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RESEARCH ON: DESIGN OF SOLAR WALL ON APCOER BUILDING USING PVSYST SOFTWARE

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Abstract: The cost of urbanization and development in today's globalized world has led to an unforeseen depletion of conventional energy resources. The demand for these energy sources has reached its peak, but due to limited land resources, urban areas have transformed into concrete jungles with towering buildings. These densely populated urban centers heavily rely on traditional electricity sources, thereby significantly altering the natural environment. The combination of high population density and the rapid consumption of conventional electricity sources has resulted in alarmingly rising energy prices. Addressing this issue requires tackling the mounting pollution levels and exploring alternative energy sources such as solar electricity, which holds great potential for benefiting humanity. In this article, we will delve into the field of solar electricity technology, specifically focusing on photovoltaic cells and the utilization of PVsyst, an automated software, for evaluating its effectiveness post-installation.The power output, calculations, losses, and various parameters associated with solar electricity are meticulously calculated after installing the system on the south-east wall of APCOER building in Parvati, Pune, Maharashtra, India. This comprehensive evaluation aims to shed light on the performance and efficiency of solar electricity technology in a real-world setting.

***Index Terms* - performance evaluation, energy efficiency, renewable energy**

I. INTRODUCTION

India's abundant sunshine has led to the increasing recognition of solar energy as a crucial resource. The country possesses favorable climatic and geographical conditions, making it conducive for the development of photovoltaic solar systems. This research paper focuses on the design and cost analysis of a solar wall implemented at the APCOER Building in Pune, Maharashtra. The primary objective of this study is to effectively showcase the utilization of renewable solar energy in meeting the surging energy demands. Furthermore, it aims to evaluate the potential financial savings and reduction in electricity bills for the academy by minimizing the reliance on conventional energy sources.A photovoltaic (PV) system comprises various components, including a PV array, a battery, an inverter, and other essential elements for the installation of a solar device. This system functions by converting solar radiation from the sun into direct current (DC). To accommodate the use of AC loads, an inverter is required to convert the DC generated by the solar panels into AC power. By implementing this project, we can assess the financial savings achieved and contribute to a decrease in greenhouse gas emissions through the utilization of solar PV facades.

II. OBJECTIVES

1. Minimize environmental degradation.
2. Optimize the utilization of existing structures for clean energy generation.
3. Quantify the energy production through photovoltaic cell implementation

- **Methods**

1. Assess the energy requirements of the APCOER building.
2. Determine the necessary infrastructure area for solar panel installation.
3. Quantify the net energy output generated by the solar panels.
4. Substituting conventional energy sources with clean energy alternatives

When designing a photovoltaic (PV) system, power plants take into account several factors, including:

1. The average sunlight availability at the specific location of the installation.
2. The frequency of rainy or cloudy days at the site where the system will be deployed.
3. Data provided by the local weather department, including peak sun time, wind speed, occurrence of cloudy or rainy days, and potential natural disasters.
4. Ensuring that the installation site is free from obstructions such as tall buildings or objects that could cast shadows on the solar panels, thus reducing their efficiency.
5. Conducting a comprehensive analysis of the following aspects during system design:
   - Evaluating the local weather conditions to determine solar resource availability.
   - Assessing the current energy needs of the user and considering potential future requirements.
   - Placing emphasis on system efficiency while also accounting for energy consumption.
   - Factoring in construction costs, transportation logistics, and the prevailing construction conditions.

III. Site Location

Latitude: 18.49067 Longitude: 73.843521, Altitude: 555m above MSL.

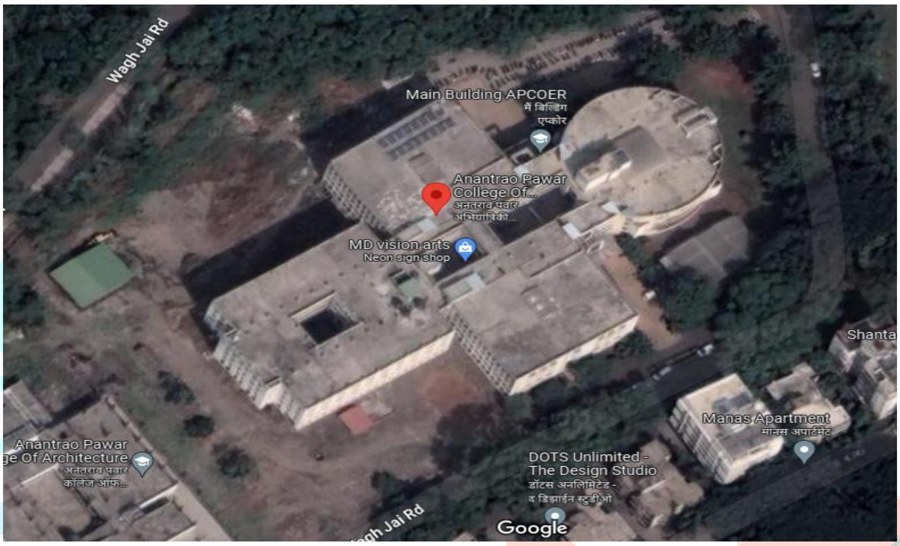

Figure 1: Site location

- PVsyst 7.2 is a computer software package developed by the University of Geneva specifically for studying, sizing, and analyzing comprehensive photovoltaic systems.
- The software is compatible with various types of PV systems, including on-grid (grid-connected), off-grid (stand-alone), pumped, and DC-grid (public transport) systems. It incorporates meteorological data, databases of PV system components, and a wide range of commonly used solar energy devices.
- With its features and functionalities, PVsyst 7.2 caters to the requirements of architects, engineers, and researchers.

IV. Limitations of the Study:

1. Power generation is not possible during nighttime as solar panels rely on sunlight.
2. The generated energy is in the form of direct current (DC), requiring conversion to alternating current (AC) for many applications.

V. Expected Outcomes:

1. Reduction in reliance on conventional energy sources.
2. Generation of clean and renewable energy.

VI. Components of a Solar Power System:

1. Solar Panels
2. Solar Inverter
3. Wires
4. Solar Panel Stand
5. Solar Charge Controller
6. AC loads
7. Surge Arrester
8. MC4 Connectors
9. ACDB (AC Distribution Box)
10. DCDB (DC Distribution Box)

VII. Connections of Solar Panels

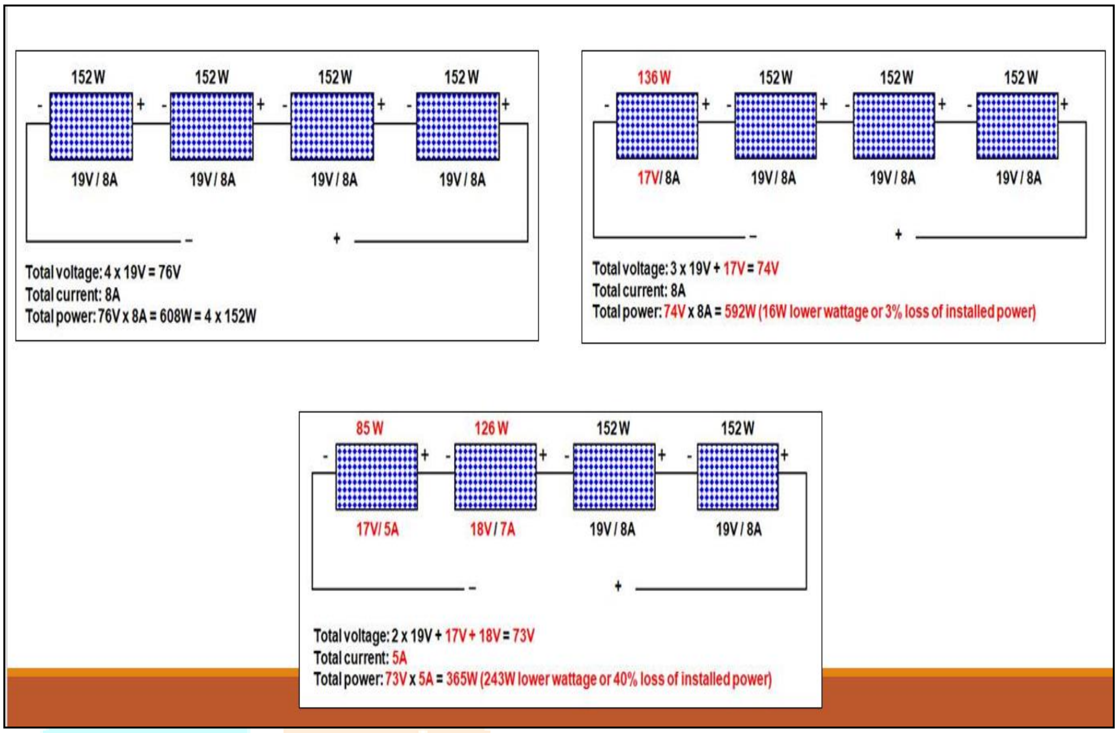

Figure 2 Connecting Solar Panels In Series Combinations

When connecting multiple solar panels in series, it is important to connect the positive post of one panel to the negative post of the next panel and continue this pattern. This series connection results in the voltage values of each panel being added together, yielding a cumulative voltage output. However, the amperage reading remains the same regardless of the number of panels connected in series.While it is generally not encouraged to connect different solar panels together, it is not prohibited either. However, it is crucial to carefully evaluate the electrical specifications (voltage, wattage, amps) of each panel to ensure compatibility. Manufacturers themselves are usually not the issue when connecting panels from different companies in series or parallel configurations. The main concern lies in potential conflicts between the electrical attributes and unique efficiency ratings of the solar panels.If the goal is to achieve increased output voltage, photovoltaic devices can be connected in series.

VIII. CONNECTING SOLAR PANELS IN PARALLEL COMBINATIONS

To achieve higher output current, solar devices are typically connected in parallel. Unlike series connections, where panels are connected in a chain, parallel connections involve connecting the positive terminals of all panels together and the negative terminals together. When connecting solar panels in parallel, there is a possibility that one panel may have a lower power output compared to the others. However, this will not significantly impact the total power output of the system as long as the voltage rating of that particular panel is similar to the other panels. It is important to ensure that the combined voltage of the series-connected modules is lower than the maximum input DC voltage of the inverter. When connecting different solar modules, the variation in power specifications is not a crucial factor. Instead, the current (for series connection) and voltage (for parallel connection) play a role in determining the system's efficiency. It is essential to consider the compatibility of current and voltage ratings to avoid any potential decrease in system efficiency.

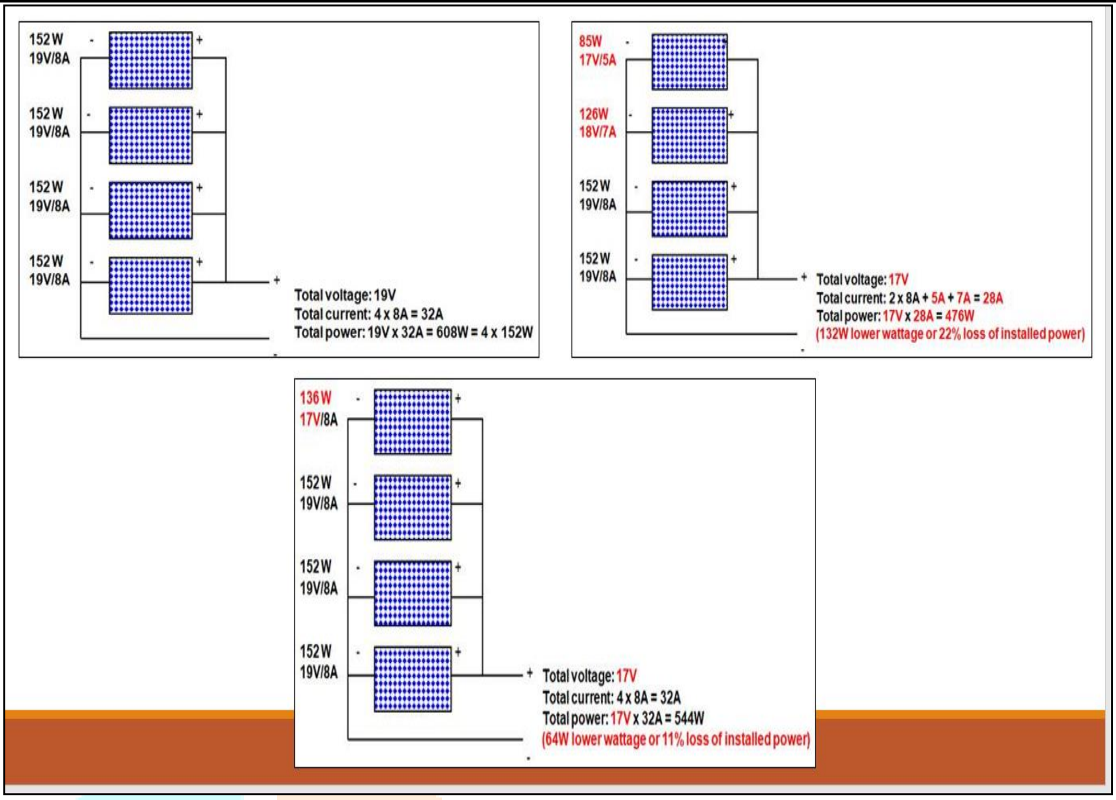

Figure 3: VIII. Connecting Solar Panels In Parallel Combinations

IX. INFRASTRUCTURE AREA CALCULATIONS

- When considering the installation of a Solar Wall, the ideal direction is South East. We also need to calculate the wall area for accurate placement.
- Wall Area = Length of the building (L) * Height of the building (H)
- Number of floors = 4
- Length of the building (L) = Floor width = 44m
- Height of the building (H) = (Floor area * number of floors) + (Slab thickness * number of slabs) + (Parapet wall) = 15.1m
- Total Area = 664.4 sqm
- Number of windows on each floor = 12
- Area to be deducted = (Area of windows) * (Number of windows on each floor) * (Number of floors) = 3.6 * 12 * 4 = 172.8 sqm
- Total available area = 664.4 – 172.8 = 491.6 sqm
- The Solar Wall can be installed on an available area of 491.6 sqm of the wall.

X. PVsyst SOFTWARE

PVsyst is a comprehensive software package designed by the University of Geneva for the study, sizing, and analysis of photovoltaic (PV) systems. It provides a range of tools and features to facilitate the design and optimization of PV installations.

Key Features of PVsyst:

a. Simulation and Modeling: PVsyst allows users to accurately simulate the performance of PV systems by considering various factors such as module characteristics, shading effects, temperature variations, and electrical losses. It provides detailed modeling capabilities to assess system performance under different conditions.
b. Energy Yield Assessment: The software enables the calculation of the expected energy yield of a PV system based on its location, orientation, tilt angle, and other site-specific parameters. It takes into account meteorological data, including solar radiation, temperature, and weather patterns, to provide realistic energy production estimations.
c. Component Selection: PVsyst offers extensive databases of PV modules, inverters, and other system components, allowing users to select the most suitable equipment for their specific project requirements. It includes comprehensive libraries with detailed specifications and performance characteristics of various manufacturers' products.
d. Financial Analysis: The software assists in evaluating the economic viability of PV projects by analyzing financial parameters such as payback period, return on investment (ROI), and net present value (NPV). It considers factors like system costs, maintenance expenses, incentives, and electricity tariffs to provide accurate financial projections.
e. Grid Integration and Grid Code Compliance: PVsyst aids in analyzing the impact of PV system integration on the electrical grid. It evaluates parameters such as voltage levels, power factor, harmonics, and grid code compliance to ensure seamless integration and adherence to grid regulations.

f. Detailed Reports and Graphical Outputs: PVsyst generates comprehensive reports and graphical outputs, including energy production profiles, meteorological data analysis, shading analysis, and system losses breakdown. These outputs facilitate a clear understanding of system performance and aid in project documentation and communication.

XI. Future Scope:

In the present era, there is a widespread discussion on carbon emissions and the implementation of technologies to minimize the carbon footprint in order to combat environmental degradation. Considering the current landscape and glimpsing into the future, clean energy is emerging as the primary preference for both developed and developing countries worldwide.There is substantial potential for extensive research to enhance the efficiency of existing solar systems. Additionally, efforts to reduce operational and installation costs in all regions, regardless of urban or rural areas, would be highly beneficial to humanity as a whole. Such advancements would serve as a valuable addition to the ongoing pursuit of sustainable energy solutions.

XII. CONCLUSION

In this study, we utilized PVsyst software to design an efficient grid-connected Solar PV Wall on the South-eastern wall of the APCOER Building located in Pune, Maharashtra, India. The installation area for the solar panels covers approximately 492 square meters, with a system capacity of 93.2 kWp.Upon implementing the Solar Wall, the projected energy generation will be 169 kWh/m2 and 83,037 kWh annually, contributing to nearly 30% of the building's total energy consumption throughout the year. This clean energy production is expected to reduce the carbon footprint by approximately 1,239.232 tons per year, resulting in a significant decrease in environmental degradation.

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