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A Review Paper on: Power Grid Associated with Web using Non-Conventional Energy Source

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Abstract— This paper proposes a household power unit which is able to automatic switching and will communicate through Ethernet/Wi-Fi so utilization of the Non-conventional energy sources like solar energy will become more reliable. Further it will have made ready to end-user through electrical setup. The ARDUINO MEGA processor is preferred to work as an Embedded Device. The program loaded on this device will be work as Real time operating system. It is necessary to process, control and communication. Other services are provided on the top of embedded device. It includes communication with server about the real-time information on energy meters at customer`s location. Energy source selection, power-up the connection and disconnection are some of the services that are provided through the online web portal. The web browser available at subscriber`s end, can act as an interface to these services provided. Greater integration of renewable energy generation may be achieved by facilitating battery energy storage systems like integrating remote access to manage the set up like Ethernet, Web communication etc. The smart energy management of the resources is very important aspect. It allows collection of energy from multiple sources. In case of commercial and large scale implementation, the generated power at distribution level can be directly fed to the utility distribution network. In this paper, the smart energy management system is used where the battery monitoring system works alternately. ARDUINO MEGA 7 microcontroller is used to regulate the actual operating function as a core part of the setup. It is ideally appropriate for residential premises along with commercial applications.

Keywords- Embedded system with WLAN, Embedded device as a server, Non-conventional Energy source

I. INTRODUCTION

In present, we all are contributing to the carbon emissions of this planet earth cumulatively. This takes place in both way: direct and indirect. Global warming has raised because of these carbon emissions and depletion of the ozone layer. Applications of non-conventional Energy Sources in domestic electric grid has always been the great effective method to minimize the proportion of carbon emissions. We can reduce carbon emission at individual level upon the environment by using alternatives like solar water heaters, solar cooker, and bio-gas plant. But these solutions are dependent on location and climate. The restructuring the electrical setup of the entire home is a lengthy and expensive process for the residential user. The use of generated renewable energy can be efficiently utilized if the way to use the power supply of their homes will be as per necessary. The contribution among the total carbon emissions due to the power generation from conventional energy sources can be minimized by these alternative solutions.

Energy is the basic factor required for progressing the human life. The utilization of energy by the human beings for their needs is the dominant parameter used to measure the economic, social and industrial development of a country. Energy demands for industrialization and transportation are increasing day by day as the population is increasing. It leads to energy crisis. To satisfy the world's growing demand is one of the society's foremost challenges. And solution is to discover OR invent the more non-conventional energy resources. Renewable energy resources are abundant in nature and low in cost. They also do not provide carbon emissions. We can contribute for stimulating the economy and providing job facilities by increasing the use of these non-conventional energy sources. It is concluded that solar energy is an efficient, safe and more secure way for generating and providing the clean energy.

The potential of renewable energy sources is large enough and they can meet demand of energy of the world in many times. Renewable energy sources like wind, biomass, solar, hydropower, and geothermal can provide sustainable energy, based on the use of widely available, enough resources. Solar energy is available during day time only and solar irradiation levels are varying due to sun intensity, change in weather and

also unpredictable shadows caused by clouds, birds, trees etc. The number of power systems like PV/FC combined have been proposed and discussed. Because of relatively high cost compared with other traditional energy sources, many PV systems are not gaining popularity. Fuel cell cannot store energy. Also it has several shortcomings as slow response, it is difficult to cold start and its output fluctuates as the load gets vary. Since strong winds are mostly flow during night time. Wind power and battery are complementary to some extent. Because, battery has dynamic response and peak power capacity. It also enhances the power generation capability as it compensates the load by charging and discharging. Hence a hybrid generation system can offer high reliability to maintain continuous power output than any other individual power generation systems.

The user interface to the services available on web can provided by using embedded system for user which is able to communicate through Ethernet. The user can access the information from server through a web browser with an Ethernet connection.

This paper is arranged as further; the section I is about the introduction of the subject. Section II contains the Literature Survey which includes different relevant papers published before with their authors and publication details. In Section III, we describe block diagram of the whole system and it`s descriptions. The different hardware and components supports for collection of data from energy meters and WLAN communication. Data acquisition process to the embedded system as well as the module used to establish the WLAN/Wi-Fi connectivity are described here. An analysis of the embedded system used in this paper, is presented in section IV. It also comprises the number of web-services like authentication of user seeking to access the data collected, user interface, display the current energy source and percentage of battery charge, power switching etc. Section V is regarding future scope and scalability of the whole project. Finally, we given conclusion of our whole project in section VI.

II. LITERRATURE SURVEY

In [1] described 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 ARDUINO MEGA Processor based devices with Ethernet capabilities. Real Time Operating System is used for process control on each of these embedded devices. LwIP Protocol Stack is implemented on top of each of these devices so that IP connectivity can be established. 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 Ethernet communication protocol. Real Time energy source scheduling, energy source selection, power connection and connection are some of the services that are provided to an online authenticated user. [1]

Renewable Energy Sources and their usage in residential electrification has always been the most effective way to reduce the proportion of carbon emissions that we are cumulatively contributing the carbon release of this planet earth. Global warming has raised because of these carbon emissions and depletion of the ozone layer. We can reduce carbon emission at individual level upon the environment by using alternatives like solar water heaters, solar cooker, and bio-gas plant. But these solutions are dependent on location and climate. The main power supply to our homes is looks like a primary source of energy for most of the domestic gadgets and appliances. The restructuring the electrical circuitry of the entire home is also an expensive and lengthy task 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 will significantly affect the total carbon emissions due to the power generation process from conventional energy sources. [1]

The quest for sustainable energy models is the main factor driving research on smart grid technology. SGs represent the bridging paradigm to enable highly efficient energy production, transport, and consumption along the whole chain, from the source to the user. Although this concept promises to be very fruitful, the research on how to deploy it in the real world has just begun. A discussion on the enabling technologies for SGs and a possible roadmap for the fit able evolution thereof is the focus of this article. After introducing the recent trends that are pushing the SG paradigm, we will discuss various key scenarios for the SG, and briefly introduce some of its key requirements. We will then provide an analysis of how current and future standard solutions in the areas of communications and networking can be engineered into a system that fulfils the needs of the SG vision. We advocate the use of small, cheap, and resource-constrained devices with pervasive computing capabilities as the key component to deploy a ubiquitous energy control system. [2]

The energy generation scenario was started to changeover by different factors. At the end of 20th century, the shortage of the crude oil brought great efforts to research to new and non-conventional energy sources; the raising demand for energy called abrupt efficiency development in the energy generation and feeding processes, and new policy towards the environment changed the progress of many energy production firms. A more “green” friendly usage of energy resources is becoming an expected and profitable policy. In

the energy market, the initial attempts of these policies will be considered as a model change. These days, scenario of single energy provider who offers the monopoly getting less preference by society. This market is suffering through the multiple transition stages involving different organizations. These are mostly the providers and vendors, and it is desired to make open approached model: customers should become energy producers at themselves. It is thankful to the availability and mobility of less expensive photovoltaic array and several reasonable sources of this energy which will be renewable. This resultant model of market is very dynamic in the transition point of view due to its distributive feature. This is becoming feasible because of the immediate availability of energy as it depends on wind, sunlight and other similar different sources. [2]

A novel dual-battery energy storage system (DBESS) is proposed to firmly dispatch the intermittent wind power onto the grid with a lower system operation cost. Thanks to the DBESS, a wind farm can commit to integrating constant power in each dispatching time interval. In the proposed DBESS, the battery energy storage system (BESS) that takes the charged role is active when the dispatch power is lower than the wind power, and another is enabled if the dispatch power is higher than the wind power. [3]

The integration of distributed energy generation systems has begun to impact the operation of distribution feeders within the balancing areas of numerous electrical utilities. Battery energy storage systems may be used to facilitate greater integration of renewable energy generation. This paper describes a method for determining the power and energy capacities a battery energy storage system would need in order to accommodate a particular photovoltaic penetration level within a distribution feeder, or conversely, the amount of photovoltaic that could be installed on a feeder with a minimal investment in power and energy BESS capacities. [4]

Hybrid energy storage can take advantage of super capacitor's high power density and battery's high energy density. At the same time, hybrid energy storage cost less. So it's suitable for micro grid power balance control. This paper presents a main circuit structure which is Buck/Boost converters connecting super capacitor and battery with PWM (pulse width modulation) inverter to achieve bi-directional power adjustment and improve utilization of super capacitor. DC bus voltage is sensitive to and fluctuates with switching of PWM inverter's working conditions. [5]

Every day, energy demands are raising and hence it causes unbalance in the current grid distribution which gives outcomes in several other undesirable situations like load shedding, fluctuations in voltage etc. So it affects the customers ultimately. The only solutions to avoid such all situations, is to serve the increasing the demand by present generation. Even we are behind the expectation in case of the conventional energy sources. And hence, by producing more power is not sufficient by conventional ways also. Therefore, the application of mon-conventional energy is most important. The amount of solar power spread over the surface of the earth is approximately about 86 k Terra Watt. It covers only 0.22% of our planet by solar panels and collectors. It has efficiency about 8%, it would be enough to satisfy the current global power consumption. Solar power has huge potential for satisfying the increasing energy needs of world. And smart grids facilitate the efficient operation of the grid distribution system. "Smart" grids which uses the data and communication technologies, so it makes the electric power systems to be more efficient and reliable, further it is adopted by power industry. Available energy resources are efficiently utilized by the new technology. Combine applications of upper levels of non-conventional energy and conventional energy sources are becoming possible because of these technologies. We are unable to control the power output of these renewable sources; hence these are not 'dispatch-able'. In the next few decades, Sustainability of the energy in future heavily depends on the way of addressing the problem of the renewable energy.

Though the production of power in India has increased and improved in previous years, but there is consistency in demand and we are lagging out of supply. Also high shortages of energy are faced in these years. Lots of skills set are requiring, so the Smart grid and renewable energy can be integrated into a system. These skills will include skill to solve the general problems, process of interfacing of different module, make use of advanced technology etc. The new problems are challenging and system integration puts it all together by the large variety of engineers. [6]

III. BLOCK DIAGRAM AND ITS DESCRIPTION

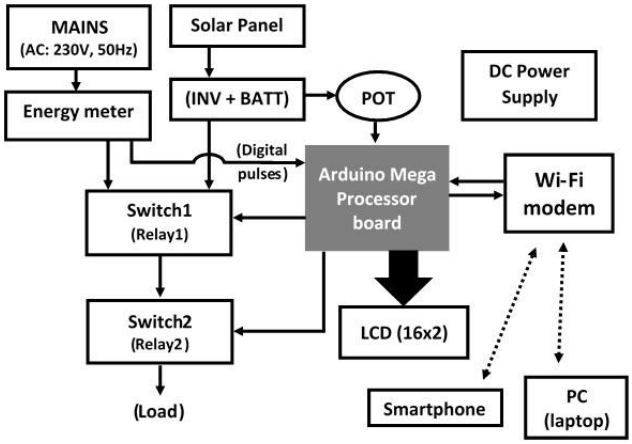

Fig. -1 Block diagram of the system

Power grid architecture presented above has two energy inputs. The first is conventional energy source which is typically the mains that left most of the carbon emission residuals within the environment. The conventional energy sources includes the Atomic Energy, Steam-turbine power, Thermal power plants etc. Another kind of energy source consist of number of renewable energy sources which are environment friendly. Our aim is to increase the utilization of these renewable energy sources. Energy derived from bio-fuel and energy from Wastes, wind turbines, solar panels, biogas plant, these are well-known non-conventional energy sources. The digital pulses of energy meter are cumulatively received and processed by embedded system. The collection of data from the digital meter is updated into an embedded system. The web services will be available on the web page. To establish this, the embedded system is used as Server for WLAN communication. The services provided by the server includes percentage of battery voltage, display of current energy source, meter information on LCD screen, it communicates through the wireless network with data available in memory. It will control energy sources by switching the source by embedded system from other location. The sources are switched between non-conventional source to mains by embedded device as per the need arises. The embedded system senses the battery voltage continuously. It switches from the inverter to mains when battery voltage goes below than threshold level. In case of commercial implementation, it is operated by an authenticated officer to switch between the energy sources and other control actions.

A username and password are need to be entered by user/authorities/operator to gain access to WLAN. It can be done from workstation/computer connected to the network. In case of multiple homes or power grid architecture, the switching between the energy sources for each home is carried by using relay logic. Embedded device will control these relay circuit.

Hardware units:

A. Non-conventional energy sources:

There are multiple ways to obtain the clean energy. It includes solar Energy, Wind energy, energy extracted from Wastes, Bio-Fuel and Bio-gases, energy from sea-waves etc. We are preferring solar panel as a non-conventional source of energy. A solar panel is not only used to supply the clean electric energy but to charge the battery also.

B. Inverter and Battery:

It consists an inverter for converting DC supply of battery to AC supply. Generally output from energy sources is fluctuating and it needs to be stored in battery. Hence it will be provided to the inverter as stable supply of energy. Battery is also used to supply DC power in case of failure OR non-availability of renewable energy source. Inverter is there to gain AC output from DC input signal to supply load. We are preferring the inverter which is capable to run with maximum 45 Watts of load and battery will be of 12 Volts.

C. Switching between energy sources:

When the both units are not able to supply necessary amount of energy or in case of maintenance/failure, the load will be automatically switched to the mains. For this, we are preferring the relay logic circuit. Relay 1 is for switching between Mains and Inverter. Relay 2 will be act as additional switch used in case of maintenance, failure of electrical setup or to control supply.

IV. EMBEDDED SYSTEM:

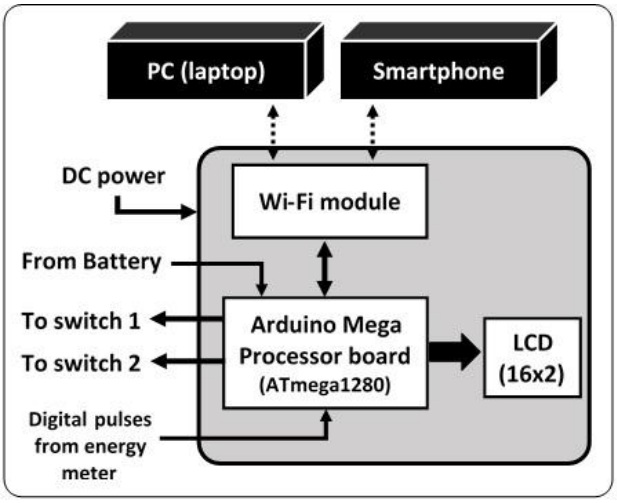

Fig-2 Arduino MEGA to be use as an embedded system and connection with wireless LAN module

4.1 Arduino MEGA to use as a CPU:

Generally we start with identifying the requirements of embedded system which is going to develop. Then the selection of microcontroller or CPU is take place according to project needs.

The Arduino Mega is chosen to be used as embedded device which has several advantages over other high-end CPUs available in market environment. Arduino processors are consists with enough I/O pins (Digital I/O pins are up to 54) to support the more peripherals. It also has enough memory (Flash memory is up to 128 KB) to operate with real-time operating system. The biggest beneficial thing with the Arduino processor is the availability of large library files. Hence, it is very easy and convenient way to develop the source code. It can supports many of the new peripherals without interfacing with the separate lengthy coded modules. There is no need to prepare the different code modules when interfacing the typical hardware. Examples are: LCD, keypad, Wi-Fi module, DC motor etc. All these features are

makes up the Arduino MEGA is a better choice for future advancements.

Also the single software needs for developing, preparing and debugging the source code. It is only Arduino IDE which is able to support all the programming activity. Even another application does not need to flash-out OR burn the code into CPU. Arduino IDE is capable of the same.

In this setup, an embedded system is designed by using ARDUINO MEGA processor and it's preferred to work as Ethernet/WLAN enabled embedded device. The program loaded on this device will be act as Real-time operating system. It is necessary for processing as well as control and communication. The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (out of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimi. These features of the microcontrollers are particularly suitable for industrial control, medical systems, and access control and point-of-sale. With a wide range of Ethernet communications interfaces, they are also very well suited for communication gateways, protocol converters and embedded soft modems as well as many other general-purpose applications.

4.2 Connection with energy meter:
The digital pulses are collected from the energy meter. A green LED on the energy meter is usually blinks as per the power consumption takes place. These pulses can be used to measure the energy usage. A connection is made from LED to CPU to take place this.

4.3 Measurement of the battery voltage:
A connection from battery terminals need to take for sensing the real time voltage level. This will be analog input and it will give to the ADC of CPU. After getting digital output, it will be measured and displayed on the LCD as well as on the web page.

The real time voltage level from battery will vary up to 12 Volts. But the input pins of the ADC of the Arduino Mega are able to sink up to the 4.5 Volts. Hence this voltage cannot be given directly to I/O pins. A voltage divider needs to use for scaling the higher voltage levels as down as compatible with the ADC. It will be placed after the battery and before the ADC.

4.4 Wireless LAN:
We preferred the Wi-Fi module: ESP8266 which is compatible with full of IEEE 802.11 b/g/n protocol services. It is very compact in size and also easy to configure by using predefined set of AT commands. It`s not only serve as a Wi-Fi adapter but wireless internet access can be added also to any Microcontroller-based design with simple connectivity through UART interface.

4.5 Communication with Wi-Fi module:
The serial reception and transmission pins will be available on CPU board which will used to interfacing with the ARDUINO MEGA processor in order to establish a wireless local area network.

This will usually done as per the following steps:
1) Initially, CPU setups the serial communication with Wi-Fi module as per the configuration available in its running code.
2) Wi-Fi module establishes the wireless LAN around its coverage region.
3) And the Wi-Fi enabled devices can access the web page by simply entering the IP address into the Web browser.

4.6 LCD module:
A 16x2 LCD module is interfaced there to display the some real-time parameters, it includes the Battery voltage level OR charging level in both the units: Volts and percentage of the same, current energy source, the usage of electricity in units etc.

4.7 User Interface:
A User Interface is designed in the form of web page and it is programmed by using HTML (Hypertext Mark-up Language). It will be accessed on the computer connected to the WLAN. The user may be subscriber, operator or any authority. The user is provided the data like his/her subscriber ID & name/site name as well as other necessary details. This can be done on the Web page accessed through WLAN**.**

These options available at this user interface are like power units consumed by subscriber, current energy source and other parameters like current energy source, the usage, billing amount, battery voltage, control buttons to operate the relays. This helps to analyse his/her energy needs and he/she can plan to utilize his/her energy sources as per his/her needs. He/she can learn his/her power usage **such as daily use,** monthly usage or yearly usage. The data can be compared to consumption of different times of energy sources.

4.8 Software requirements:
- Arduino IDE installed on the PC
- Web browsers installed on a PC.

Ex. *Internet Explorer, Mozilla Firefox, Google Chrome* etc.

4.9 Hardware requirements:

- ARDUINO MEGA 1280
- LCD (16x2) – HD44780U
- Relays to use as Switches
- Inverter with battery
- Wi-Fi module: ESP8266
- Solar Panel
- Static Energy meter

4.10 Advantages:

- Easy to Maintenance
- Helps to reduce the Electricity Bills,
- Low Maintenance Costs
- Technology Development
- Less Power Consumption
- Less skilled technicians are sufficient to operate.
- Installation is simplified very much to use renewable energy.
- Produces no pollution or waste
- If the area is sunny, excess solar energy can be used to store in battery.
- By using Wi-Fi module, a wireless local network can be setup easily.

4.11 Applications:

- Can be used in household electrification.
- It can be implemented on the large scale basis as per the need
- Suitable for remote access areas where power transmission is very expensive.
- Convenient way for regions where no another power source is available. Ex. Desert areas, Mountains, rural areas etc.
- It can be implemented at public places for ex. Auditoriums/schools/Temples/commercial buildings/organizational campus etc.

V. FUTURE SCOPE

The presented model is reliable to build up on existing meters installed at residential locations. The whole set up can be developed with the electrical components and these can be choose according to size of the project. So it will be a cheaper installation on a countryside region. It can be expanded up to a large scale project with high security. Now days, most services are made available through the Web, the operations and procedures can be reconfigured from remote and it depends on requirements and feedback from user side. The additional services can be managed frequently at the time when the necessary is there.

VI. CONCLUSION

The described system can be easily build up and it is also scalable according to requirements. It gives an effective way to use our renewable energy sources. It has been underutilized otherwise. We can conclude that; it gives very efficient techniques for deploying green energy concept on a scale which may vary from domestic applications to industrial. The integration of WLAN with existing architecture of subscriber power grid will offer lots of opportunities to us for advancements in our techniques to save energy.

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