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HYBRID SOLAR SYSTEM FOR REAL-TIME POWER MANAGEMENT

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***Abstract*— Hybrid Solar System gives efficient utilization of renewable energy source (i.e. solar energy). This paper presents an architecture that enables the simultaneous use of solar system with grid source. The main purpose of this paper to give idea about use of solar energy as much as possible, on other hand it gives smart handling of appliances with the use of GSM module. The architecture of the Hybrid Solar System gives maximum utilization solar energy by minimizing the use of non-renewable energy, consumer gets report of usage of electricity and also bill of the equipment and owner can handle the loads or equipment through GSM.**

***Keywords*— Hybrid Solar System, Renewable Energy, Grid-tie Inverter, Net metering, Bill Calculation.**

I. INTRODUCTION

Electrical power is one of the most important infrastructure input necessary for rapid economic development of country. Non-renewable sources (i.e. coal, natural gases) are used to generate electricity which is getting exhausted day by day, and demand of electrical power is increasing day by day, due to increasing demand it is quite difficult to keep pace of generation, transmission and distribution [1]. In future non-renewable sources may not be available for power generation which will directly affect the development of country. To overcome this problem renewable energy must be used as much as possible.

According to estimation made, it indicated that after assuming the capita electricity need of 2000 kWh/annum and stabilized population of 1700 million by 2070, india would need 3400 TWh/year. A systematic analysis of information available on all the renewable energy sources indicated that the total potential is only around 1229 TWh/year. Thus it was concluded that in the future as fossil fuels get exhausted, renewable energy sources alone would not suffice for meeting indias electricity needs [2].

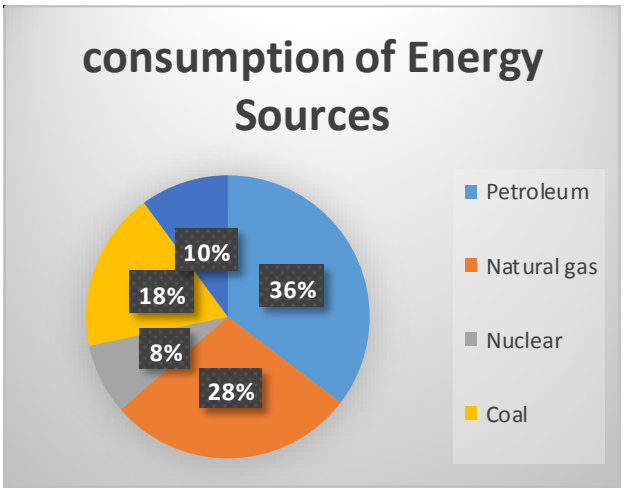

Fig. 1 Energy Consumption

Drawbacks of conventional solar system are 1) we don't use solar power when grid power is available. 2) Normally in urban areas, where problem of load shedding does not occurs at such places conventional solar system has no use 3) When inverter battery is completely charged then excess of solar energy generated will be wasted.

The main purpose of writing this paper is to overcome the drawbacks of conventional solar system. This system enables us simultaneous use of solar system with grid source. Ratio of solar and grid is decided by tie-grid inverter. This system also provides remote monitoring and controlling of electric loads via mobile phone. The separate report of consumption of power from solar and grid along with bill will be provided to consumer.

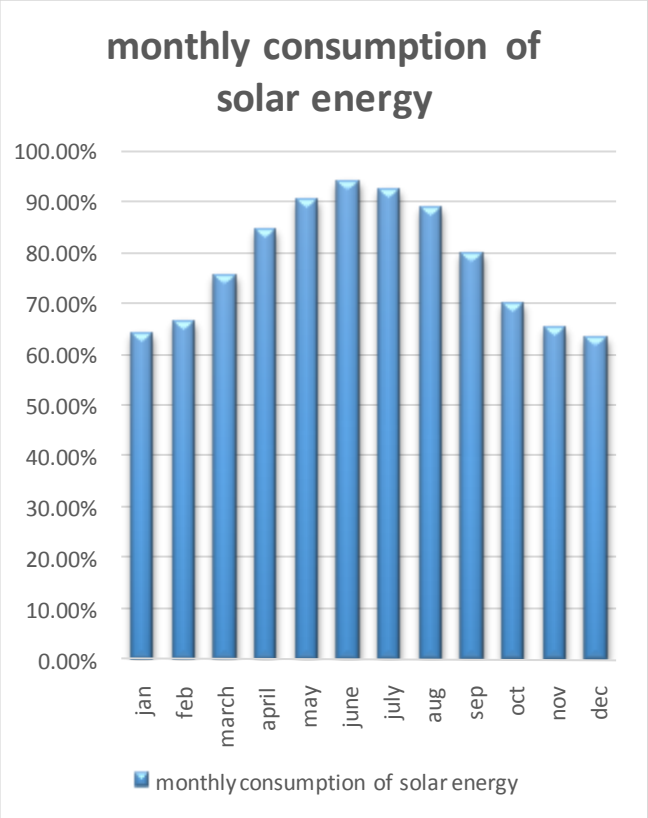

Fig. 2 Monthly Consumption of Solar Energy

II. LITERATURE SURVEY

Modern world demands for more and more electric power, but there is a limit for which nature can provide us. In order to meet the growing demand for energy, we need to find new resources and allocate them efficiently. This is where the concept of smart grid comes into picture. Smart grid consists of a power grid with both renewable and non-renewable sources of energy like solar, hydro, wind turbines and nuclear reactors. It is the duty of the smart grid to reduce losses, and thereby meet the demand in a more efficient way. Smart grid will be an automated grid, which can route the power from different generating stations based on the demand schedule. Smart grid will have a sophisticated information network, which is separate from the power lines. The proposed project a smart grid system based on GSM technology which is capable of load management.

III. ARCHITECTURE

The HSS consists of solar panel, Grid-tie inverter, signal conditioning, microcontroller (LPC2148), GSM module, ULN2003, LCD (20x4).

First, the grid-tie inverter checks whether Grid is providing supply or not. If grid is on then the synchronizer inverter takes the input from solar panel and grid. Inverter gives a synchronized output of solar and grid. This inverter provides an output, which consists of maximum solar power and remaining power from grid. This output is then step down and provided to the microcontroller. The signal conditioning circuit consists of current to voltage converter. With the help of microcontroller and logic used in the code, input current and voltage are measured and displayed on LCD. The driving circuit is consists of ULN driver, relay and contactor. These devices are used to drive the home appliances. GSM module is used to provide the facility of handling the home appliances remotely. It makes the system smart and user friendly. Devices in the house can be handled via just a text message.

A. BLOCK DIAGRAM

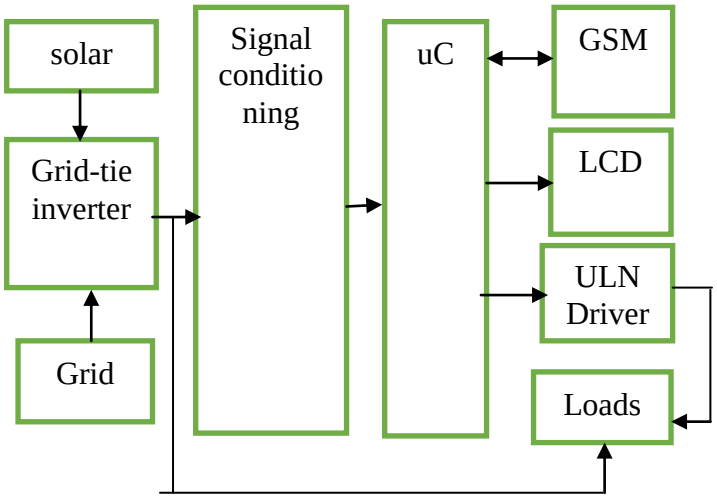

Fig.3. Architecture of Hybrid Solar System

The proposed system works under three conditions:

When grid fails to provide the power, then microcontroller switch the source from grid to the

inverter. The output from these sources is also passed through a signal condition circuit to the microcontroller. The process after this is similar to the working as explained above. In this way, this system provides a smart and cost effective way of electricity supply.

1. When grid and solar both are available

In this condition grid-tie inverter will take input from both and combination of both with maximum of solar energy will be provided to load.

2. When solar source is not available

As no solar source is available grid-tie inverter will take only grid source as input and the whole system works on grid source.

3. When grid is not available

The grid-tie inverter will not work as it requires a reference which is provided by grid. But we can overcome this problem by providing battery to grid, grid will charge the battery with the working system. When grid is not available it will take input from battery which will work as reference for grid-tie inverter and system will work as first condition.

IV. BRIEF EXPLANATION OF COMPONENTS

A. SOURCES

There are two sources

1. Grid-tie inverter
2. Solar energy source

B. GRID-TIE INVERTER

A grid tied solar inverter is a special type of power inverter that converts PV output direct current electricity into alternating current electricity so that one can flow the electricity out into the power grid and actually sell electricity back to the power company. The technical term for a grid-tied solar inverter (GTSI) is "grid-interactive inverter" which is also known as synchronous inverters because of their capability to synchronize with Grid power. Grid-interactive inverters typically cannot be used in standalone applications where utility power is not available.

The AC electricity produced by a power inverter is basically the same as the power on the grid - both of them use alternating current, 230 volts, 50 cycles per second. The problem is electricity in the two systems may not be cycling in phase with each other. Moreover, in order to ensure the flow of electricity from source to grid, the source must be kept at some higher voltage value than the grid voltage value. A grid tie inverter monitors the power from the grid, ensures the power coming from inverter stays in sync with the phase of the electricity from the grid and also checks whether the supply voltage gains the upper hand. The effect of this is any electricity that aren't used flows out to the grid, power meter runs backwards and one can sell this excess electricity back to the power company. Because of the extra work involved in monitoring and conditioning the output power to match the power from the grid, a grid tie inverter is more expensive than a more simple power inverter that can't tie into the grid [5].

C. SIGNAL CONDITIONING

This block consist of current to voltage converters. Output of solar and grid will be stepped down and given to signal conditioning block, which will convert current to voltage as microcontroller takes voltage as input. And this converted output is given to ADC of microcontroller for current, voltage and bill calculation.

V. BILL CALCULATION

For calculation of bills, we require the current and voltage values, these values are obtained from current and voltage sensing circuits.

A. CURRENT MEASUREMENT

For AC current measurements we use CT's (current transformers). This transformer steps down the current and such current is provided to I-V converter and then output voltage is supplied to ADC of microcontroller.

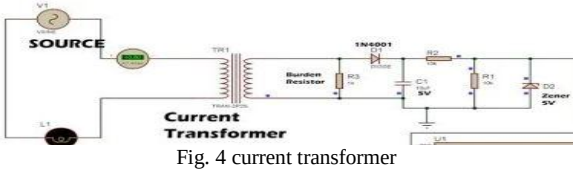

Fig. 4 current transformer

B. VOLTAGE MEASUREMENT

We can use Potential Transformers (PT'S) for scaling voltage. A PT is a simple transformer with less current rating. The output of such transformer is directly provided to ADC of microcontroller for measurement of voltage.

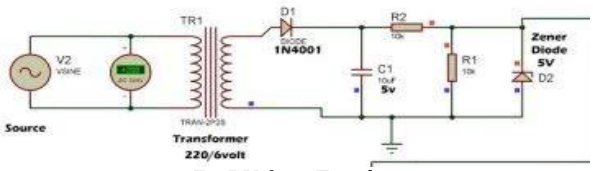

Fig.5 Voltage Transformer

Power can be calculated by

P= (v*I) Watt ……for resistive load

P= (v*I*cosØ) Watt ……..for inductive loads

P= (v*I*cosØ) Watt……for capacitive loads

Where, Ø=phase shift

Consumed energy is a function of time. So energy is given by,

E=Power* Time

The cost for billing is given by,

Total cost/Bill= Energy*Cost per unit value of energy.

VI. FUTURE SCOPE

A. NET METERING

Net metering is a billing mechanism that credits solar energy system owners for electricity they add to grid. For example, if a residential customer has a PV system on the home's rooftop, it may generate more electricity than the home uses during daylight hours. If the home net metered, the electricity meter will run backward to provide a credit against what electricity is consumed at night or other period where the home's electricity use exceeds the systems output. On average, only 20-40% of a solar energy systems output ever goes into the grid [6].

Net metering allows residential and commercial customers who generates their own electricity from solar power to feed electricity they do not use back into the grid.Net metering provides substantial statewide economic benefits in terms of jobs, income and investment [7].

VII. CONCLUSION

In this way we aim to design a system which makes maximum utilization of solar energy and provide a smart way of handling appliances. Use of GSM allows the consumer to operate loads remotely through just a text message. Also daily report of system will be given to the consumer using GSM. Hence given system provides a bidirectional communication between consumer and the microcontroller.

We can make this system more efficient by measuring more entities like gas, water usage and displaying it on LCD display and giving a daily report of these various parameters to the user. We can control each and every appliance individually by using an android app. When generated power from solar is more than our requirement we can send excess of power to substation if bidirectional transmission is available in future.

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