Hybrid Solar Smart Grid System Based on Web of Things

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Abstract - In India generation of power is less as compared to the consumption. Hence we need to use renewable energy sources to mitigate the power need .This paper describes a development of "Hybrid Solar Smart Grid System Based on Web of Things". The outcome of the system is to control and monitor energy sources as well as demand side load management. The previous designed system by using Bluetooth, RF Transmitter has some drawbacks like short distance controlling. HSSGS based on WOT is designed to generate solar energy to meet energy demand and Control energy sources from anywhere in the world through GPRS. With the help of this system it is possible to control and monitor real time energy devices like fan, tubes and computer, printer etc. through internet as well as manually.

The present system is designed using microcontroller LPC 2138. An algorithm is developed to predict the behavior of the output loads & monitor, control the power consumption. This system designed helps to reduce energy bills on electricity.

Index Term – Web of Thing (WoT), Hybrid Smart Grid System(HSGS), Load Management, General Packet Radio System (GPRS), Graphical User Interface(GUI), Microcontroller, MSEB.

1. INTRODUCTION

The aim of the system design is operate energy devices o on the solar power by saving MSEB power. Operation of the solar devices using solar power and communication protocol has been reported earlier. The communication was established using Ethernet, etc. The limitations are that the communication is restricted to LAN [1]. In the present design, system is connected to the internet through GPRS and gives the facility to user to control remotely ON/OFF the device from any location without physically being present near the device and check status of devices (loads) on the web page which is designed in PHP language. The solar power as well as MSEB power consumption by load is stored in external memory of controller in number of pulses. This system is designed for maximum 600 Watt output load. In this system the hybrid solar inverter is used to convert DC to AC by removing the disadvantages of grid connected and off grid connected inverter. Intelligence is also provided in the system to switch the load to MSEB in case the solar power is insufficient.

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2. ARCHITECTURE

The goal of this project is to operate the energy devices on the solar power & eliminate the need of MSEB power leading to saving of electricity. The architecture is as shown in the block diagram below (Fig.1 Block diagram of Hybrid Solar Smart Grid). The block diagram comprises of

1) Controller LPC 2138
2) Charging Unit
   - i) Battery
   - ii) MOSFET IRF 3205
   - iii) Solar Panel
3) Inverter Unit
   - i) Transformer 11-0-11
   - ii) ATMEL 24C16 (Generation for PWM)
4) Communication Unit
   - i) GSM MODEM
   - ii) GUI
   - iii) Opt coupler IC MCT 2E
5) Output Unit
   - i) Relay
   - ii) Energy Meter
   - iii) Load

The solar panel generates DC power which is stored in the batteries through the charge control circuit. The charge control circuit avoids the overflow of battery charging and fully discharging of battery. Battery output is connected to inverter circuit which converts DC to AC voltage and given to the load through the energy meter. Energy meter measures the output units consumed by the load, simultaneously the meter reading is measured by the microcontroller through opto coupler and saves the data in the external memory. Microcontroller sends the real time consumption of loads to graphical user interface (GUI) through the GPRS. A graphical user interface page i.e. web page is designed to access control buttons for ON/OFF of

the energy devices (loads) & also monitor the status of device. A facility is also incorporated to display the total power consumption of solar & MSEB. The microcontroller measures the battery voltage and the solar voltage continuously and sends the real time value of voltages to GUI through GPRS which is displayed on the web page. If the battery voltage is less than the 10% i.e. 11.3 volt then the controller automatically switches the load to the MSEB power.

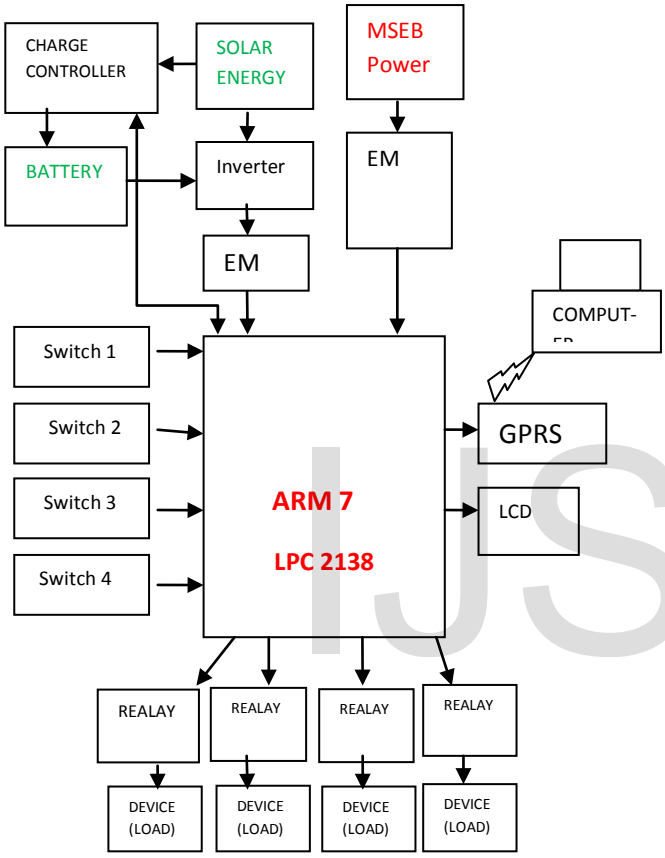

Fig.1 Block diagram of Hybrid Solar Smart Grid

3. SYSTEM COMPONENTS

The system components are classified into two categories software and hardware components. They are classified as follows

3.1 Software

3.1.1 Keil IDE Software

Keil µvision 4 IDE software is used to develop the program in C language for LPC 2138 processor

3.1.2 Flash Magic Software

Flash magic software is used to download the hex file to LPC 2138 processor.

3.1.3 PHP Language Software

PHP means Hypertext Preprocessor language. It is general purpose scripting language and used for Web page development.

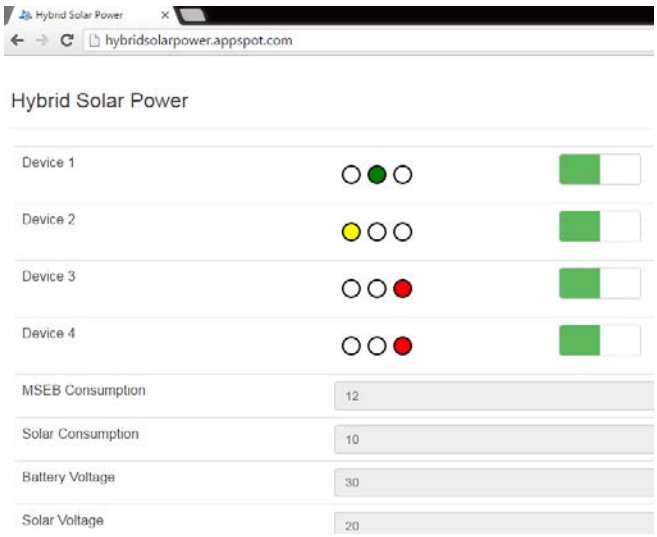

Fig .2 Webpage for GUI

3.2 Hardware Components

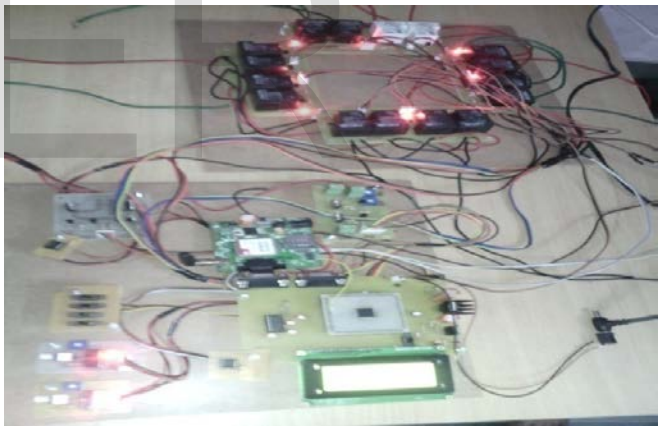

Fig.3 Hardware of the smart grid system

3.2.1 Microcontroller

Microcontroller LPC 2138 is the brain of the entire system. It is used to access the real time data from output load, battery voltage, meter reading etc. and send to the server through internet (GPRS). It takes input from the manual switch as well as web page switch and takes decision according to algorithm for ON/OFF of the devices .

The figure bellow shows the display of solar panel and battery voltage. It also shows status of different loads and total consumption of power.

Fig.4 Real time status display

3.2.2 Solar Panel

The three different 70W, 100W and 40W solar panels are installed in south direction at an angle 33^0 in winter and also given provision to change angle 5^0 degree in summer. The total solar wattage of panel is the 210 watt.

Fig.5 Solar panel installation on the terrace

3.2.3 Global System for Mobile

GSM means the Global System for Mobile. It is used for accessing the Internet through the GPRS (General Packet Radio Service) for exchange of the real time wireless data between server and microcontroller.

3.2.4 Remote Station

The local server or Remote station can be an internet connected personal computer or any Android mobile phone. It provides the graphical user interface to control and observe the status of load by login to the website "http://www.hybridsolarpower.appsspot.com". This web page is designed in PHP language. Microcontroller is connected to local server or Remote station through the GPRS Service of GSM which is connected by RS 232 port of controller.

3.2.5 Office Appliances

The office appliances which are operated on the AC 230 volt supply like Computer, Printer, Fan, Tube etc. are connected to any one power supply which may be generated from solar or MSEB. The various conditions of appliances are controlled and observed by user from any location.

i) ON/OFF status by MSEB are indicated by led indicator.
ii) ON/OFF status by Solar are indicated by led indicator.
ON-Green color
iii) OFF status-Yellow color

4 ADVANTAGES

4.1 Accessibility

This designed system gives easy access to control and monitor of the office appliances. This system provides control of the switches manually when in office and switches remotely from any position i.e. away from the office through the internet.

4.2 Real Time control

The real time status of all the devices can be checked using GUI.

4.3 Addition of appliances

Appliances can be added without change in hardware upto the designed capacity.

4.4 Renewable Source of Energy

Using Smart grid system we can generate electricity from solar energy. In Maharashtra capability of electricity generation from solar energy is 11.2MW and saves MSEB electricity.

4.5 Easily available and Environmental Friendly

Solar energy is easily available and abundant in nature.

5 FLOW CHART

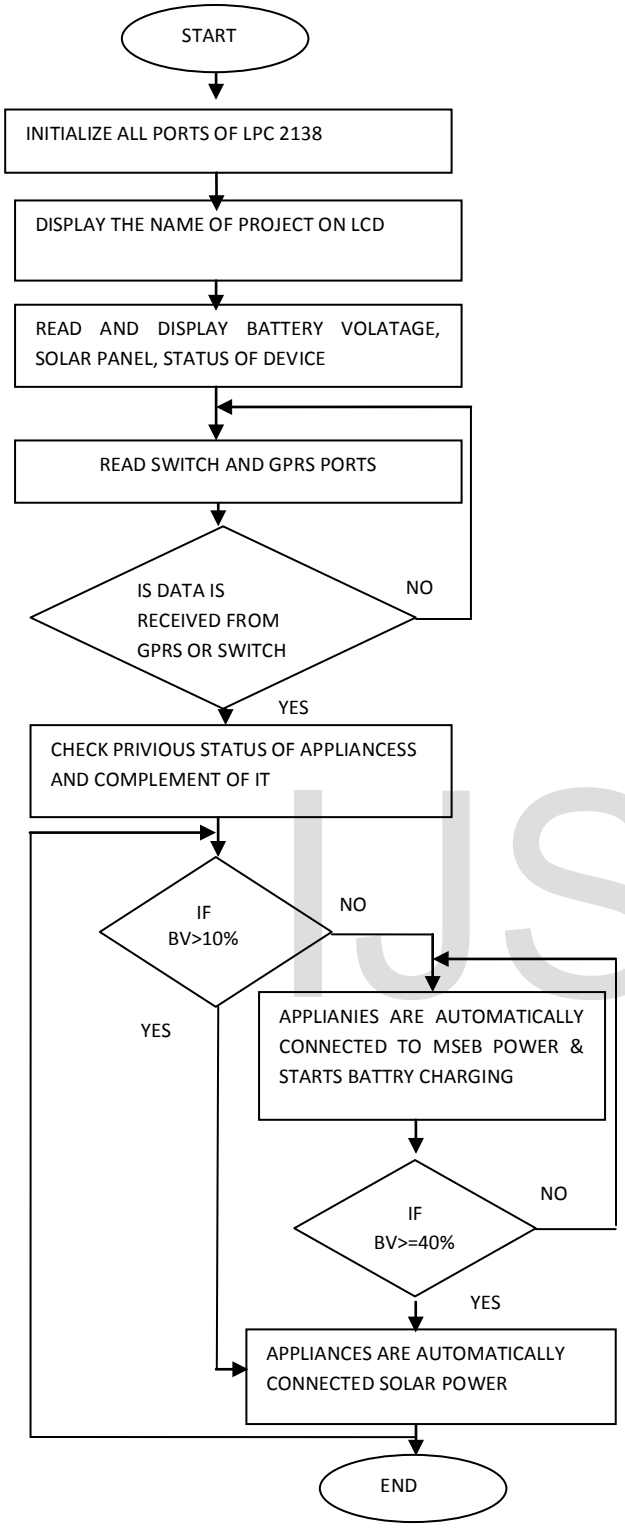

Fig 6.Flow Chart of Hybrid Solar Smart Grid System

6 OBSERVATIONS AND RESULTS

The average voltage and current values for one month of April is shown in table bellow.

Time	Current(A)	Voltage(V)
09:00 AM	3.140	19.344
09:30 AM	3.733	19.200
10:00 AM	4.185	19.071
10:30 AM	5.832	18.790
11:00 PM	5.823	18.611
11:30 AM	6.494	18.538
12:00 AM	6.427	18.594
12:30 PM	6.440	18.602
01:00 PM	6.425	18.531
01:30 PM	5.815	18.429
02:00 PM	5.409	18.371
02:30 PM	4.978	18.412
03:00 PM	4.499	18.517
03:30 PM	4.143	18.537
04:00 PM	3.892	18.560
04:30 PM	3.503	18.615
05:00 PM	3.412	18.716

Table1. Voltage and Current Analysis of Panel in April-16

7 GRAPHS

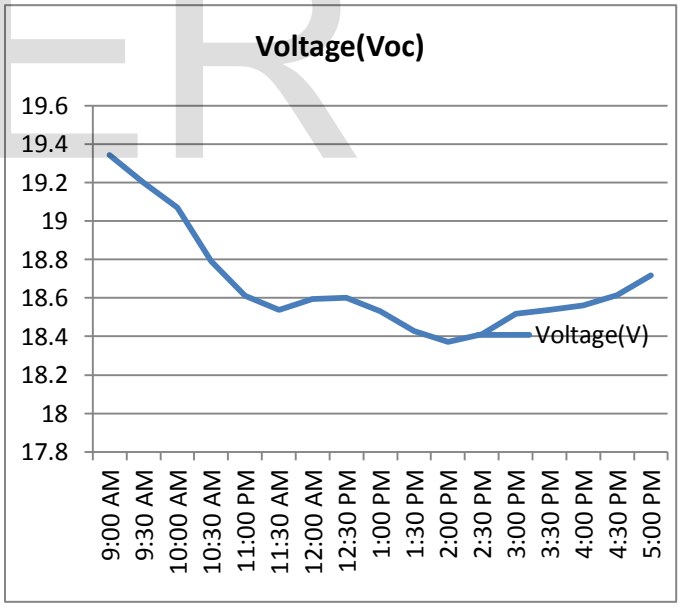

Fig 7 .Open circuit Voltage of Solar Panel in April -2016

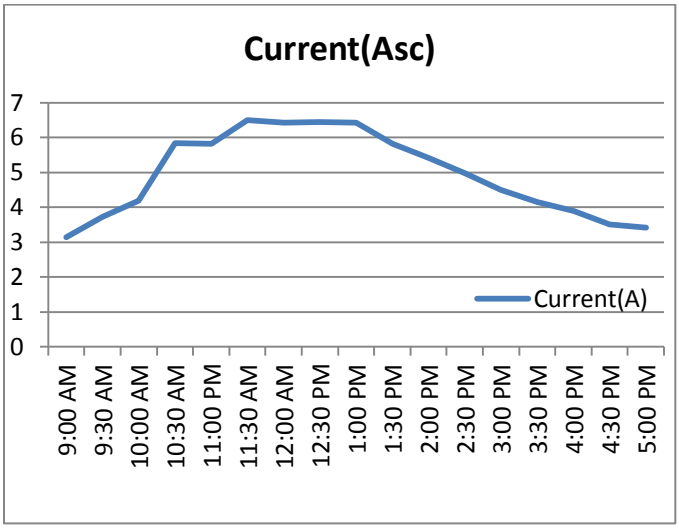

Fig 8 .Short circuit Current of Solar Panel in April -2016

The output waveform on Digital Storage Oscilloscope of step-up transformer is shown in figure. The output voltage observed is 240 V.

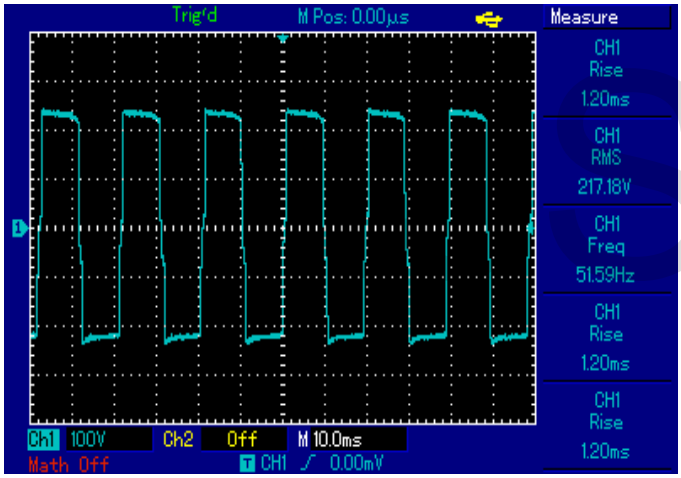

Fig .9 Quasi sine wave inverter output

The inverter is designed for 600 Watt load. In this inverter the center tap step up transformer is used. The voltage and current consumption at primary winding and secondary winding for different loads is checked & monitored.

The Primary and secondary voltages and currents changes according to the load applied. For 100 Watt load the primary DC voltage and current are 13.05 V and 8.437 A respectively. The secondary AC voltage and current are 245.3 V and 0.403 A respectively.

Primary winding of Inverter		Secondary winding of Inverter		Load
DC Voltage (Volt)	DC Current (Amp)	AC Voltage (Volt)	AC Current (Amp)	
13.6 V	1.313 A	298.3 V	0.056 A	No Load
13.05 V	8.437 A	245.3 V	0.403 A	100 Watt
13.6 V	12.8 A	223 V	0.687 A	200 Watt

Table 2 .Different voltage and Current Consumption for various Loads

9. CONCLUSION

The "Hybrid solar smart grid system based on web of things" is designed to generate electricity and it can reduce the load of MSEB to an extent. Energy crisis is the main problem that this world is facing because the conventional sources to generate electricity like coal, nuclear, thermal are limited. Hence using non-conventional Source of energy is a need of the time. Using this system we can manage them.

This system provides power back-up of 6 Hrs for 100 Watt load. If system is connected to output of panel .The given load remains continuously ON in daytime.

10. ACKNOWLEDGEMENT

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