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Research Article

Smart Grid Power System by Integrating IOT

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Abstract

In a typical smart grid, the central management centre controls all the units connected to it making sure to operate them at the highest efficiencies. The central management centre does not only assist in better energy management inside the facility but also it helps in reducing the electrical consumption during peak times. This reduction is reflected as huge energy savings. Our model includes a renewable energy generating block installed in the house or industries which delivers power to batteries and also powers the grid. The power from the generating station is also coupled with the grid. The combined grid can lower the electricity bill and consumption. The renewable energy in our case is from the sun, so hereby we use PV cells to harness the DC power and use power electronics to convert the DC to suitable DC and AC. The converted AC can be connected to the grid. The major including in our smart grid is the implementation of monitoring and control with the help of microcontrollers which can measure the generating voltage and current levels. The monitored values are stored and displayed via cloud to customers by implementing IOT and the state's power station which helps in more efficient usage of energy and thereby reducing the electricity bill.

Key words: PV-Photovoltaic Cells, IOT-Internet of Things

1. INTRODUCTION

In our day to life, we use electricity for all kinds of needs. The electricity we get or generated from mostly involves fossil fuels or non-renewable ones. The renewable energy systems provide decent alternatives or additions to our energy needs, but are often feasible and not efficient for daily needs. The Idea of combining both renewable and non-renewable energy sources to deliver a hybrid power source is in developing stage and mostly implemented in several areas in the world. This idea of combining two types of sources is called smart grid networks. The smart grid uses communication networks to ensure efficient power delivery and monitoring systems. The idea of load sharing and measuring parameters is the main concept of our proposed model. From this model, load sharing is achieved from the relay control and hence the distributed power sources help in the low electricity bill. By this the hybrid network is used in a way that can be efficient and also the measurements and data can be monitored to provide a intelligent network of grid.

1.1. SMART GRID

In a typical smart grid, the central management centre controls all the units connected thereto ensuring to work them at the very best efficiencies. The central management centre doesn't only assist in better energy management inside the power but also it helps in reducing the electrical consumption during peak times. This reduction is reflected as huge energy savings. A smart grid also facilitates switching from conventional energy to renewable energy. In case of getting a source of renewable energy within the facility, the grid allows quick access to integrate it into the grid. Smart grid permits greater penetration of highly variable renewable sources of energy, like wind generation and solar power. Smart grid may be a new gateway to a green future. It not only provides better energy benefits but also exposes new avenues of employment for future. For example, conversion of normal operating units into smart ones capable of connecting to the smart grid is filled with new and exciting opportunities. The global marketplace for smart instruments is trending up with out-of-the-box ideas and innovations from young energetic minds.

1.2 INTERNET OF THINGS (IOT)

Internet of things is basically a concept of connecting multiple devices with help of internet, which serves a multifunctional use and has advantages over modern technologies in this era. The Internet of things have certainly made an impact on our current generation. The phone and the devices we use in our home are smart and connected in a grid network called Internet of things. We make use of this Internet of things technology in our Smart grid power systems project by connecting different sensors alongside the power system and establishing a connection between them with the help of this internet of things technology. The connected sensors function and collects data in real time and it's shared between the other sensors and to the servers as well. For this implementation of Internet of things, we use micro-controllers and internet connecting modules such as node MCU in case of Arduino type micro-controllers. We use cloud technology to collect these data to calculate the problem statement we have and can automate the system based on the details of values and data from these sensors. In our proposed model we

collect the parameters of current, voltage thereby calculating power from different sensors to automate our switching relay process in our model.

2. BASIC BLOCK DIAGRAM AND COMPONENTS

The proposed model contains three sections such as renewable energy generation section, power controllers' section and finally control section.

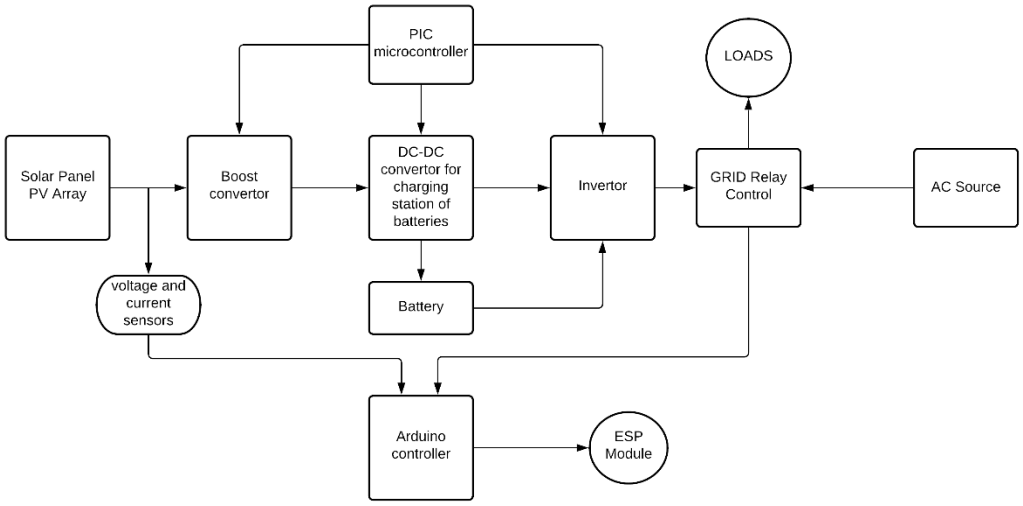

Fig. 1. Block Diagram of Proposed Model

2.1 COMPONENT REQUIREMENTS

2.1.1 HARDWARE

- Solar PV array 12V
- PIC Microcontroller
- Arduino Microcontroller
- MOSFETS
- Diodes
- Current and voltage sensors
- NODE MCU
- Battery
- DPDT relay
- LED bulbs for load

2.1.2 SOFTWARE

- MATLAB simulation software
- Blynk Application for displaying parameters

3. OPERATION

3.1 POWER GENERATION FROM PV CELLS

Our Model uses Solar power as a major renewable energy source to provide load for the grid. This solar power is generated from the PV array of cells placed in the sunlight which can provide enough power to provide electricity to the loads. In our case we are using a 12V solar panel. This solar panel is also connected to a battery for bi directional way of providing power to the grid and also the battery charges via the converter charging circuit provided.

3.2 CONVERTOR CIRCUIT OPERATIONS

3.2.1 DC-DC BOOST CONVERSION

The voltage obtained from the solar panel is a little bit low and we require a specific high voltage to provide ample working of charging circuits and to step up the voltage to match the load. For this the voltage obtained from the Solar array is boosted by DC-DC boost converters and also a charging station is provided for the charging of bi directional rechargeable batteries.

3.2.2 INVERSION

The DC stepped up voltage obtained should be made possible to match with the load which works on AC. So inverters are used to convert the DC voltage into an alternating AC voltage. This inversion circuit uses power semiconductor devices such as MOSFET which can be used in high switching frequencies. Once the inversion operation is done the power is delivered to the load which is separated by our model's relay control block.

3.2.3 RELAY CONTROL

Here comes the main proposal of our project's idea. Our relay control works in a way that it separates and distributes the load based on the generation from PV and the availability from the AC source.

For example,

If a house is taken, the loads given to the house are distributed to multiple load sections, these multiple load sections are connected to both DC source from PV and AC source. That is, the Ac load is separated into, for example 3. load sections. And the output power from the inverter is also divided into 3 load sections. These both power sources are connected to the load via a two-way relay which is controlled automatically by an arduino microcontroller. This relay control works in multiple cases according to the power availability.

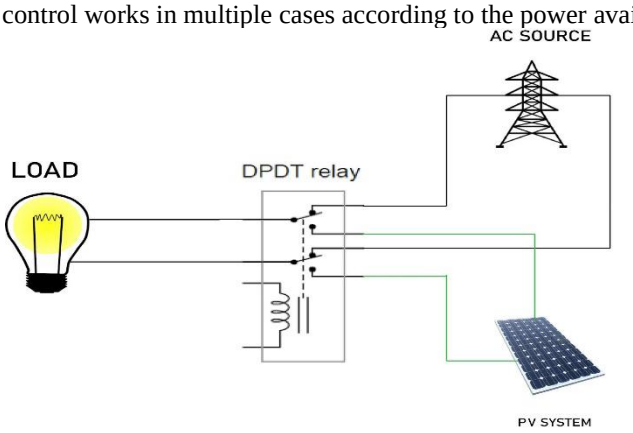

Fig. 2. Relay control

CASE 1: Full Load provided by PV source

In case of maximum power generation from the PV cells, the 3 relays sense the power generated and decides to deliver the load from the power obtained from the PV itself

CASE 2: Partial load to PV and partial load to AC

In the shortage of power generated from the PV cells. The controller detects the power lag and switches the top priority relay to the AC source and remaining load to the PV grid.

For multiple cases of low generation of power, we can switch between loads and the choice of power source between AC source and renewable side's source

CASE 3: Full load provided by the AC source

In case of no power generation from the PV cells, the 3 relays sense the blackout and decides to deliver the load from the power obtained from the AC source alone. In this manner when there is a minimum to no generation from the PV cells, we can deliver the load without any interruptions.

CASE 4: No power from both AC source and PV system

We have included batteries and battery charging systems which can deliver power to the grid in case of no power from both sides.

3.2.4 MEASUREMENT OF PARAMETERS IN IOT

In our proposed model, we also measure the parameters with the help of sensors and the sensors are connected to a Arduino microcontroller and with the help of an internet module like NODE MCU, we can display and communicate the measured parameters in the website and store the data in the cloud.

4. MATLAB SIMULATION OF PROPOSED MODEL

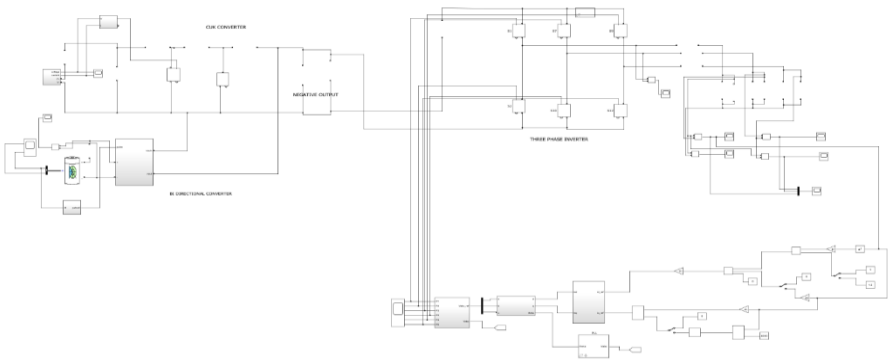

Fig 3. MATLAB Simulation

4.1 MATLAB SIMULATION RESULTS

4.1.2 Voltage and Current waveform from PV Panel

This graph is plotted against the voltage and current generated from the PV panel at a decent lamination value provided that is when PV Solar panel is kept in a sunny outdoor.

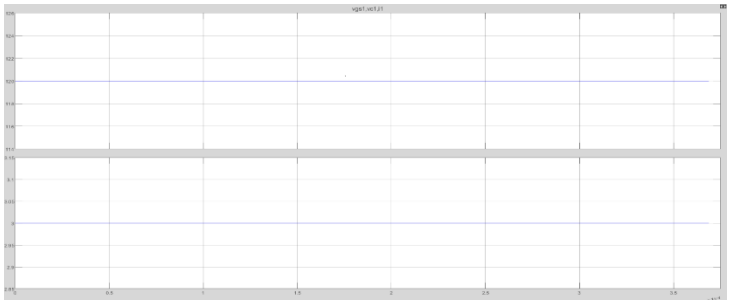

Fig. 4. Voltage Current waveform from PV panel

4.1.2 Charging waveform of battery

This graph represents the charging waveforms of battery when it's being charged with the PV solar panel when it's placed at a decent lamination value provided as the case above.

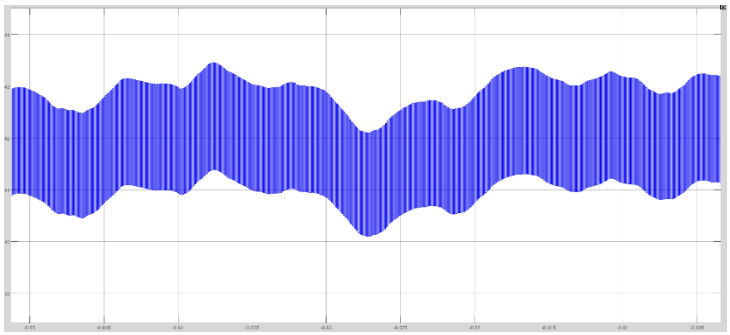

Fig. 5. Charging waveform of battery

4.1.3 Output voltage waveform from invertor

The below graph represents the output voltage waveform obtained from the invertor when the DC current is converted to AC with the help of power system controllers

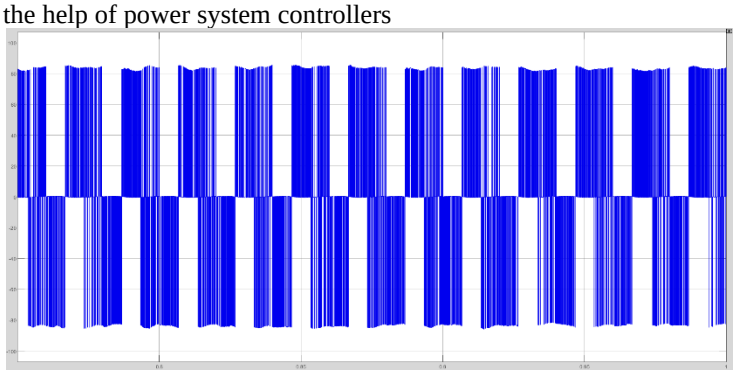

Fig. 6. Output voltage waveform from inverter

5. RESULTS AND CONCLUSION

By alternatingly changing the source to load from relays, the renewable energy is used in an efficient manner providing low usage of state electricity. Thus, helps in deduction in bills. Also, the power generated from the Solar PV array and the amount of power used etc are monitored via cloud and displayed in the website. As a result of switching the loads we can ensure the reduction of electricity bill and also there's an advantage in our proposed model that is uninterrupted power supply can be obtained as there is no switching of entire power source to the loads.

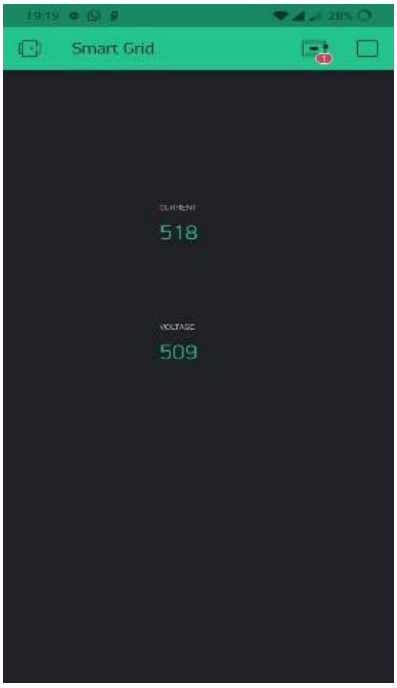

Fig. 7. Parameters displayed via IOT

5.1 Advantages of switching loads

By Switching the priority loads by the relay control, we can achieve a distributed grid of energy sources, so since there is no control of voltage or current by any resistance and frequency control, no power losses are noted and also no ripples are generated.

6. FUTURE SCOPE

Our Proposed model uses the help of an Arduino controller to control the relay networks. But it can be more efficient if we introduce Artificial Intelligence to it. Also, by collecting the usage stats of loads from users. The AI can decide the amount of power a grid can provide to the respective load or user. This implementation takes a lot from the software side and require Ai microcontrollers like NVIDIA, INTEL etc.

Also, the future of this smart grid lies in the efficient usage of multiple power sources, not just one such as solar, the grid networks can utilize the most out of many renewable energy sources such as tidal, wind, geo-thermal and work together to provide enough power to reduce our global electricity consumption.

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