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SOLAR BASED HYBRID INVERTER

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Abstract

Solar energy has incredible potential to power our daily lives. Researchers suggest that the amount of sunlight that strikes the Earth's surface in an hour and a half is enough to handle the entire world's energy consumption for a full year.

Solar based hybrid inverter is one of the best renewable energy technologies which is not only cost effective but environment friendly as well. For our research, we have suggested methodologies that may be applicable to other off grid applications. we will be explaining design methodology using an example of an off-grid classrooms. Solar based hybrid inverter can be defined as independent systems that are not connected to any electrical grid. These come in different sizes and are mostly used in location where there is little access to grid infrastructure.

The off-grid classroom project will completely depend on the solar energy i.e., solar photovoltaic will harvest electricity to supply the devices such as bulbs, fans, and sockets. A battery backup would be used as a continuous power supply in case of the worst weather.

This report will focus on how methodology of solar based hybrid inverter can help to reduce the dependency of grid and allow us to live in self-sufficient manners without reliance on one or more public utilities. Further, a solar based hybrid inverter will be designed for classrooms in library to demonstrate the concept.

The Methodology is divided into 6 Parts :

1. Solar power generation
2. DC to AC conversion
3. Battery storage
4. Load management
5. Safety and reliability
6. Grid connectivity

Keywords: Solar cell, Hybrid inverter , Battery storage , Renewable energy

1. Introduction

Over the years there has been an increase in the earth's population which is directly proportional to the energy used as well. All the possible gadgets and equipment need some or the other kind of energy to function. With depleting fossil fuel reserves it becomes necessary to identify viable renewable energy resources that can decrease the dependency on fossil fuels.

Solar energy is the most abundant form of energy available to us. It is approximated that 10000 TW worth of solar energy is incident on earth's surface in a day (Bosshard, 2006). According to a report, the world energy consumption in 2015 was 17.4 TW altogether (Seger, 2016). There has been a minimal increase in the energy consumption every year, approximately 1-1.5% annual growth. The world's total energy consumption is expected to grow by 56% by the year 2040 (U.S Energy Information Administration, 2013). Comparing current consumption, projected growth in two decades, and the amount of solar radiation received in an hour the potential solar energy usage is good.

Despite this energy potential available to us the current utilization of solar energy is less than 5% globally. There are countries that are taking initiatives to switch from using fossil fuels to solar applications. These countries form a pool called the G-20 countries which have taken the global leadership to adopt renewable resources of energy. Germany is one of the G20 countries that has switched its energy needs to approximately 38% to solar and aims to go completely stop its dependency on nuclear and replace it with solar by the year 2050 (Richardson, 2017).

Apart from harvesting the resource and decreasing the dependency on fossil fuel because they are limited, burning of fossil fuels for energy has an adverse effect on the environment. It releases CO_2 into the atmosphere which is responsible for the greenhouse effect. Further, it also causes the ozone layer to be depleted. These mentioned phenomena can result in acid rain, air pollution, etc. A 4 KW solar panel used in homes for 25 years can offset 199,697 lbs of CO_2. It is fascinating to know the impact in the environment by

Using solar panels

2. Literature Review

Being off grid means the system works independently and the consumer is not connected to any utility's power system. An off-grid PV system refers to an installation that is not connected to the electricity grid. This means that all the energy produced is stored and used on site.

Census 2011 throws light on the darkness across India. Of the 246 million households, 67 per cent get electricity from the grid, while 31 per cent have no option but to use kerosene lamps. In 2001, government initiated a nationwide program to provide off-grid, clean alternatives, mostly solar, in remote areas. Solar has now lit up more than a million homes a 100 per cent increase since 2001—though the program has its share of loopholes. This situation presents both challenges and opportunities. The answer to the country's energy poverty could lie in decentralized solar.

Joel Kumar, Ankur Paliwal and Sayantan Bera from Down to earth organization who assessed the programmer's performance, says the case for off-grid solar is clear and urgent and carries out a reality check in Uttarakhand, Bihar and UttarPradesh, and in Assam where there is a need of electricity to the households.

According to IFC's lighting India program, nearly 400 million people in India do not use grid electricity as their primary source of lighting. 43 percent of rural households still use kerosene as a primary source of fuel for lighting. A variety of modern off-grid electric lighting technologies have emerged globally over the last decade. These technologies are popular because they are cost-effective, robust, and use small amounts of energy. As per the research conducted by Times of India, barely one in every ten households in rural Bihar and two-thirds of houses in the state's urban areas use electricity to light their houses.

Just over half of rural India uses electricity as its main source of lighting, an increase of 12% over 2001. If that seems heartening, the data also shows that 43% of rural households still use kerosene to light their houses. In urban India, the spread of electricity is more complete, with 93% of households using electricity as their primary source of light.

3. Problem Statement

Sure, here's a problem statement for a solar-based hybrid inverter:

"Design and develop a solar-based hybrid inverter system capable of efficiently integrating solar energy with the grid or battery storage, ensuring optimal power management and seamless transition

between different power sources. The system should prioritize renewable energy utilization while providing reliable backup power during grid outages, with a focus on cost-effectiveness, scalability, and user-friendly operation."

This statement outlines the key objectives and requirements for creating a solar-based hybrid inverter, including its functionality, efficiency, reliability, and user experience.

4. System Design

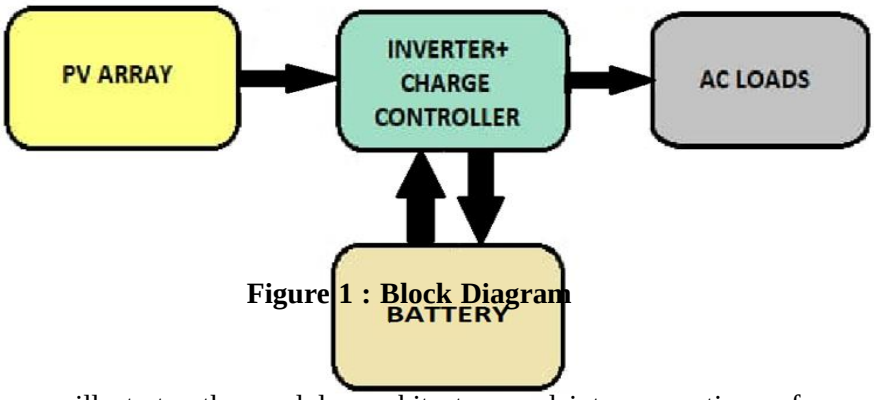

Figure 1 : Block Diagram

The block diagram illustrates the modular architecture and interconnections of components within the Monthly Electricity Billing Display System with SMS feature. Each block represents a functional module or component of the system, interconnected to fulfill specific tasks and facilitate seamless operation. Here's an explanation of the components depicted in the block diagram:

5. Hardware Components

1. *Solar Panels:* Photovoltaic panels that convert sunlight into electricity.

2. *Charge Controller:* Regulates the voltage and current from the solar panels to optimize charging of batteries and prevent overcharging.

3. *Battery Bank:* Stores excess solar energy for use during periods of low sunlight or grid outages.

4. *Inverter:* Converts DC electricity from the solar panels and batteries into AC electricity suitable for household appliances and grid synchronization.

5. *Grid-Tie Inverter:* Allows the system to feed excess electricity back into the grid, if permitted, and synchronize with grid power.

6. *Power Meter:* Measures electricity consumption from the grid and tracks energy production from solar panels.

7. *Transfer Switch:* Automatically switches between grid power and battery/solar power during grid outages or when solar energy is available.

8. *Monitoring System:* Provides real-time monitoring of energy production, consumption, and battery status for optimization and troubleshooting.

9. *Safety Components:* Such as surge protectors, grounding systems, and disconnect switches to ensure safe operation.

10. *Mounting Structures:* Supports for solar panels, ensuring proper installation and orientation for maximum sunlight exposure.

6. Circuit Diagram

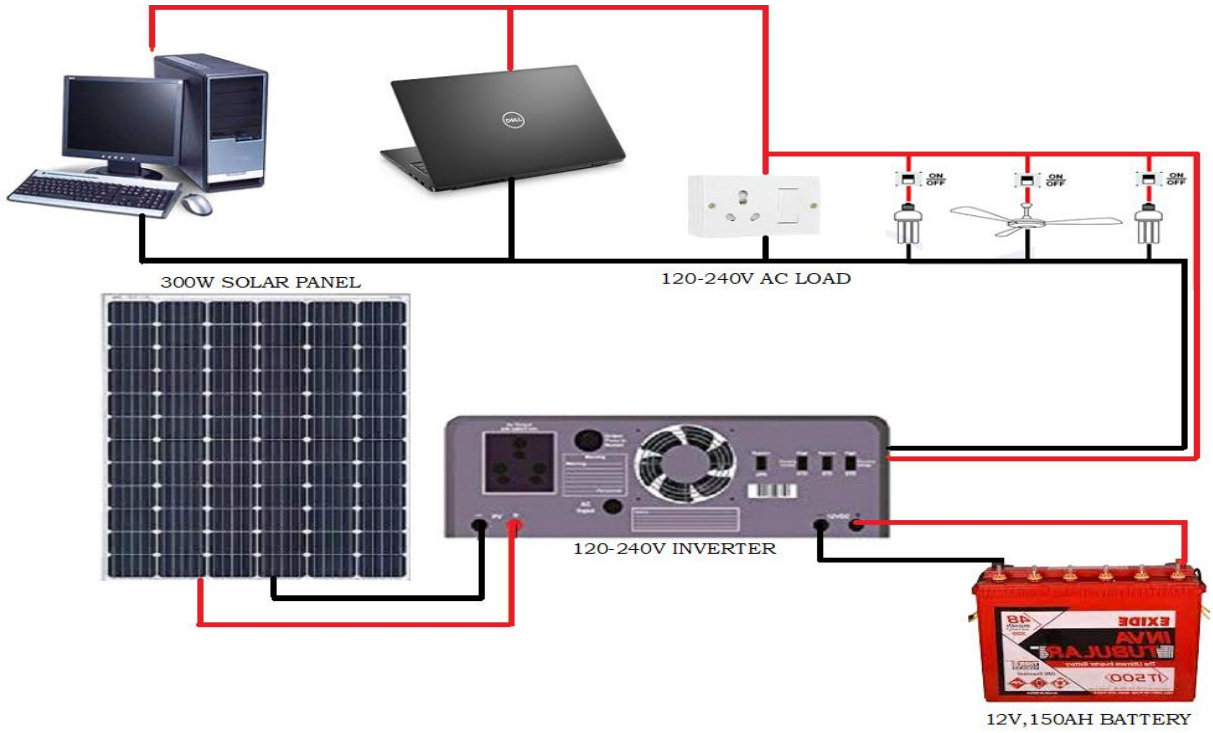

Figure 2 : Circuit Diagram of solar based hybrid inverter

A solar-based hybrid inverter circuit diagram may also include a maximum power point tracker (MPPT) circuit array. This circuit array receives real-time information from current transducers (Hall sensors) about the solar array section's impedance and I-V characteristics. The control unit then uses these signals to determine the next PWM cycle activity.

A solar-based hybrid inverter uses DC coupling to connect with batteries. The DC from the solar panels charges the batteries through a DC charger, and the inverter's electronics manage the charging and discharging of the battery.

Hybrid inverters can help with issues like unreliable utility grids and intermittent sunlight, and they can store energy for later use. This includes backup power during power outages or peak hours.

7. Some Common Mistakes

Some common mistakes to avoid when dealing with solar-based hybrid inverters include:

1. *Incorrect Sizing:* Underestimating or overestimating the system size needed for your energy requirements can lead to inefficiencies or insufficient power generation.

2. *Poor Placement of Solar Panels:* Improper orientation or shading of solar panels can significantly reduce their efficiency and overall energy production.

3. *Inadequate Battery Capacity:* Not having enough battery storage capacity can limit the system's ability to provide backup power during periods of low sunlight or grid outages.

4. *Mismatched Components:* Using components from different manufacturers that are not compatible can lead to compatibility issues and reduced system performance.

5. *Inadequate Monitoring and Maintenance:* Neglecting to monitor the system's performance and perform regular maintenance can lead to reduced efficiency and potential system failures.

6. *Improper Wiring and Installation:* Incorrect wiring or installation practices can result in electrical hazards, reduced efficiency, and system malfunctions.

7. *Ignoring Local Regulations and Codes:* Failing to comply with local regulations and building codes regarding solar installations can lead to legal issues and safety hazards.

8. *Neglecting System Upgrades:* Not keeping up with technological advancements and system upgrades can lead to outdated and inefficient equipment.

8. Conflict of Interest

A conflict of interest regarding solar-based hybrid inverters could arise if someone involved in promoting or selling the inverters has a financial interest in a particular brand or technology, potentially compromising their impartiality or objectivity. It's crucial for those involved in promoting or selling such products to disclose any potential conflicts of interest to ensure transparency and trust among consumers.

9. **Result and Discussion**

- Aiming to the exact methodology, project will depict almost like in the blockdiagram.
- Off grid PV solar system will be fully functional along with its facilities as desired.
- Major aim of the project will be electrifying the HOD chamber of EEE dept. using solar energy by deploying off grid PV solar system.
- Automatically the project will result in promoting the usage of renewable energy sources effectively.
- The project can be implemented to help thousands of remote households in providing the stand-alone power where there is no nearby connection to the grid.
- It can be implemented in promoting to take over from polluting way of power generation to a better and convenient conventional form of power generation.
- It can be implemented in encouraging the new generation of youth to take up their own business end overs in face of our project

10. Conclusion

This project works provides the methodology of designing an solar based hybrid inverter using in library A solar based hybrid inverter was designed that houses essentials such as bulbs, fans, and sockets etc.
Total load for 7 hours continuous usage is = 700 W
Considering minimal usage of 7 hours (college hours 9am to 5pm) in a day.
The total power consumption is 700*7 = 4.9 kW-hr i.e., 4.9 units per day. Assuming 20 working days in a month, the total power consumption is of 114 units. The tariff cost per unit is Rs. 8.95/-. The savings per month by using alternative fuel source(sun) is Rs. 1,020/-. By this project work, we have contributed a little to save nature and create awareness regarding the need for alternate energy source and the need to reduce dependence on conventional energy source like coal, petroleum etc.

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