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Development of Solar Tree

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ABSTRACT—

These days, with a growing population and increasing energy consumption, we should choose sustainable energy sources while also remembering that energy shouldn't contribute to pollution or other environmental risks. For us, sunlight is the ideal choice in this situation. Given that India has a large population, we should make use of this energy, which can be produced with relatively little area. Solar tree might be the best choice for us in this situation. It may be used in industrial power supplies, street lighting systems, and other things. From an area perspective, it is far superior than the conventional solar PV system and is also more efficient. Thus, this is a great choice that ought to be put into practice. Solar energy is the greatest option these days due to growing population and energy needs for sustainable energy sources that shouldn't contribute to pollution or natural disasters. From an area perspective, a solar power tree is a far better and more efficient method of producing electricity than a standard solar Photo-Voltaic (PV) plant since it uses considerably less space. While it may be used to any kind of property, it focuses mostly on the creation of isolated and underdeveloped places when there are opportunities.

Keywords : Solar tree , Light system , Battery , inverter , Charging etc.

Introduction

It is a type of renewable energy source that can compete with fossil fuels in certain situations. Water movement energy is known as hydro power. In the US, it supplies around 96% of the energy from renewable sources. Hydroelectric power plants provide energy without using any resources or causing air pollution. Thermonuclear fusion is the method by which the sun, a hydrodynamic spherical ball of extremely hot ionised gases (plasma), produces energy. The estimated temperature of the sun's interior, where energy is generated by the reaction of hydrogen and helium, ranges from 8×106 k to 40×106 k.

Solar energy is widely accessible and regarded as the most straightforward and environmentally friendly way to access renewable energy sources. Solar thermal, solar photovoltaic, and solar architecture are the methods for directly converting solar energy into a form that may be used. However, installing huge solar collectors demands a considerable amount of room, which is the biggest issue with using solar energy. Despite the fact that solar panels take up a lot of area, we may construct a solar tree to circumvent this issue.

The innovative urban lighting idea known as "Solar Tree" is a superb example of the fusion of cutting-edge, environmentally friendly technology with innovative design. Solar Tree creates new opportunities for urban illumination by meeting the most important environmental, social, cultural, and aesthetic needs of the modern world.

Problem Formulation

since less land is needed When compared to a standard PV system, it requires less land. Therefore, we need a plant that can produce the most energy on the least amount of area. The main issue is that the solar panel doesn't function at night. It's really needy to overcome this. This might be applied to a wind turbine on the same configuration, as solar tree arrangement is more expensive than sensible solar positioning. Even though they are a free energy source, wind turbines are not frequently seen in cities.

Objective

We employ solar trees to generate extra electricity. Basically, these trees have solar panels installed in a Fibonacci sequence to maximise energy output while using minimal area.

• The primary goal of the suggested effort is to "use traditional free source of energy in unconventional way to increase the effectiveness of energy generation."

• To decrease the amount of land utilised for conventional solar system setup.

• To use solar trees to create electricity even at night.

Literature survey

- **Ayneendra B et.al. 2018 ,** There is a growing need on sources of clean energy that fail to contribute to emissions or dangers to the environment due to the expanding global population and rising energy demand. Solar energy stands out as the most viable substitute in this situation. In terms of area efficiency & overall efficacy, a solar power tree outperforms conventional solar Photo-Voltaic (PV) plants by effectively harnessing solar energy while taking up very little space. Because of its great adaptability, this technology may be used in a variety of environments, however it is especially well-suited for use in isolated, impoverished communities without access to power. With less area needed than with traditional techniques, solar trees provide a useful and affordable way to harness solar energy. In order to lessen or completely remove our clients' need on traditional electric energy sources, we are creating custom solar trees for each unique home in isolated locations. We are able to efficiently supply a household's energy demands by designing and installing solar trees on their land based on an analysis of their minimal power requirements.

- **Dr. N. N. Wadaskar et. al. 2020** , The social and economic development of each country is contingent upon its energy supply. While keeping in mind the constraints imposed by ecological, social, and economic factors, it is imperative to fully use domestic energy resources in order to decrease dependency on imported fuels. In order to fulfil energy demand and lessen dependency on fossil fuels, this is essential for developing research and development in addition to financing the renewable energy sector. Solar and wind power become more and more popular since they are abundant, portable, and simple to utilise to generate electricity. Currently, it is not financially viable to extend the grid in order to cover the rural population which is not electrified. Furthermore, oil prices will rise, and conventional energy solutions—like fuel-based systems—will progressively be dropped from agricultural growth agendas in favour of "Hybrid the authority Generation," or the generation of energy via wind and solar power, due to the unsustainable effects of this form of energy on users and the environment. This research presents the conceptualization of a hybrid energy producing system that combines solar and wind energy for usage by a house family in a remote area that is disconnected from the grid. It has been shown that the most effective choice for providing "high quality" power is to use hybrid systems.

- **Sumeet Mahesh Kajaniya , et. al. 2021 ,** Carbon dioxide is naturally converted to oxygen by trees.However, due to greed and selfishness, people are taking down trees and forests nowadays, and we are creating white cement forests in their stead. As a result, we people do not breathe clean air. The population is growing while the number of trees is declining. In this insane society, people are felling trees one after another and even chopping down hills to construct structures in order to make money. Although CO2 is harmful to people, trees are able to transform it into oxygen, which is necessary for human survival. This will cause issues with acid rain, global warming, respiratory illnesses, and many other things. But don't worry just yet—artificial trees will take care of this task later on. We must come up with a solution for each of these issues in order to either solve them or lessen their impact on the human population. And with our model, we want to offer it as the answer. With the use of renewable resources, our model can produce and release pure oxygen into the atmosphere. Furthermore, hydrogen gas is generated, stored, and may be utilised as fuel in the future. We think that this kind of design will help to address the lighting needs of both developed and emerging cities, in addition to helping to deliver clean oxygen to the urban environment.

- **K. Ramash Kumar , et. al. 2018,** With today's growing population and increased energy needs, renewable energy sources (RES) are essential. It's also important to remember that energy cannot result in pollution or other natural disasters. Among the many RES, solar energy is better appropriate for this. Given the dense population of India, solar energy has the advantage of requiring very little area to generate energy effectively. Large land expanses are required for PV system installations, and partial shade of the PV panels causes issues with voltage production. The biggest issue in cities, especially in India's metropolitan centres, is also a lack of land. To combat these negative effects, solar tree structure power generation (STSPG) is developed. Thus, a 120 Watt STSPG pilot plant's design and construction are presented in this article for an effective use of LED street lighting. The shrubs, plants, and trees that make up SPT's design framework include built-in structural elements that depict their leaves and their density in sunlight for photosynthesis. This article's approach takes into account how the STSPG's efficiency has enhanced with the aid of natural tree structure design. A range of environmental operating conditions was investigated for the STSPG prototype model intended for use in LED street lighting applications. As a result, it is a better choice for a power source in a variety of applications, including home and industrial power supplies. Solar energy is the process of directly converting sunlight into electrical power using photovoltaic (PV) technology or concentrated sunlight. A solar cell was a device that uses the photoelectric effect to convert light into electric current. SPT is a beautiful method of generating power from solar radiation. It employs several solar panels to create a tree-like shape. The panels are set up in a tall structure or pole in the shape of a tree.

- **Roshani B. Pawara et. al. 2020,** We should have access to renewable energy sources because of the recent increase in population and energy consumption, and these sources should not contribute to pollution or other natural disasters. The best option available to us under these circumstances is solar energy. The most creative method that uses the least amount of space to effectively create energy is a solar power tree. We may also increase the plant's efficiency by using the "0.3W Solar Modules." From a zone standpoint, it is significantly superior to a traditional solar PV framework and is also more efficient. This will be a really sensible choice that is carried out. The technique used to structure solar-powered trees is called spiralling phyllatography. This invention is used to increase plant efficiency. Thus, this will be a great substitute in general. However, installing a huge solar collector demands a lot of room, which is the biggest issue with using solar energy. We can also employ the process known as "SPIRALLING PHYLLATAXY" to enhance the plant's efficiency.

- **Swastik S. Awaze et. al. 2018,** PV system installations on flat surfaces or roofs require a sizable amount of land. The biggest issue facing Indian cities and even rural communities is a lack of land. A superior substitute for PV system flat mounting is the Solar Power Tree. When using a PV system for home illumination and other purposes, Solar Tree use makes more sense. This project involves the construction of a novel product termed a "solar tree," which uses solar energy to produce power output that is multiplied many times over. It may be put up on the sides of busy roads and on buildings with rooftops. The solar panel tree is made up of several panels that are linked to each other in parallel and series. A solar panel is fixed on each stem of the solar tree, which is made up of several branches that are welded to it. Voltage in series or current in parallel connections are added.

Concept And Methodology

A. Block Diagram

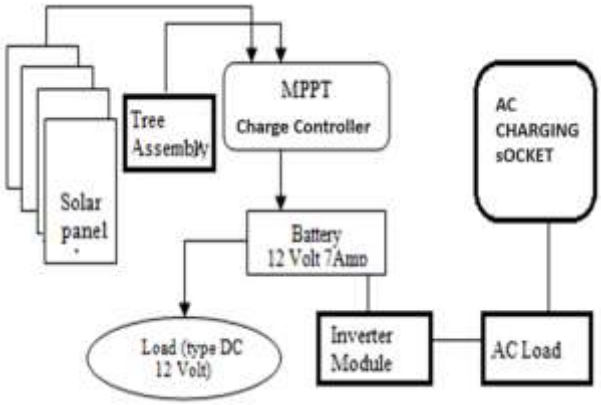

Fig.1. Block Diagram of system

B. Working of system

In this study, we have shared our belief that the Solar Tree idea for home electrification is a significant step towards lowering electricity costs and reducing reliance on India's increasingly unstable grid power. Additionally, it offers an alternative to fossil fuels to lessen global warming. The small family's energy consumption (load) is taken into account when calculating the suggested system's capacity and the sizes of its component parts. When compared to typical systems, it can create energy quite efficiently.

The tall pole with spiralling phyllotaxy will be fitted with solar PV modules, and the load distribution across the pillar will be adjusted to balance the system. Simultaneously, the design is such that throughout the day, the upper panels won't obstruct the bottom screen from receiving the most sunlight possible. In order to get the most amount of solar energy possible during the day, the panels will be angled towards the sun as needed. There are five primary components that make up the Solar Power Tree. Throughout the day, the PV panels are mechanically moved by the solar cells, a long pole, LDEs, batteries, and stems to connect the panels so that they are always facing the sun.

A semiconductor of the p-type and a semiconductor of the n-type make up a solar cell. Two different sorts of electrons are produced in the semi-conductors by solar light striking the cell: both positively and negatively charged electrons. The n-type semiconductor is surrounded by negatively charged (-) electrons, whereas the p-type semiconductor is surrounded by positively charged (+) electrons. Electric current travels between both electrodes when loads, such light bulbs, are connected. First of all, keep in mind that solar light, not heat, is what powers panels. In actuality, under excessively hot circumstances, most solar panels lose some of their efficiency.

Sunlight is converted into DC power by solar panels. Electrons are released from the silicon cell in a solar panel when photons from sunshine impact it. With the aid of an electric field, the liberated electrons fly around and produce energy in the process. In a conventional setup, each panel on your tree is connected by a string, which carries electrons that eventually travel to the inverter for the sun or battery. Solar tree power is utilised for a variety of purposes, including as lighting and phone charging.

Calculation

- **Peak Watt Power**

With the charge controller's efficiency at around 85% and the battery bank and wiring loss at roughly 3% in mind. The PV module's energy requirements: E

$$E = \frac{1}{(\eta \text{ battery } \times \eta \text{ charge controller } \times \eta \text{ wiring })} \quad \ldots\ldots\ldots\ldots\ldots 1$$

$$= \frac{1}{(0.85x\ 0.85x0.97)}$$

= 1.42

= 1.40 approximately.

Hence, energy from module (PV array): EA

EA = FL x 1.4 … ……(2)

Where, FL= Estimated average daily energy consumption in Wh/ day.

Hence, P array = 228Wh x1.4

= 319.2Wh/day

= 320Wh/day (approximately)

The peak watt rating of module for solar tree system will be,

$$W_{peak} = \frac{P\ array}{Average\ \ daily\ sun\ hour\ on\ tilted\ \ surface\ \ at\ latitude}$$ ……..3

$$W_{peak} = \frac{320}{6}$$

W peak = 54 WP

- **Total Array Current (I dc)**

The total module current: Idc

$$I_{dc} = \frac{Peak\ \ watt\ \ rating}{system\ \ \ voltage}$$ ……4

Where, Peak rating: W peak

System voltage: Vdc

$$= \frac{54}{12}$$

= 4.5A

- **Array Size**

The number of modules in series: N mp

$$N_{mp} = \frac{I\ dc}{I\ mpp}$$

$$= \frac{4.5}{2.8}$$

=1.607

The total amount of units in the series, rounded above the calculated value, is 2. The quantity of parallel-connected modules: N mp

$$N_{ms} - \frac{Nominal\ \ system\ \ voltage'\ (V\ dc}{U\ mpp}$$

$$= \frac{12}{2.1089}$$

= 6 (approximately), 6 modules will be in parallel. Total array size = 6 x 2 = 12.

Battery Bank Size

The total DC load requirement $= \frac{P\ array}{system\ \ voltage}$

$$= \frac{120}{12}$$

= 10A Considering battery autonomy for two day total requirement = 10A

Considering battery efficiency and depth of discharge (DOD) equal to 80%, Battery capacity

$$= \frac{10}{2(0.8 \times 0.8)}$$

= 7.8A = 8A (approximately)

- **Charge Controller Capacity**

The factor of safety (Fsafe) is necessary in order to allow for a reasonable system expansion.

Thus, the desired charge controller current (Icc) is as given by the equation,

$$I_{cc} = I_{scm} \times N_{pm} \times F_{safe}$$

Where, I cc = charge control current

I scm = short circuit current of the selected module

N pm = number of modules in parallel

F safe = safe factor

I cc = 3.04 x 5.84 x 1.3

= 23.07

= 24A (approximately)

Advantages

• Environmentally Friendly: Using solar power is one of the "greenest" ways to produce electricity, and for good reason. There is no concern about the depletion of yet another substance because they function by interacting with sunlight, a renewable energy source.

• Low Maintenance: solar energy systems are really easy to operate and don't require any moving components. Once correctly configured, they require no adjustments and will function for many years. In actuality, the panels from several manufacturers come with 25-year guarantees.

• Lower Electricity Bill: You will see a monthly savings on your electricity expenses when you convert to solar power. You will feel secure in the knowledge that your energy costs will not increase even if they do in the coming months source is based on solar power.

•High Efficiency: You can probably utilise solar panels to successfully meet your power demands no matter where in the world you reside. The newest variants of these resilient and climate-adaptable panels are efficient enough to function even when not facing straight south; some of them can even generate energy when covered in clouds.

• Extremely low land requirement: Compared to a standard solar system, it requires significantly less area, making it the ideal alternative for energy generation. Thus, we need a plant that can produce the most energy on the least amount of area.

No matter who you are and what kind of house you own, one of the finest methods to give yourself and your family electricity without further harming the environment is through solar power. The cost savings from solar panel installations may be utilised in a variety of ways. In addition to saving you money by reducing the amount of energy you need to purchase from the energy supplier, it could also enable you to lock in a cheaper solar power rate. You may reduce your overall cost for all of your electrical consumption by utilising the energy generated by your unit during the day, when rates are at their highest, and using the electricity company's power in the late hours, when rates are at their lowest.

Disadvantages

1. Operating and maintenance cost is high

2. May cause hazards to the birds and insects

3. Hazards to eyesight from solar reflectors

Applications

1. Street lights
2. House supply
3. Industrial power supply

4. Charging solts for E Vehicles
5. Mobile charging

Results & Discussion

A brand-new 120 watt STSPG prototype plant for effective LED street lighting installation under various operating circumstances is shown in this section. The output example of the created model is displayed in Fig. 9. This statistic indicates that the LED provided a good amount of light at night. The study of the developed model under various climatic circumstances is shown in Table 2. Ultimately, in sunny conditions, the proposed STSPG (1x1) square foot of LED street lighting has generated a maximum output of 90 Watts, 16V, and 5.6A. Table 3. compares the power generation of solar tree configurations versus flat setups. This table makes it evident that, when compared to a flat plate arrangement, the planned STSPG has generated good electrical power with the least amount of land area.

Table. 2. Analysis of the designed model at various climatic operating conditions with fixed battery voltage =14V

Sl. No.	Weather Conditons	Charing Current for battery (A)	
		Minimum	Maximum
1	Cloudy	2	4
	Mormal	4	7
	Noon	5	8

Table. 3. Comprehensive analysis of the STSPG and flat plate arrangement

Parameters	Flat plate arrangement	Solar tree arrangement
Power Output (W)	85	90
Voltage(V)	17	16
Current(A)	5.31	5.6
Land area (sq. feet area)	(10x10)	(1x1)

This article presents the design and construction of a revolutionary 120 Watt STSPG pilot plant for the successful demonstration of a prototype model for efficient LED illumination in the street application. This article's discussion of solar technology will yield efficiency that is almost competent. Compared to other buildings, the planned solar structure made of trees is particularly effective at avoiding shadows, producing more electricity throughout the day, and conserving land space. There are no issues with power outages at night when the produced power is coupled to LED lighting applications. In this case, LED street lighting is utilised due to its lower power consumption and luminous efficiency, which ranges from 80% to 90% when compared to conventional lighting. The planned model's dimensions are (1 x 1) square feet, and its production will cost 25k rupees. maximum power of 90 Watts. Also, it can be connected to the grid for electricity under construction.

Conclusion

This project is highly effective in meeting the growing need for electricity among people while conserving land.This can supply electricity without the need for a power outage.The solar tree can readily supply us with extra energy, which we can use to power our electric cars and improve the environment in an environmentally beneficial way.

In the conventional approach, a substantial area of land is needed to produce a negligible quantity of power. About 1% more land is needed than under the conventional arrangement. Solar energy is widely accessible and regarded as the most straightforward and environmentally friendly way to access renewable energy sources.Solar thermal, solar photovoltaic, and solar architecture are the methods for directly converting solar energy into a form that may be used. However, installing huge solar collectors demands a considerable amount of room, which is the biggest issue with using solar energy. Despite the fact that solar panels take up a lot of area, we may construct a solar tree to circumvent this issue.

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