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SOLAR POWER TREE: A SUSTAINABLE INNOVATION IN ENERGY HARVESTING

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Abstract: The Solar Power Tree is a cutting-edge method of capturing solar energy and gives a possible response to the increasing global demand for renewable energy sources. The Solar Power Tree's concept and advantages are examined in this abstract. It consists of a central pole that resembles the trunk of a tree with several solar panels organized in a radial pattern, simulating the canopy of a tree. This design uses the least amount of land possible while maximizing energy capture, making it the best option for confined urban spaces. The Solar Power Tree has a number of benefits, including improved energy efficiency, a smaller environmental impact, and adaptation to different environmental factors. Its sophisticated design is also aesthetically pleasing and blends in well with urban environments. Additionally, because of its scalability and modular design, it is appropriate for both small-scale residential.

Keywords: *Solar Power Tree, Solar Panels, Sustainability, PV Module, Energy Harvesting.*

1. Introduction:

A necessity in light of the environment's problems and the rising demand for energy is the search for sustainable and renewable energy sources. The Solar Power Tree, a ground-breaking invention that aims to address these issues while enhancing the aesthetics of our urban and rural environments, stands out in this setting. This research paper explores the idea, design, advantages, drawbacks, and restrictions of the Solar Power Tree in order to give readers a thorough grasp of its potential as a reliable and effective energy harvesting device.

The Solar Power Tree unites two crucial components: the traditional and symbolic shape of a tree and the most advanced solar energy producing technology. While solar power epitomizes the renewable energy revolution and offers a way towards a greener and more sustainable future, trees have long been used as a symbol for life, growth, and environmental balance. The Solar Power Tree idea captures the best of both, demonstrating how nature-inspired biomimicry design may transform the clean energy industry.

The Solar Power Tree is the subject of this essay's investigation, which starts with a look at its historical development, modernization, and widespread application. Then it digs into the precise intricacies of its construction, highlighting the special configuration of solar panels, the layout of the supporting framework, and the incorporation of energy distribution and storage systems.

The advantages of the Solar Power Tree are highlighted in the benefits section, with a special emphasis on how well it uses the land it occupies, the harmony it creates between urban and rural areas, and its potential to increase energy production through the use of hybrid systems and tracking devices. Although the Solar Power Tree has a lot of potential, it is not without difficulties and restrictions. This study examines the engineering and upkeep issues it raises, taking into account the need for structural integrity, cleaning, and maintenance, as well as the economic factors, such as initial costs and return on investment.

The Solar Power Tree is the meeting point of environmental awareness, technical advancement, and aesthetic fusion and has the potential to completely alter how we gather and distribute energy. Its attractiveness stems not only from its power to provide sustainable, clean energy but also from its ability to infuse our surrounds with life and beauty. This article intends to shed light on the potential and

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constraints of the Solar Power Tree, highlighting its contribution to creating a more environmentally friendly and aesthetically beautiful energy future as we navigate a world in transition.

2. Literature Review:

1	Chandel, S. S., & Agarwal, S. (2011)	Review of solar photovoltaic water pumping systems for irrigation and community drinking water supplies.
2	Tiwari, G. N., Sodha, M. S., & Chandra, A. (2006)	Environmental impact assessment of centralized and decentralized energy systems.
3	Chen, H., Cong, T. N., Yang, W., Tan, C., Li, Y., & Ding, Y. (2016)	A critical review of electrical energy storage systems.
4	Al-Saadi, S., Al-Jabri, K., & Al-Hinai, H. (2017)	Comparative review of various solar technologies.
5	Goetzberger, A., Hebling, C., & Schock, H. W. (2003)	Overview of photovoltaic materials and their past, present, and future.
6	Zhang, G., Li, X., Chen, L., & Zhang, L. (2015)	Current status and future prospects of solar photovoltaic (PV) energy.
7	Liu, B., Wang, R., Zeng, J., He, G., Liu, Y., & Xing, F. (2017)	Review of photovoltaic/thermal hybrid solar technology.
8	Panda, S. K., Akolkar, A. B., & Akolkar, R. (2013)	Review of research and development in air-cooled condensers.
9	Mellit, A., & Kalogirou, S. A. (2008)	Development of an artificial neural network-based model for estimating the power produced by photovoltaic panels.
10	Li, G., & Lou, Y. (2018)	Key issues in lithium-ion battery management for electric vehicles.
11	Fthenakis, V. M., & Kim, H. C. (2012)	Life-cycle analyses of photovoltaics.
12	Pearce, J. M. (2002)	Analysis of photovoltaic performance and environmental cost.
13	Sartor, D., & Falcey, J. (2009)	Introduction of a "Solar Tree" patent.
14	Garg, H. P., & Agarwal, R. K. (2017)	A manual on solar photovoltaic technology and systems.
15	Hussain, A., & Khan, A. (2015)	Comparative study of grid-connected solar tree vs. conventional PV systems.
16	Guarracino, I., Cesare, D., & Nasta, S. (2019)	Introduction of an innovative tree-shaped structure with thin-film photovoltaic modules.
17	Razali, M. A. A., Abdollah, M. F. B., Hasim, M. M., & Sulaiman, S. A. (2019)	Development of solar energy trees for distributed energy generation.
18	Wang, W., Zhao, Y., Liu, X., Yu, J., Yuan, H., & Zhang, W. (2017)	Experimental investigation of a novel bifacial bifacial solar tree for urban areas.
19	Cucumo, M. A., Ferraro, A.,	Introduction of a renewable energy tree for smart

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	Hava, A., & Iannuzzi, D. (2018)	cities.
20	Rahman, M. M., & Ali, M. H. (2020)	Development of an innovative solar tree with an integrated storage system for smart cities.
21	Akoshile, C. O., Soomro, S., Zhao, Y., Li, H., Li, X., & Zhang, G. (2018)	Introduction of a novel double-layer rotational sun-tracking solar tree.
22	Kadam, P., & Rane, K. S. (2017)	Introduction of an innovative solar tree with a dynamic tracking system.
23	S. Khatoon and H. Khan (2017)	Comparative study of Fibonacci pattern and conventional pattern of solar cells.
24	H Khan, P Gaur (2015)	Design of a solar tree with photovoltaic panels using the Fibonacci pattern.
25	Snigdha Sharma, Lokesh Varshney, R.K. Saket (2022)	Comparative evaluation of novel configurations under shading conditions.
26	Kanhaiya Kumar, Lokesh Varshney, A. Ambikapathy, R. k. Saket, and SAAD MEKHILEF	Review on Solar Tracker Transcript.
27	Kanhaiya Kumar, Lokesh Varshney, A. Ambikapathy, Vrinda Mittal, Sachin Prakash, Prashant Chandra, Namya Khan	Study on Soft Computing & IoT based Solar Tracker.
28	Kanhaiya Kumar, Lokesh Varshney, A. Ambikapathy, Inayat Ali, Ashish Rajput, Sajal Omar	Vision-based solar tracking system for efficient energy harvesting.
29	Snigdha Sharma, Lokesh Varshney, Raj Vikram Madurai Elavarasan, Akanksha Singh S. Vardhan, Aanchal Singh S. Vardhan, R.K. Saket, Uma Shankar Subramaniam, Eklas Hossain	Performance enhancement of PV system configurations under partial shading conditions using MS Method.
30	Lokesh Varshney, Aanchal Singh S. Vardhan, Akanksha Singh S. Vardhan, Sachin Kumar, R.K. Saket, P. Sanjeev Kumar	Performance characteristics and reliability assessment of self-excited induction generator for wind power generation.
31	Kanhaiya Kumar, Tanya Aggrawal, Vishal Verma, Suraj Singh, Shivendra Singh, Dr. Lokesh Varshney	Modeling and simulation of a hybrid system.

3. Benefits:

The Solar Power Tree is a promising alternative for generating sustainable energy because of its cutting-edge design and effective energy-harvesting capabilities. The following advantages have been examined

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and underlined in this study paper:

Efficiency of Land Use:

The Solar Power Tree efficiently uses vertical space to maximize land utilization. Its tree-like design reduces the ground footprint, making it possible to place solar panels in spots with little room. This advantage is particularly significant in metropolitan locations, where there may not be as much acreage available for solar installations and where the Solar Power Tree may easily be integrated into existing infrastructure.

Aesthetic Integration:

The Solar Power Tree offers an aesthetically pleasing and visually appealing design, resembling a natural tree. Its elegant and artistic appearance allows it to blend harmoniously into various environments, including Universities, parks, urban plazas, and streetscapes, enhancing the visual appeal of these spaces while simultaneously generating clean energy.

Enhanced Energy Generation:

The Solar Power Tree often incorporates tracking mechanisms that allow the solar panels to follow the sun's path throughout the day. This tracking capability significantly increases energy generation by ensuring that the panels are always oriented to receive maximum sunlight.

Urban Heat Island Mitigation:

In urban areas, the shade provided by the Solar Power Tree's canopy can help mitigate the urban heat island effect. The cooling effect from the shade contributes to a more comfortable outdoor environment, reducing the energy demand for cooling systems.

Fig.1. Solar Tree Structures

Versatility in Energy Applications:

The electricity generated by Solar Power Trees can be harnessed for a variety of applications, including lighting, charging stations, and powering small devices. This versatility makes them valuable in public spaces, enabling energy access for a range of purposes shown in figure 1.

Reduction of Carbon Emissions:

Solar Power Trees contribute to the reduction of greenhouse gas emissions by generating clean and

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renewable electricity. The decrease in reliance on fossil fuels for energy generation has positive environmental implications, particularly in the fight against climate change.
Minimal Environmental Impact:
The construction of Solar Power Trees typically has a minimal environmental impact compared to traditional energy infrastructure, as they avoid excavation and ground disturbance. Additionally, their design can incorporate sustainable and recyclable materials.

4. Applications:

In this research paper it is essential to explore the diverse applications of this innovative technology. Solar Power Trees offer a range of practical and versatile uses, making them valuable assets in various sectors. The following are the applications to provide a comprehensive view of their potential:
Urban Landscapes:
Solar Power Trees can be strategically placed in urban environments, including parks, plazas, and streetscapes, to provide clean energy while enhancing the visual appeal of the city. They offer shade, seating, and mobile device charging stations, creating functional and eco-friendly urban spaces.
Residential Areas:
Solar Power Trees are adaptable to residential settings, offering homeowners an aesthetically pleasing renewable energy solution. They can provide clean electricity for households and contribute to reducing energy bills.
Educational Institutions:
Educational institutions can benefit from Solar Power Trees as a tool for teaching renewable energy concepts. These installations can serve as educational hubs, demonstrating the integration of science, technology, and sustainability.
Recreational Spaces:
Solar Power Trees can be installed in recreational areas, such as sports fields and playgrounds, to power lighting and amenities. They support outdoor activities while minimizing the environmental impact.
Community Parks and Gardens:
Solar Power Trees in community parks and gardens can offer renewable energy for lighting and irrigation systems. They create environmentally friendly and energy-efficient spaces for communal gatherings.
Charging Stations:
Solar Power Trees can serve as charging stations for electric vehicles and mobile devices. Their dual function of energy generation and device charging makes them highly practical in public locations and parking lots.
Rural and Off-Grid Areas:
Solar Power Trees can be deployed in remote or off-grid regions to provide access to clean energy. They can be a valuable energy source for agricultural applications and small-scale businesses.
Emergency Power Supply:
Solar Power Trees equipped with energy storage capabilities can serve as reliable emergency power sources during grid outages and natural disasters. They contribute to disaster preparedness and response efforts.
Transportation Hubs:
Solar Power Trees can be installed at transportation hubs, such as bus stops and train stations, to power lighting, digital displays, and electric vehicle charging stations. They contribute to energy efficiency in the transportation sector.
Water and Wastewater Facilities:
Solar Power Trees can be integrated into water and wastewater treatment plants to provide renewable

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energy for water purification and pumping processes. They help reduce the carbon footprint of water treatment operations.

Agriculture and Horticulture:

Solar Power Trees can be employed in agricultural and horticultural applications to power irrigation systems and lighting for greenhouses. They enhance the sustainability of farming practices.

By exploring these applications, the research paper underscores the versatility and adaptability of Solar Power Trees across various sectors, highlighting their potential to address energy needs while promoting sustainability and environmental consciousness.

5. Construction of the Conventional PV System

Conventional PV system is a 10 horizontal panels fixed with a card board in a simple way. One card board has been used to attach all the panels using glue.5-5 panels had connected in series and the combination of 5-5 panels was connected in parallel. One switch has been connected to the panels series parallel combination output to measure the value of open circuit voltage and short circuit current. Then the switch has been connected to the DC motor, and to an inverter circuit. Then inverter circuit has been connected to a holder to glow a CFL by converting DC into AC. The card board was placed at 45° so that maximum power can be calculated. Figure 3 shows the model of conventional solar system.

The open circuit voltage and load current have been measured of the conventional solar system. Then power has been calculated by using measured values of voltage and current in the systems. The analysis of power between 10 horizontal panels attached with a conventional solar structure on the card board from 9:00 AM to 12:30 Noon are represented in Table I.

Fig. 2 Hardware for conventional solar system.

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TABLE I. Calculation for solar system.

Calculations for Conventional Solar System	
Energy at a point	$62.4\,mVA$
Energy for an hour	$0.0624 \times \frac{3600}{1000} KWh = 0.224 KWh$
Total	$0.224 \times 8 = 1.79 KWh$
Panels required for 1KWH	$\frac{10}{1.79} = 5.586$
Panels required for 2MWH	$5.586 \times 2 \times 1000 = 11173$

6. Conclusion:

The Solar Power Tree represents a remarkable marriage of two distinct yet interrelated worlds: the natural elegance of a tree's form and the cutting-edge technology of solar energy harvesting. This union has the potential to revolutionize the way we perceive and harness renewable energy.

The Solar Power Tree concept has come a long way, and its potential is undeniable. It offers a unique blend of sustainability, aesthetics, and innovation that aligns with the global transition toward cleaner and more environmentally conscious energy solutions. However, to fully harness its potential, continued research and development are imperative. Technological advancements, innovative engineering solutions, and economic incentives must converge to mitigate the constraints and further enhance the benefits of the Solar Power Tree.

In conclusion, the Solar Power Tree is a symbol of what is possible when human ingenuity harmonizes with nature's wisdom. It has the power to transform urban and rural landscapes, providing not only clean energy but also an opportunity to educate and engage communities. As we look to a future where renewable energy is not just a necessity but a way of life, the Solar Power Tree stands as a testament to our commitment to sustainability and a greener, more vibrant world. Its journey has just begun, and as it continues to evolve, it promises to play a pivotal role in shaping the sustainable energy landscape of tomorrow.

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