IoT Based Smart Grid System To Monitor and Control Renewable Energy Source.

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ABSTRACT

This paper is an extraction of a smart grid technology applied on renewable energy source based on Web of things. The smart grid fetches the digital technology and data management practices and is a core ingredient in the current modernization of the electricity delivery subsystem. The renewable energy source consulted here is solar energy hence use a photovoltaic cell. This system consist of some of major subsystems namely power generation and storage, power monitoring and billing with power control and managing by using IoT. IoT technology can effectively combine the infrastructure resources in such a manner that it increase the quality of power system information, and increases the utilization efficiency of infrastructures in the being power system. The part of vision of a smart grid is its attainment to enable informed participation by customers making them an entire part of the electrical power.

Keyword: - *Web of thing(WoT), Internet of thing(IoT),Smart Grid, Power control and manage, modernization of electricity*

1. INTRODUCTION TO SMART GRID AND WEB OF THINGS:

A smart system delivers electricity from generation unit to customers using full duplex digital technique to control devices at consumers' homes to save energy, reduce billing amounts and increase reliability and effectiveness of system. It mainly consists of electricity distribution grid with data management and smart metering system. Power travels from the power plant to customer through an specialized system known as power distribution grid. Such a modern technology in the field of electricity links is promoted by many governments as a part of addressing energy save and effective use, global warming and issues created in emergencies. Smart meters are part of smart grid, but alone do not built a smart grid system. A smart grid comprises an intelligent monitoring system that follows of all electricity flowing in the system [1].

When power is having low cost the customer can allow the smart grid to turn on selected home appliances such as washing machines or factory machinery that can run for several hours. At ultimate times it could turn off selected appliances to reduce damage of equipment. Building the smart grid means adding workstation and data exchange technology to the current electricity grid. With a connection of digital technology, the grid promises to work more efficiently and reliably. It can also hold more solar and wind energy, which are uneven sources of energy that can become more reliable with better controls. Much like computers and communication device like routers manage the flow of bits on the Internet, smart-grid technologies use statistics to optimize the flow of electricity [3].

Web of Things, explicitly "the Internet in which all the things allied to each other", is the tremendous extension and expansion of Internet network. Implementing the smart grid means including workstation and data exchange technology to the present electricity grid. With a connection of digital technology, i.e. IoT with the grid promises to work more efficiently and reliably. It can also uses solar source which are more reliable and economical than wind and hydro energy source. Much like computers system and communicating devices like routers, switches manage the flow of bits on the Internet; smart-grid technologies use statistics to optimize the effective use of electricity [3]

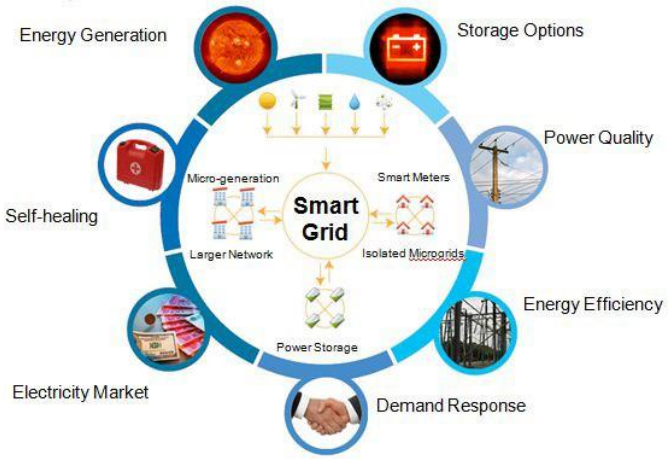

Fig -1: Concept of smart grid

Web of Things, explicitly "the Internet in which all the things allied to each other", is the tremendous extension and expansion of Internet network .The protocols, with WOT key technologies: radio frequency identification technology (RFID), sensor technology, smart technology, and nanotechnology, the communicated information can be exchanged, and the intelligent identification, positioning, tracking, monitoring and management can be easily managed.

You might have noticed that the Internet of Things feels very much like an Intranet of Things: to interact with 10 different devices from your phone, you have to install 10 different apps. The problem is that there's not a single "lingua franca" spoken by every object – there are literally thousands! The defeat part is that most of these IoT standards and protocol aren't compatible with each other, and for this reason the IoT hasn't delivered on its promises.

Connecting every Thing to the Internet and giving them an IP addresses in only the first step towards the Internet of Things. Things could then easily exchange information with other, but not necessarily understand what that data is. This is what Web standard like HTTP brought to the IoT: a universal way to explain images, text, symbol and other media elements so that machines could "understand" each. The Web of Things – or WoT – is simply the next part in this technology: using and adapting Web protocols to connect thing in the physical world and give it a existence on the World Wide Web!

2. LITERATURE SURVEY

Web of Things consist of a combination of Web services provided on top layer of a Internet aided embedded devices. The Web browser on any one computer can work as an interface to the services provided by these Web of Things. (Saswat Mohanty, Bikash Narayan Panda, 2014) [1]. The Embedded Systems lab Substructure at the TIFAC CORE for 3G/4G technology at National Institute of Science and Technology was applied for the hardware testing of the embedded components. We were helped by the Software developers at NIST Technology Consultancy Services in designing the web applications and interfaces for our Internet of Things architecture. Mahesh Hiremth, Prof: Manoj Kumar(2014)[2] The target of the Energy management using Internet of Things (IoT) is to develop the reliable power supplies to the end users by making effective use of solar energy to the smart metering data from current sensors and stores it in cloud and network will select any of the two power sources automatically according to power consumption of load and predefined scheduling. Then Embedded device by communicating with Internet real time information about power consumption and controlling authority can be given to the legal person applications, wherein people communicate with data and vice versa, including remote control to objects by humans, and objects. The Melike Erol-Kantarci(Member, IEEE) and Hussein T. Mouftah defines the smart grid and WOT as:" Smart grid has restructured the way electricity is generated, transported, distributed, and consumed by integrating smart sensing, communicate ones, and control in the day-to-day operation of the grid. Electricity is a fundamental utility for the functioning of society and for the services provided by information and communication technologies (ICTs). Several concept of the smart grid, such as unique pricing, distributed network, generation, and demand management, have significantly impacted the operation of ICT services, in particular, communication networks and data centers [4] S.Ramkrishan (2013) explores a way to facilitate management of electrical power in the context of the evolving smart grid technology that are consistent with sustainability practices. The strategy

reflects a cyber-physical software technology that incorporates web-enabled physical devices and REST full APIs to activate monitoring and controlling electrical appliance or devices [5].The A. R. Al-Ali, Raafat Aburukba (2015) proposes a conceptual model for the smart grid inside the Internet of Things concept. The projected model is based on IPV6 as the heart of the smart grid communications layer [6]

According to Liu Hua1, Zhang Junguo, Lin Fantao[3],implementation in the construction of smart grid which is depend on Internet of things are made, and the design and implementation in typical application links, including wind power est imation, condition monitoring of overhead transmission lines, power analysis, smart home and asset management are evaluated insistently.The literature states that The Web interfaces offer us real time information on every energy meters that are mounted on location and communicate to the Embedded Internet devices using MODBUS communication protocol. Real Time energy source arrangement, energy source selection, power connection and disconnection are some of the amenities that are provided to an on -line identified user.

3. METHODOLOGY

The system uses two sources of energy first one is solar and second is MSEB supply which is available door to door to us. The photovoltaic cell continuously charges battery using charge controller. The charge controller is use to show the status of charged battery. The load is operated through charged battery ultimately the system uses renewable energy source. When battery is not charged by photovoltaic cell (during night time, cloudy environment, rainy season) the load is run by MSEB source. The decision of switching between solar and MSEB is taken by controller. Here the system is set in such a manner that maximum utilization of solar energy is take place. Here controller is also use to monitor current status of load. It also executes the scheduling of switching as per predefined manner. Here billing section is activated by controller only when MSEB source is in active state.

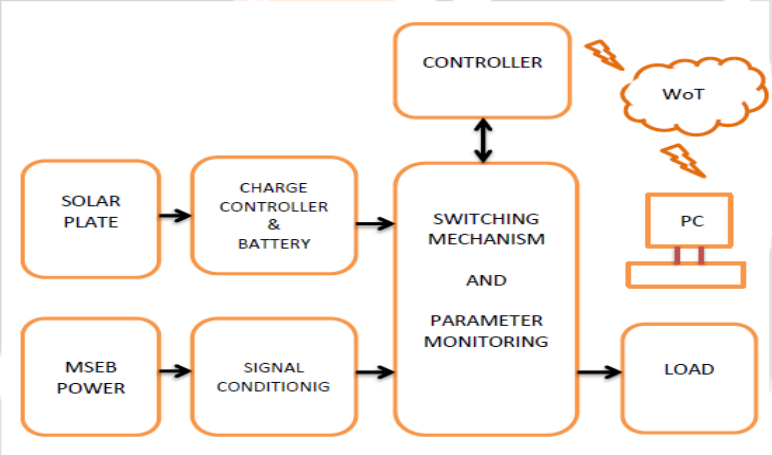

Figure3: Block Diagram of WoT and energy management system.

The data collected will continuously update in the cloud by the GPRS/GSM modem. Web of Things platform with initial applications tailored to building energy insight control. Once the data is kept in the cloud using the Web service authenticated user can access data from anywhere in the world and can analyze the power consumption, he just need an internet connection for this and no any data. The status of his application processing can be tracked by the user on the login screen by WoT. One of benefit is there, options is to check for the average power Consumption of a particular home. The user gets help to track his energy needs and accordingly plan the scheduling of his power sources. The comparison between consumption data and consumption data of other times by means of graphical representation of comparison of average consumption data. Based on the power consumption data, the user plans ahead how and when to use its energy sources.

Internet services customer to allow configure the switching of energy sources according to power availability. The billing of power consumption of MSEB is done online by IoT. The devices which are carry on after we are not as per present at home is switch off using WoT. Thus monitoring and controlling of all operating devices is done through web page.

4. SYSTEM SPECIFICATION

We have to Design system for following specification
Load = 100W
Back up time = 10Hrs
Battery voltage = 12V

Solution:

- Battery Specification:

  Battery Backup time (BB) = Output Load*Load
  Backup B.B = 100*10=1000
  Current = B.B/Input=1000/12=83A

  i.e. we need a Battery of 12V, 83A.

- Photovoltaic (Solar) Plate design:
  Current of System=83A
  Battery charging Hour: 7Hr (time during which sunrays will presents)

- To find Current of Solar Plate:83/7=12A
  Power=Current*Voltage
  P=12*12=144

  i.e. Solar Specification: 144W ,12A,12V

5. RESULT DISCUSSION:

5.1. Controlling and monitoring:

The controlling of 4 switches is done with the help of control panel provided on web page. The screen shot of window is shown in figure 4. Here, column shows reading of various parameters like. Temperature, light, current etc. The readings collected from various sensors are continuously updates on web page after interval of 5 seconds. This gives monitoring of all sensor parameter. We also have provided a column to switch ON/OFF the device. These devices can turn ON and turn OFF by manual as well as automatic mode. Depending on scheduled value, the devices work automatically otherwise can be control through web page manually.

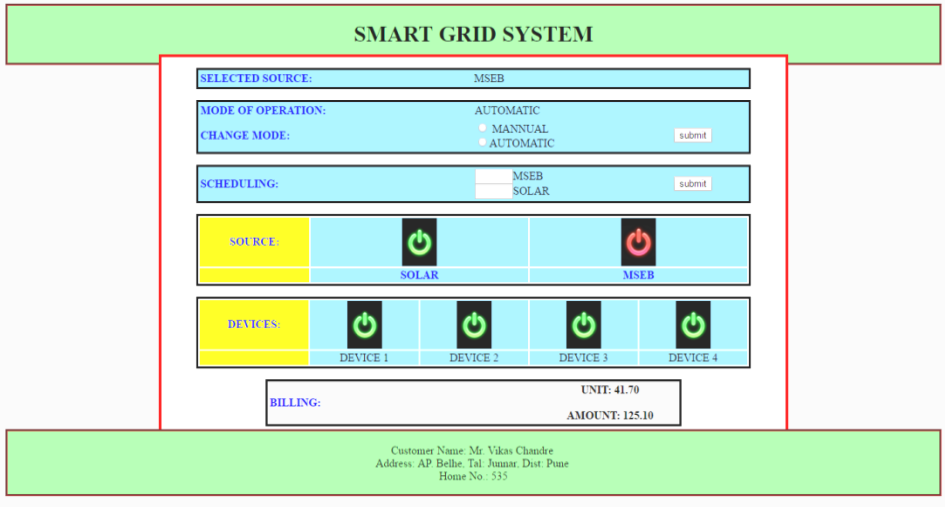

Figure 4: Web page for monitoring and controlling.

The table below shows comparison of theoretical and practical reading:

Parameter	Voltage rating	Current rating	Backup time	Output load connection
Power from solar	Battery=12V	80A	7 Hrs	Yes
Power from MSEB	230 V AC	13A	1Hr	Yes

Table1: Theoretical observation table.

The above table gives information about theoretical value and status of load connection. The following table gives practical readings and status of load connection. It shows above parameter for both sources i.e. solar power and power from MSEB i.e. mains.

Light sensor(LDR)			
Illumination	Transducer range	Display reading	Status of output device
Moderate	0 to 6.9 V	95 to 80 %	Device OFF
Dim	0.7 to 2.5 V	80 to 40 %	Device OFF
Dark	2.5 to 2 V	40 to 20 %	Device is ON

Table2: Practical observations for Light sensor

The above two table shows practical output of light and temperature sensor. To operate connected load automatically we have set the value and according to scheduled value hence the system will operate automatically. The LDR will maintain the device OFF till light is 40%, when light falls below 40% the device (bulb) will turn ON automatically.

Temperature sensor(LM35)		
Temperature range	LM 35 output	Status of output device
0^0C-15^0C	0.48V	Device OFF
15^0C-35^0C	0.75V-1.75V	Device OFF
35^0C-50^0C	1.0V-2.5V	Device ON

Table3: Practical observations for Temperature sensor.

Meanwhile we can control the device ON/OFF by webpage. Also temperature sensor will manage the other device. The device (Fan) will remains OFF from 0^{0C} to 100^{0C} and maintain ON above the temperature100^{0C} Here the device will ON/OFF automatically due to sensor while make it ON/OFF manually with the help of web page.

6. CONCLUSION

The designed system is reliable to implement and very customizable according to requirement. It provides very efficient methods of monitoring and controlling our renewable (solar) energy resources which would otherwise have been underutilized. It ultimately economical and help to minimize pollutions because of use of non - renewable energy source will reduce a carbon emission footprint. Finally it gives a very effective solution for implementing green energy techniques on a larger scale.

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