IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14149

INDEPENDENT SOLAR PV SYSTEM

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Abstract: This Independent solar powered PV system is a reliable and sustainable energy solution designed for remote or rural areas with limited or no grid connectivity. The system integrates solar panels, battery storage, and an inverter to generate, store, and distribute electricity. Solar panels convert sunlight into DC electricity, which is regulated by a charge controller and stored in batteries. The stored energy is converted into AC power by an inverter, making it usable for household appliances, schools, healthcare facilities, and other critical infrastructure.This system is ideal for powering rural homes, schools, healthcare facilities, and community centers. Its modular design and scalable architecture enable easy customization to meet specific energy requirements. Key benefits include energy independence, reduced energy costs, environmental benefits, and increased energy access.

I.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 C02 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.

II. LITERATURE SURVEY

Being off grid means the system works independently and the consumer is not connected to any utility's power system. An Independent 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 programme 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 2001though the programme 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 organisation who assessed the programme's performance, says the case for Independent solar is clear and urgent and carries out a reality check in Uttarakhand, Bihar and Uttar Pradesh, 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 Independent electric lighting technologies have emerged globally over the last decade. These

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technologies are popular because they are costeffective, robust, and use small amounts of energy. The emergence of a large market **for these technologies has led to efforts to develop the market for them.**
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, implying that the kerosene subsidy may not be as pointless as some would suggest. In urban India, the spread of electricity is more complete, with 93% of households using electricity as their primary source of light.

III. OBJECTIVE OF THE PROJECT

A small attempt is made to electrify EEE classrooms using solar energy and contribute a minute way (micro level) to the energy crisis solution.
Normally, the classrooms of EEE dept. are powered with grid supply. In order to reduce the dependency on fossil fuels, the electric load of the classrooms is powered by using off grid PV solar system.
An Independent PV system will generate enough power all year-round, with enough battery capacity to meet the power requirement of classrooms, even in the heart of winter, when the days are short and there is a lot less sunlight. Independent solar systems will produce extra electricity during the day. This extra electricity is stored in the batteries. The energy stored in the batteries can then be accessed at night or during cloudy days when the system is not producing energy.

IV. METHODOLOGY

Proposal to use Standalone PV System for EEE Classroom's lighting/fans:
Department of Electrical and Electronics Engineering of RYMEC has always been a leader in embracing new technologies that promotes betterment of the environment and its students. The classrooms of EEE dept. teaches hundreds of the students on a day-to- day basis. Currently, all the classrooms in the

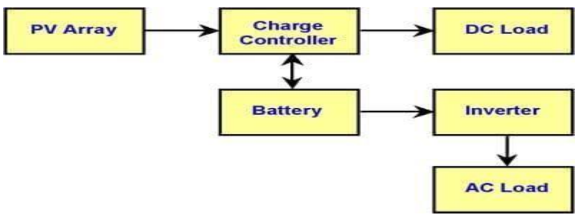

Figure: Block diagram of Independent PV solar system

department are connected with the existing electrical grid. Hence, taking an initiative to contribute to the department (socio- responsibility) and create awareness among the students regarding the need for alternate energy source the following PV system has been designed.

V. LOAD CALCULATIONS

V.I <u>In LH1</u>
<u>Classroom:</u> Total number of tube lights = 4 Total number of fans = 5
Power consumption of each tube light = 20 W
Power consumption of each fan = 70
W
For four tube lights = 20*4=80 W
For five fans= 70*5=350 W
Total load in LH1 Classroom = 80+350=430 W

V.II <u>In LH2</u>
<u>Classroom:</u> Total number of tube lights = 4 Total number of fans = 5
Power consumption of each tube light=20w
Power consumption of each fan=70w
For four tube lights=20*4=80w
For five =70* 5 = 350W

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Total load in LH2 Classroom = 80 + 350 = 430W
According to the above load calculations, the components are considered as below:
In this direction an "**OFF GRID PV SOLAR SYSTEM**" of 900 W is installed using the following **COMPONENTS**
The components used are listed below:

[1] Solar panel
[2] Battery
[3] Inverter

The ratings of the above components are given below:

V.III Solar Panels Sizing

As per the load calculations for LH3 and LH4 classrooms, Wattage details of solar panels used is described below: Total Number of solar panels used = 2 solar panels with rating of 36V ,450W = 2
Total Wattage of solar panels used
450+450=900 W

V.IV Battery Sizing

Total number of batteries used = 2
Specifications of a battery:
Nominal Voltage: 12V
Max. charge Current: 25A
Capacity: 100Ah
Type: C20, tall tubular, Lead-Acid Battery

V.V Invertor Sizing

As per the solar panels used, the Invertor with following specifications is used: Input voltage: 100V-300V
Output Voltage (Main mode): 100V~300V
Output Voltage (UPS mode): 210V±10%
Current: 50A
Output Waveform: Pure Sinewave

VI. CONNECTION DIAGRAM

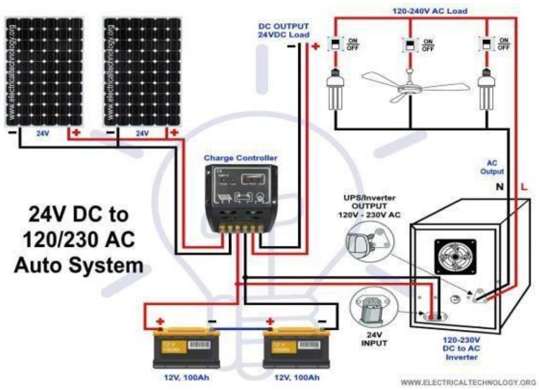

Figure: Connection diagram of Independent PV system

The above **Connection diagram** shows **how to wire a four 36V Solar Panels in series- parallel connection to a pair of 12V, 100Ah battery** with an automatic inverter system. Note that the number of solar panels and batteries depends on the system's design and load requirements i.e., multiple batteries and solar panels can be connected in series, parallel or series parallel connection to increase the Ah rating and storage capacity.

VII. Solar panel

VII.I Photovoltaic Cells

In the 18th century, Swiss physicists assembled a warm trap, which was a small- scale greenhouse. He developed a hot box, by a glass box in another larger glass box, a total of up to five boxes. When they are proposed to coordinate the sun illumination, the temperature in the deepest box can be raised to 108 degrees Celsius; warm enough to soak water and cook food. These crates can be considered the world's first solar collection. In the late 1950, some organizations and research facilities began to create a silicon

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based solar cell that considers the goal of controlling Earth-orbiting satellites. These include RCA, Hoffman Electronics, and in addition, the U.S. Army Alert Corps (Desideri, Zapparelli, & Garroni, 2013).
A solar cell, or photovoltaic cell, is an electrical device that converts the energy of photons that are incident on it to electrical energy, which is a natural and synthetic marvel. A separate cell unit can be connected to a frame module, also known as a solar panel. Different solar cells in a unified set, all arranged in the plane represents a solar photovoltaic board or module. PV modules usually have a glass in front of the panel, allowing light to pass through, while ensuring that the semiconductor plate is protected inside the case.

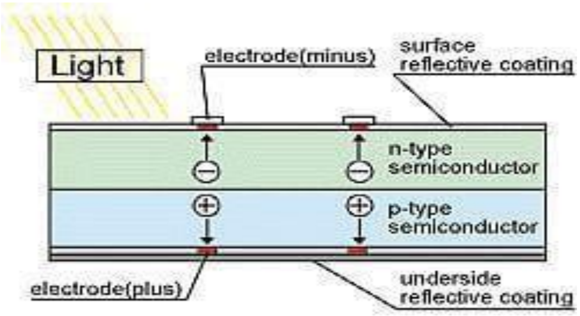

Figure working of solar cell

VII.II Battery
An electrochemical power source or battery is a device which enables the energy liberated in a chemical reaction to be converted directly into electricity. Batteries fulfil two main functions; they are portable sources of electric power and they are used to store the electrical energy. The primary cell or battery is a system whose useful life is ended once its reactants have been consumed by the discharge process. But the secondary battery is capable of being charged or recharged when its reactants have been used up. The spontaneous electrochemical reaction can be reversed by passing current through the cell in the opposite direction to that of cell discharge. It means the secondary battery might be considered as an electrochemical energy storage unit. For our application we select the lithium-ion battery because it came with less maintenance cost and more power efficient. Here we are using 12V 100Ah battery. We used two 12V 100Ah battery in series connection.

VII.III LEAD-ACID
Li-ion batteries, as one of the most advanced rechargeable batteries, are attracting much attention in the past few decades. They are currently the dominant mobile power sources for portable electronic devices, exclusively used in cell phones and laptop computers. Li- ion batteries are considered the powerhouse for the personal digital electronic revolution starting from about two decades ago, roughly at the same time when Li-ion batteries were commercialized. As one may has already noticed from his her daily life, the increasing functionality of mobile electronics always demand for better Li-ion batteries. For example, to charge the cell phone with increasing functionalities less frequently as the current phone will improve quality of one's life. Another important expanding market for Li-ion batteries is electric and hybrid vehicles, which require next- generation Li-ion batteries with not only high power, high capacity, high charging rate, long life, but also dramatically improved safety performance and low cost.

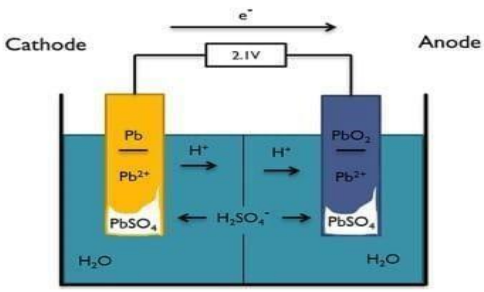

Figure. Chemical reaction in Lead acid battery

VII.IV Inverter
Inverter deals with following main tasks of energy: (ALTE store, n.d.)Convert DC from PV module to AC Ensure that the cycle of alternating current cycles is 60 cycles Reduce voltage variations Ensure that the condition of the AC waveform is suitable for the application

Most system-connected inverters can be introduced externally, and most of the Independent inverters are not weatherresistant. There are basically two types of grid intelligent Inverters: Those designed for batteries and those designed for systems without battery- connected inverter systems and give excellent void-quality strength. For matrix associations, the inverter should have a "useful-interactive" typeface, which is printed specifically for the publication name.

Grid-connected systems measure the power of extracting PV clusters rather than a bunch of prerequisite buildings. It asserts that what each power supply needs are what the matrix- related PV system can give naturally is drawn from the net.

VIII. OUTPUT WAVEFORM

An inverter may produce a square wave, modified sine wave, pulsed sine wave, pulse width modulated wave (PWM) or sine wave depending on circuit design. Common types of inverters
produce square waves or quasi-square waves. One measure of the purity of a sine wave is the total harmonic distortion (THD). A 50% duty cycle (on half of the time) square wave is equivalent to a sine wave with 48% THD.

Technical standards for commercial power distribution grids require less than 3% THD in the wave shape at the customer's point of connection. IEEE Standard 519 recommends less than 5% THD for systems connecting to a power grid.

VIII.I Square wave

This is one of the simplest waveforms an inverter design can produce and is best suited to low-sensitivity applications such as lighting and heating. Square wave output can produce "humming" when connected to audio equipment and is generally unsuitable for sensitive electronics.

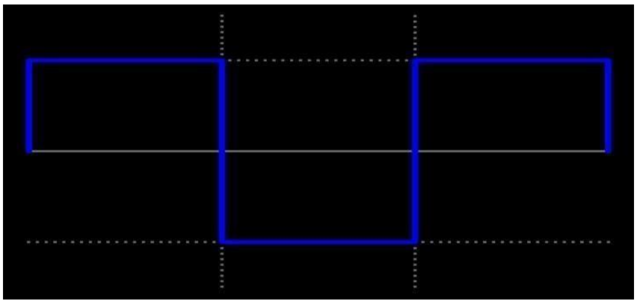

Figure. Square wave

VIII.II Sine wave

A power inverter device that produces a multiple step sinusoidal AC waveform is referred to as a sine wave inverter. To distinguish the inverters more clearly with outputs of much less distortion than the modified sine wave (three-step) inverter designs, the manufacturers often use the phrase pure sine wave inverter. Almost all consumer grade inverters that are sold as a "pure sine wave inverter" do not produce a smooth sine wave output at all, just a less choppy output than the square wave (two-step) and modified sine wave (three-step) inverters. However, this is not critical for most electronics as they deal with the output quite well.

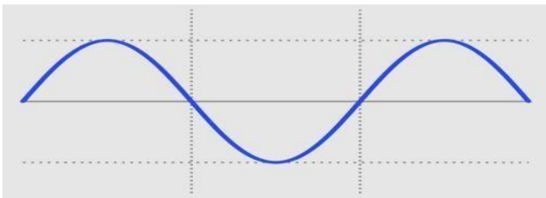

Figure. Sine wave

VIII.III Pure sine wave

Pure sine wave inverters are up to 2 times more expensive than a modified sine wave Werter. A pure sine wave inverter will transform direct current (DC) into alternating current
(AC) which can then be used to deliver high- quality electrical current (similar to utility standards, voltage: 230V, frequency: 50/60hz) to all sorts of home appliances. In addition, pure sine wave inverters are also transformers. They raise the input DC voltage, for example, 12V, to a much higher AC voltage, for example, 230V.

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IX. OUTPUT VOLTAGE

The AC output voltage of a power inverter is often regulated to be the same as the grid line voltage, typically 120 or 240 VAC at the distribution level, even when there are changes in the load that the inverter is driving. This allows the inverter to power numerous devices designed for standard line power. Some inverters also allow selectable or continuously variable output voltages.

X. RESULTS

➤ Aiming to the exact methodology, project will depict almost like in the block diagram
➤ Off grid PV solar system will be fully functional along with its facilities as desired.
➤ Major aim of the project will be electrifying the classrooms 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.

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