It is an alternative to a conventional solar charge controller. The main idea is to develop an intelligent algorithm which enables SEMS to extract maximum power from solar to meet electricity needs. It will function according to its defined intelligent algorithm which controls the solar, batteries and grid combination so that maximum power is always extracted from solar. If the solar energy is not sufficiently available to drive the load or to charge the batteries effectively, then the intelligent algorithm takes the energy from the grid either to charge the batteries or to drive the load. Implementation of SEMS includes designing of a smart charge controller with a view to charge the battery efficiently on time by providing supply from solar or grid lines. The complex algorithm present inside the controller takes care of a load management and improves theefficiency of a entire system. Hence making energy management system smarter.

Keywords: Grid Tie, PV Solar, Energy Management System, Load Management, Charge Controller.

INTRODUCTION

Recently, electric utilities are facing lots challenges like rising energy demand, increasing fuel costs, shortage of fossil fuels, aging assets, pressures to adopt renewable energy resources [1]. The renewable energy has become a fastest growing technology for meeting the demands of energy consumption to solve all these problems and at the same time it reduces the pollution in the atmosphere. The importance of renewable energy sources is becoming a great technology and today the world is looking forward to develop these technologies.

Among all the renewable energy sources available (like solar, hydro, wind, tidal and biomass), solar energy gives highest benefits as it is available free of cost, its noise free and most abundantly available renewable source of energy. Therefore, in upcoming future PV systems will play an important role of energy source in meeting electricity demand.PV systems may be operated in grid tied, standalone or hybrid mode. Grid tied photovoltaic systems have wide application in remote isolated areas and islands, where utility grid is not always available to meet the essential electric load [2].

In this paper, we introduced a grid tied smart solar energy management system with two battery systems. The SEMS is capable of charging the battery efficiently either by solar or grid and also take cares of load management effectively.

MOTIVATION

Crisis of electricity is major issue everywhere across India. Government of India is taking lots of new initiatives to improve the condition by introducing many schemes to save energy. By using renewable energy sources like solar with grid tied system, an individual resident could generate his/her own electrical energy. This helps in reduction in utilization of energy from grid lines and could save lots energy and money.

Thus, a more open and seamless work has to be done in this sector to insolate, utilize and store maximum solar energy. We need to decrease the dependence on the fossil fuels/grid power for the sake of reducing our electric bills and also to massively reduce the pollution due to burning of fossil fuels for generation of electric power.

The remainder of this paper is organized as follows: in section III the research activity related to solar energy and solar system is reviewed. In section IV we will discuss about the proposed design. We will understand the 2 battery concepts, and draw the flow chart and mention advantage and disadvantage of SEMS system. In section V we will drop our conclusion.

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RELATED WORK

To meet the needs of the everincreasing power demand, solar energy proves to be more effective, especially in countries like India, where we have equivalent hours of full sun and summer takes up the major part of the calendar. Based on the variation in the intensity of the sun's radiation during the day and also the variations in the length of the day the graph below in fig 1 shows an example in which the insolation increasing during the day from a very low value at dawn as the Sun rises to a peak at noon and falling again as the Sun sets. Insolation reaches 1000 W/m2 at noon when the sun is at its highest point in the sky [3].

The study of a photovoltaic system is necessary to understand the main components such as PV generator model, storage element (batteries). The knowledge of their electrical characteristics remains a key factor in their analysis. Batteries are the most complicated element, as they are the only dynamic element in a PV system which gets charge and discharge by supplying continuous power to the load connected [4].

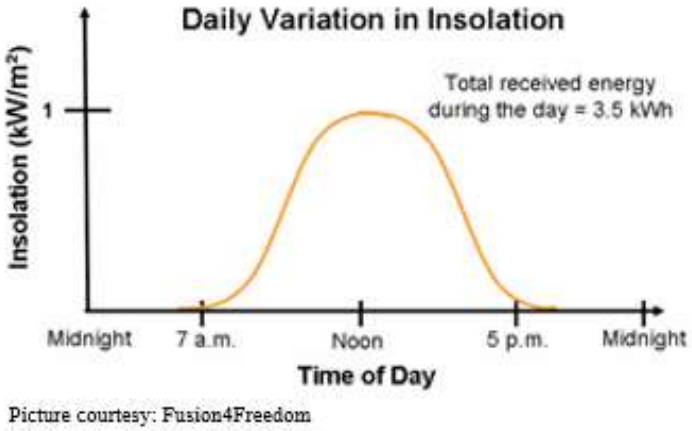

Fig 1 Daily Variation in Insolation

To increase the operating and conversion efficiency of solar cells a maximum power point tracking (MPPT) algorithm is used [5]. There are various MPPT control techniques available to attain maximum efficiency[6][7][8].

In the absence of sun or when it is cloudy/rainy outside the solar panels won't generate the enough quantity of power and that is why it is connected to the grid. It will then power the system by taking from grid [9]. Also, when there is no supply from utility grid, solar panels will often generate more electricity which is stored in batteries [10] so that we always get non-stop uninterrupted electricity at home. Smart SEMS holds a lot of promise. This concept will become increasingly useful as we transition towards the smart grid system in India in the coming years.

PROPOSED DESIGN

The whole idea is to build a system that works like stands alone, but have the flexibility to switch over to utility power when solar is inefficient to charge the batteries. The system should be sized to provide all the energy that a house needs during the best irradiation day in the year.

Table 1 SEMS Modes of Operation

Modes	Supply from Solar	Supply from Grid
1	0FF	0FF
2	OFF	ON
3	ON	OFF
4	ON	ON

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A detailed block diagram of the SEMS is shown in Fig 2 which consist of a system like any standalone system having solar panels, batteries, inverter, load and a new component is SEMS, which is going to switch over to grid power once the solar energy is unavailable by using relays. Microcontroller and current sensor present inside SEMS will monitor and control the switching of relays.
The SEMS will run any of these 4 modes based on availability of sources:

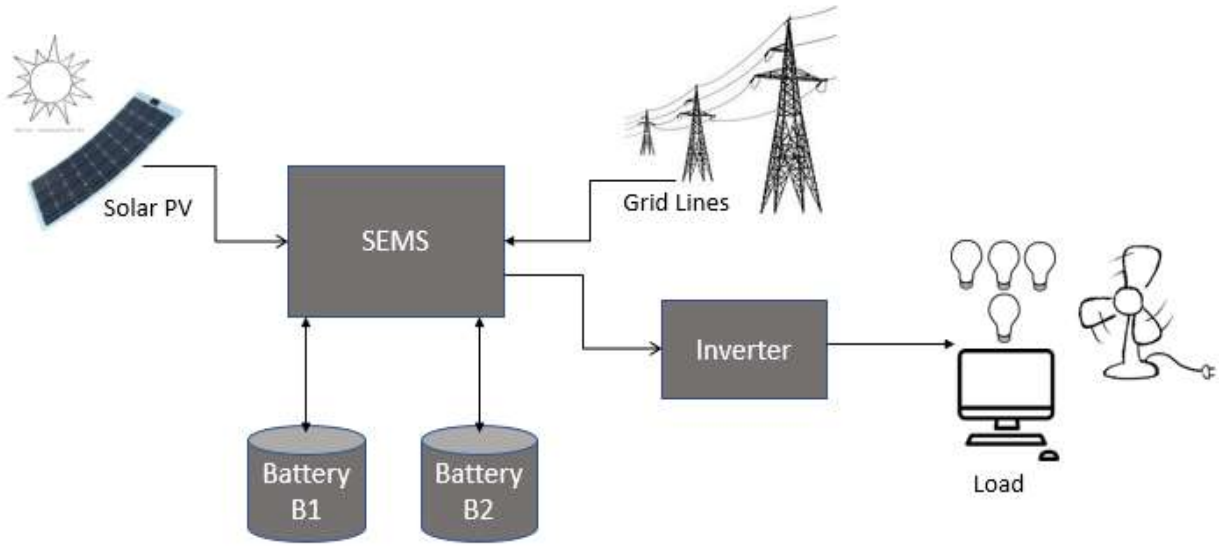

Fig 2 The SEMS Block Diagram

Based on these modes the microcontroller will run its charging and discharging algorithm for battery. All this mode switching is automatic and no user intervention is required. Solar PV powering preference is given to charge battery bankfirst.

A. Two Battery Concepts
The reason which makes this design unique is its two battery concept. Presently the solar power products sold in the market demands a higher battery bank capacity for supporting larger loads for longer time and solar power is used only for charging of battery bank and not powering AC loads directly. Batteries can either get charge or discharge simultaneously [11]. In this designed we can program a SEMS in such a way that when one battery (B1) gets charge other battery (B2) will start discharging to load or vice-versa.Battery bank can be charged on PV power or GRID power.Depends upon the state of charge available in the batteries it will keep getting charge or discharge. The microcontroller will keep on monitoring SoC of both the batteries and will run the smart algorithm to manage the load on the batteries. Thus, batteries will never run out of juice until its getting charge by any of these two sources.

B. Algorithm Flow Chart
Initially voltage value is calculated and fed into the system. The microcontroller will calculate the voltage difference and based on the mode selected it will perform the operation. Fig 3 shows the flow chart of a complex algorithm present inside SEMS. EMS logic will keep switching the relays timely to charge and discharge the particular battery and equally manages the load. Following is the abbreviation for some words used in flow chart:
B1- Battery 1, B2- Battery 2, C- Charge, L-Load, NC- Not Charging, CO- Cut Off voltage

C. Advantages
The advantage of this system is:
1- Need minimal amount of PV panels
2- Don’t need large battery bank as it’s a standalone system
3- Most importantly its very reliable compared to stand alone
4- System becomes energy self sufficient.

D. Disadvantage
The disadvantage of this system is:
1- Grid tied systems are more expensive as 2 batteries are involved here.

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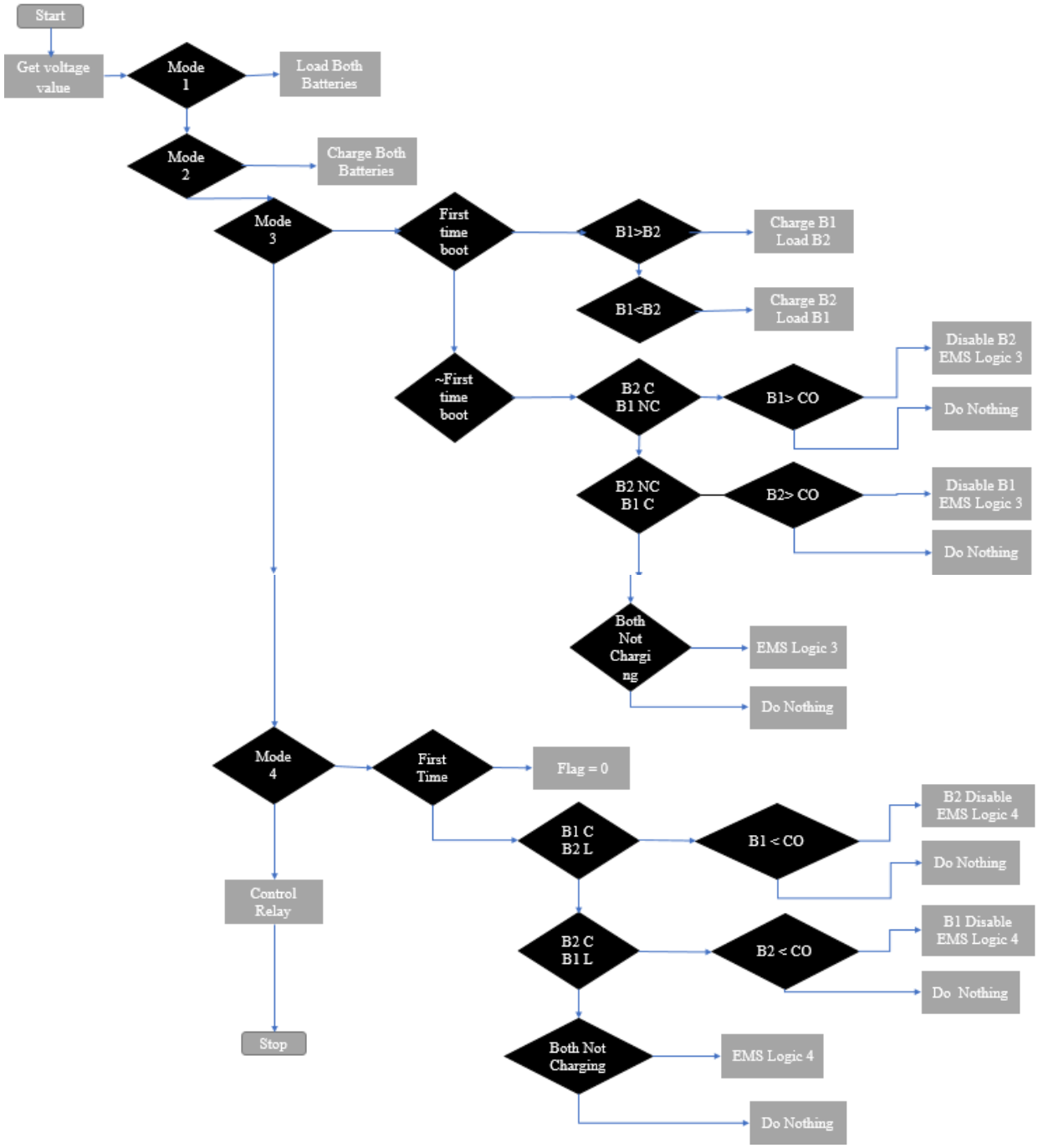

Fig 3 Flow Chart

CONCLUSION

In this paper, we proposed a smart solar energy management system which extract maximum power from solar to meet electricity needs. In the absence of solar energy, batteries keep on getting charge by utility grid source. In this way we always get non-stop uninterrupted electricity at home and also save some money. In future, we can use net metering technology to send excess amount of energy over a grid.

REFERENCES

[1]J.G. Cupp, M. E. Beehler "Implementing Smartgrid communications," Burns and McDonnell Tech brief 2008 [Online] Available: http://www.smartgridnews.com/artman/uploads/1/article-smartgridpart2-084.pdf, [Accessed:Apr 20,2011].

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[2] Priyabrata Shaw, Pradeep Kurnar Sahu, Sornnath Maitl and Punit Kurnar "Modeling and Control of a Battery Connected Standalone Photovoltaic System",1st IEEE International Conference on Power Electronics. Intelligent Control and Energy Systems (ICPEICES-2016)
[3] http://fusion4freedom.us/solar-power-technology-and-economics/
[4] Budi Amri, Soedibyo, "Design of Batteries Charging by ChargeManagement Concepts on Photovoltaic Standalone System" 2016 International Seminar on Application for Technology of Information and Communication page 93-98
[5] P. Midya, P. T. krein, R. J. Turnbull, and J. Kimball, "Dynamicmaximum Power Point Tracker for PhotovoItaic Application," inProc. IEEE PESC'96, Jun. 1996, pp. 1710-1716.
[6] S. Maity and P. K. Sahu, "□odeling and Analysis of a Fast andRobust □odule-Integrated Analog photovoltaic MPP Tracker,"IEEE Trans. Power Electron., vol. 31, no. I, pp. 280-291, Jan.2016.
[7] D.V. de la Fuente, C. L. T Rodriguez, G. Garcera, E. Figueres, andR.O. Gonzalez, "Photovoltaic Power System With Battery BackupWith Grid-Connection and Islanded Operation Capabilities," IEEETrans.lnd. Electron., vol. 60, no. 4, pp. 1571-1581, Apr. 2013.
[8] E. Fossas and A. Ras, "Second order sliding mode control of a buckconverter," in 41st IEEE Conf Decision Control, 2002,pp. 346-347.
[9] http://energyinformative.org/grid-tied-off-grid-and-hybrid-solar-systems/
[10] Danish Hameed, Saad Hamayoon, Asad Ali Malik, "Solar Grid-Tied Inverter, with Battery Back-up, for Efficient Solar EnergyHarvesting", 2016 the 4th IEEE International Conference on Smart Energy Grid Engineering.
[11] http://batteryuniversity.com/learn/

BIOGRAPHIES

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