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A Review on Application of Solar PV Tree Design

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ABSTRACT: Owing to the exponential depletion of traditional fossil fuels, climate change, global warming and the ever rising need for electricity, the search for renewable and clean energy supplies has become one of the major challenges facing the world today. Energy from the sun is also considered the only energy supply that is plentiful and completely "free." The most common and established technologies of all the numerous technologies applied to harness solar energy is the photovoltaic processing of energy from the sun. Solar PV technology, considering its merits, has problems with land requirements (particularly in urban areas), performance capture and public perception (due to the absence of pleasing aesthetics).The efficiency of solar PV is dependent on local climatic conditions and solar radiation availability. The idea of a solar tree is capable of successfully solving these concerns with sophistication. An effort to study the implementation of the solar tree and its relation to Flat PV is illustrated in this article.

Keywords: Fossil Fuels, Photo Voltaic, Solar Energy, Sunlight, Tree, Renewable source.

INTRODUCTION

Owing to the exponential depletion of traditional fossil fuels, climate change, global warming and the ever rising need for electricity, the search for renewable and clean energy supplies has become one of the major challenges facing the world today. Utilizing modern technology like solar heating, solar photovoltaic, solar thermal electricity, solar fuels, solar design and artificial photosynthesis, solar energy consists of light and heat from the Sun and is harnessed. Photovoltaic (PV) systems constitute the most common use of solar energy. The efficiency of solar PV is dependent on local environmental conditions and solar radiation accessibility.The measurement and calculation of solar radiation is very useful for the proper construction of solar energy conversion systems. Sun ray incidence angles fluctuate during the day and during the year.

Solar modules mounted at a given angle cannot, thus, be entirely configured. The implementation of solar PV modules does have the responsibility of needing land that will always be a premium product, especially in urban areas restricted by land. Rooftop solar PV is an appealing choice, but there is also limited room for assembling modules in an array. Sun monitoring PV systems can be built, but since they are expensive and require maintenance, they greatly increase the overall cost of energy production. Building Integrated Photovoltaic Systems is a modern and exciting way to implement solar PV into the built environment. However, it could be important to provide more novel systems that combine performance, land requirements and general public acceptability. One such revolutionary idea could be solar PV plants. In this review article, to illustrate an effort to study the implementation of the solar tree and its relation to Flat PV[1].

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DISCUSSION

Basic components of a solar tree

• Photo voltaic modules: The maximum efficiency of solar cells made from silicon has been reported for domestic and commercial use, and 80% of the total solar panels sold around the world are reported to be made from silicon. Monocrystalline and polycrystalline solar cells were used in the first wave of solar cell technology, whereas amorphous silicon and thin film technology were integrated in the following. Any modern and exciting solar PV panel developments such as Copper Zinc Tin Sulfide Solar Cell (CZTS), Dyesensitized Solar Cell, Organic Solar Cell, Polymer Solar Cell, Quantum Dot Solar Cell, etc. are launched in the 3rd generation Silicon tends to be the most commonly utilized solar cell material, despite the availability of new innovations[2].

• Cables for connecting modules: Atmospheric conditions such as precipitation, snow formation, solar irradiation and high temperatures are subject to photovoltaic modules. There is a need for cables of outstanding mechanical strength for use in environments with high mechanical stress, dry and wet weather, higher temperature levels and high solar insolation, including in building with such a significant risk of explosions and burning, in order to provide safe links between the modules[3].

• Inverter: The aim of the inverter is to convert the DC voltage generated from the solar in to grid frequency of the AC voltage. The most significant feature of an inverter is conversion efficiency. It is possible to run advanced devices with a performance of about 98 percent. Other essential activities of the inverter are energy management, i.e. maximum power point tracking (MPPT), control of the PV plant's power output and protecting the plant by disconnecting it from the grid in the event of faults. Each panel receives a different irradiance in a solar tree, so it will have different I-V and P-V curves, and so the voltage fixed by the inverter will result in significant conversion losses.To prevent this from happening, a battery may be used to store energy and provide the inverter with continuous electricity[4].

• Batteries: The batteries utilised in solar energy systems should comply with "unstable grid power, heavy cycling (charging and discharging) and irregular full recharging" specifications. For years, deep-cycle battery are used around the planet in green and alternative energy systems. "Lead acid batteries, lithium ion batteries, lithium ion polymer batteries, nickel cadmium batteries and so on are among the commonly utilized battery systems in solar PV system implementations"[5].

• Steel structure: For the solar tree, there is no uniform framework, it can be built dynamically to make it appear appealing to the public eye and use less area while minimising the impact of shade on leaves/panels. One such novel style is that of the Solar Tree of Ross Lovegrove. The architecture of Ross Lovegrove consisting of a sinuous tree made of 5.5 m steel tubing, protecting a light bubble wherein 38 solar PV panels, each with a 38 watt peak rating, were attached to a secret 12 V battery grid that illuminated an array of 1 W LEDs at the end.

• Charging points/LED's: Throughout the day period, solar tree modules recharge battery and a basic process will automatically turn on their LEDs at evening hours. The amount of light emitted is controlled by an inner control circuit. To track and record the amount of light in the atmosphere, a picture sensor is used to activate the LED to ON at Sunset and eventually to

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OFF at Sunrise. For charging cell phones, computers and electric cars, the charge contained in the battery may also be used[6].

Comparative analysis of Solar PV Tree and Flat PV

There are several distinctions between the solar tree and the standard flat panel fixed tilt solar PV device on the field. In their simulation analysis (utilizing Monte Carlo simulations) on a solar tree, the analogy is planned using a solar tree design (hypothesised model) as described by Mazumderet. al. In their model, solar panels were directed to incoming solar irradiation at almost random angles, indicating that while certain panels (leaves) would experience grazing angles, other panels might face near normal incidence angles. Therefore, a solar system can successfully absorb sunlight during the day[7].

Power/area comparison

A comparison assessment was conducted out by using PVGIS simulation tools for a reference 5 kW solar PV tree and a 5 kW land-based fixed angle PV system for the city of Bhopal in central India (Latitude: 23°15'35 'North, Longitude 77°24'45' East)[54]. With altitude = 23 ° and azimuth = 112 °, and simulated with PVGIS software, a 5 kW land based fixed angle PV method was found. The annual average energy yield was equivalent to 6450 kW h. The energy yield of the Solar Tree was measured for different altitude and azimuth angles for each 1 kWp panel (each panel is a different combination of angles).Only for a single solar PV tree was the simulation carried out and estimated values of area specifications were taken. The ground area is the soil area required by the PV system, not the panels, and the only base area for the PV tree is taken into account. The results of the simulation showed that solar tree (6470 kW h) provided more power compared to land-based fixed angle PV system (6450 kW h). For a 1 kW of solar PV module, a simple rule of thumb is to consider 100 sq.ft of land area. The area needed for a solar PV tree is roughly 4 sq.ft, required for its base and foundation.It is observed that, while taking just 0.8 percent of the soil area, solar tree will provide about the same amount of energy as a fixed panel and based PV device. Therefore, in the case of a solar tree, a slightly lower volume (1 percent) of land is needed for the same amount of electricity[8].

Solar tree technique is applied to the following areas:

(1) Metropolitan district: To satisfy a house's everyday demand for electricity while using far less property. This is beneficial when land is limited in urban areas.
(2) Remote territories: Providing electricity to rural households that are not connected to the grid, as well as powering farm instruments and water pumps.
(3) Spa and Golf Course: Providing power for golf buggies, water fountains, lawn cutters and other devices for cleaning. The overall look of the resort can also be enhanced by the beautiful solar tree arrangement.
(4) Highways: This would otherwise cost a lot to bring grid electricity for lighting the highways to provide street lighting on the highway. It is possible to erect a solar PV tree on dividers in the centre of the highway.
(5) City Street Lights: To provide the street lights in the city with electricity. It is possible to erect a solar PV tree on the road side and it would not cause traffic or pedestrians any discomfort.
(6) Lighting the garden: To provide electricity in the garden and walkways for street lamps, thereby lighting and enhancing their appearance.

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(7) Parks of the Leisure Area: To supply electricity for maintenance equipment such as lawn cutters, movers, etc., as well as provide Wi-Fi hubs and mobile/laptop charging ports with power.
(8) Airports: The solar tree would provide energy when using much less land in order to provide the electricity needed at airports, since they already use large chunks of land for runways.
(9) Mountainous areas: To satisfy the energy requirements of mountainous communities that are off-grid. Unlike land-based Solar PV, the solar tree can be easily installed on rugged and messy mountainous terrain.
(10) Regions of the desert: To have street lights, shade (on the side of the road), to provide power to remote parts of the oasis, etc.
(11) Office parking spaces and Commercial Units: To supplement the industry's energy needs and boost the beauty of these otherwise dull-looking places. The working climate will be strengthened by this.
(12) Charging purposes: To have battery charging capacity that can be used to power different electronic devices, such as computers, cell phones, cameras, lamps, etc.
(13) Charging Hybrid cars (electric vehicles): To supply power for electric and hybrid car charging points. The promotion of safe and green transport.
(14) Data centres, ads and video screens: To supply ads and display boards with electricity and fuel the isolated information centres.
(15) Vending cabinets, machines for water coolers/tea/coffee.: To satisfy the criteria for power in vending machines, water coolers etc. [9].

CONCLUSION

The PV tree idea can be a suitable alternative for urban areas with fewer open fields, with land still being a valuable and limited resource for human activities. The aim of this analysis is to examine the different PV tree designs and suggest future research directions. The following primary inferences were made after a comprehensive literature review on PV Tree.

1. In terms of sunlight collected during the day, the PV tree can be more powerful than the conventional land-based solar system.
2. The effect on the solar tree of grazing angles of solar irradiation is lower.
3. In contrast to ground-based PV systems, PV tree addresses today's most pressing social, cultural and environmental needs with very less land footprint.
4. With the aid of exciting aesthetic results, solar tree architecture opens up new possibilities for urban lighting in smart cities with area restrictions, unlike conventional flat PV systems on land.
5. It is worthy that's used to provide the grid for a number of uses, including smartphone & laptop charging, street lighting, household supply, automotive supply, electric car charging and surplus electricity.
6. The architecture of the PV Tree can be a green technology prototype and opens up a large variety of research products in the world for the photovoltaic industry.
7. Further study is, however, necessary in the fields of MPPT techniques and solar PV tree inverters.

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