Web of Things Based Smart Grid to Remotely Monitor and Control Renewable Energy Sources

D. NAGALAXMI
M.Tech Student
CMR Technical Campus
Kandlakoya (V), Medchal (M)
Hyderabad-501401.

Mr. A. VAMSHIDHAR REDDY
M.Tech
Assistant Professor, ECE Department
CMR Technical Campus
Kandlakoya (V), Medchal (M)
Hyderabad-501401.

Abstract: This paper describes a Smart Grid architecture implemented with the help of Web of Things. Web of Things comprise of a set of Web services provided on top of a number of Internet enabled Embedded devices. The Web browser on any computer can act as an interface to the services provided by these Web of Things. The Embedded devices are raspberry pi processor based devices with Ethernet capabilities. Real Time Operating System is used for process control on each of these embedded devices. The Web interfaces provide us real time information on each of the energy meters that are installed on site and communicate to the Embedded Internet devices using MODBUS communication protocol. Real Time energy source scheduling, energy source selection, power connection and disconnection are some of the services that are provided to an on-line authenticated user.

Keywords: Smart Grid; Web of Things; Raspberry Pi; Real Time Operating System; Renewable energy sources.

I. INTRODUCTION

Use of Renewable Energy Sources in Household electrification has always been the most effective method to minimize the amount of carbon emissions that we contribute towards the cumulative carbon emissions of this planet earth. These carbon emissions have given rise to global warming due to depletion of the ozone layer. Use of alternatives like solar water heaters helps to reduce individual carbon emission footprint upon the environment. But the use of these alternatives is location and climate dependent.

The power grid supply to our homes still remains the primary source of energy for most of the Appliances in our homes. Also the reconfiguration of the electrical circuitry of the entire home is a cumbersome process for the end user.

If the users are provided with an inexpensive process to configure the power supply of their homes as per requirement, the use of generated renewable energy can be maximized. This would eventually put an impact on the total carbon emissions due to the generation process of power from non-renewable energy sources.

The Web of Things comprise of a number of Internet enabled Embedded devices which provide such an interface to the user by means of Web services. The end user can access this through a web browser of any computer with an Internet connection.

II. HARDWARE DESCRIPTION

Renewable Resources:

Renewable resources are resources that are replenished by the environment over relatively short periods of time. This type of resource is much more desirable to use because often a resource renews so fast that it will have regenerated by the time you've used it up.

Think of this like the ice cube maker in your refrigerator. As you take some ice out, more ice gets made. If you take a lot of ice out, it takes a little more time to refill the bin but not a very long time at all. Even if you completely emptied the entire ice cube bin, it would probably only take a few hours to ‘renew’ and refill that ice bin for you. Renewable resources in the natural environment work the same way.

Solar energy is one such resource because the sun shines all the time. Imagine trying to harness all of the sun's energy before it ran out! Wind energy is another renewable resource. You can't stop the wind.
Controller:

Raspberry pi unit is the heart of the designed prototype which performs 90% of the functions. In this prototype we are using raspberry pi 3 version.

The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.

The ARM Cortex-A53 is a micro architecture implementing the ARMv8-A 64-bit instruction set designed by ARM Holdings. The Cortex-A53 is a superscalar processor capable of dual-issuing some instructions. It is available as SIP core to licensees, and is marketed by ARM as either a stand-alone, more energy-efficient alternative to the more powerful Cortex-A57 micro architecture, or to be used alongside a more powerful micro architecture in a configuration. ARM is a heterogeneous computing architecture developed by ARM Holdings, coupling relatively battery-saving and slower processor cores with relatively more powerful and power-hungry ones.

III. IMPLEMENTATION OF WEB OF THINGS

The Smart Grid [3] architecture implemented has two kinds of energy sources. The first kind of energy sources used is non-renewable Energy Sources that leave a significant carbon emission footprint on the environment. The second kind of energy sources that we used comprised of a number of Renewable energy sources that were environment friendly. Our goal was to maximize the utilization of the latter. But the final choice of the Energy Source that is used is taken by the end user of the services that are provided by the implemented Web of Things architecture. This is depicted in Fig 1. The Non-Renewable energy sources consist of Nuclear Power plants, Thermal Power plants etc. The Renewable energy sources consist of wind turbines, Solar panels, Biogas plant and energy derived from Biofuel.

The Energy sources are connected to individual digital energy meters of industrial standard. Different parameters like current, voltage, power, frequency etc. are derived from each of these energy meters by means of RS 485 connections. The collection of meter readings is controlled by Internet enabled embedded devices which are in constant communication with the meters. The data that is collected from the meters is periodically updated into a server. This server provides the web services that make up the web of thing on top of these embedded system devices.

The services provided by the server include display of meter information, location of the homes connected through smart grid, scheduling of the power sources for each individual home and remote control over the energy sources by switching the source controllers by means of the embedded devices [2]. A user only needs a username and password to gain access to these services from any computer connected to the Internet. The controlling of the energy sources for each home is done by the help of source changers. These source changers are controlled by embedded devices. The embedded devices wait for the instruction from the server which is furthermore instructed by the authenticated user to switch the energy sources.

IV. DESIGN AND IMPLEMENTATION

The Raspberry Pi ARM processor board communicates with the RS232 port by interfacing its UART (Universal Asynchronous Serial Transmission) Port with MAX232 IC. But the data from the commercial digital meters is obtained in form of RS485 Port out. So we convert the output from RS232 to RS485. The RS485 MODBUS protocol allows the serial data to be transmitted over a distance of 1200 meters. Single processor board. The meters are connected to the various Non-Renewable and Renewable energy Sources directly to record the voltage and current readings. If voltage is more than 450V, Voltage Transformer is required.
and for current, Current Transformer is required for current more than 5A. The Transformers also help to isolate the meters from the high current and voltage of the input supply. The surroundings can be captured by the controlling embedded device by means of a series of commands. The choice of current transformers depends on the maximum current that is expected to be measured.

The Ethernet port (RJ 45) needs to be interfaced to the LPC1768 processor in order to establish an Internet connection. The LwIP protocol suite [6] helps to establish the Internet connection on the port. There are 3 steps for this:

1. Initializing the Internet connection (mapping MAC address to a particular IP address which has access to the World Wide Web).
2. Connecting to the Internet when the need arises.
3. Terminating the Internet connection when there is no longer required to transfer or receive data over a connection.
4. Interfacing to electrical source changers.

Electrical source changers which are DC Voltage controlled are interfaced to the embedded controller boards by means of relay controllers like H-bridge drivers.

A photovoltaic (in short PV) module is a packaged, connected assembly of typically 6x10 solar cells. Solar Photovoltaic panels constitute the solar array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions, and typically ranges from 100 to 365 watts. The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are a few commercially available solar panels available that exceed 22% efficiency[1] and reportedly also exceeding 24%.[2][3] A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, a solar inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating.

Advantages of Solar Energy
- Renewable Energy Source
- Reduces Electricity Bills
- Diverse Applications
- Low Maintenance Costs
- Technology Development

Disadvantages of Solar Energy
- Cost
- Weather Dependent
- Solar Energy Storage Is Expensive
- Uses a Lot of Space
- Associated with Pollution

V. CONCLUSION

The designed system is easy to implement and very customizable according to needs. It provides very effective techniques of using our renewable energy resources which would otherwise have been underutilized. Finally it gives a very effective method for implementing green energy concept on a larger scale. The integration of Web of Things with existing power grid architecture will provide us numerous opportunities for improvements in our energy saving techniques.
VI. REFERENCES


