

Solar Tree: A Sustainable Energy Approach for Farmers

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SUMMARY

Sunlight is crucial for synthesis of food in plants through a process known as photosynthesis. There is similarity between photoelectric effect and photosynthesis. Agriculture is an energy intensive sector as there is a need of electric as well as fuel energy to perform different activities like irrigation, ploughing, harvesting etc. We are still dependent on conventional modes of energy (coal, crude oil etc.) for all these purposes. The conventional modes of energy production cause damage to the environment. Use of sunlight for production of clean and sustainable energy could be very beneficial for agricultural sector, thereby directly benefiting the farmers. Researchers have developed different designs of solar panels to capture the sunlight and its conversion into electric energy. One of the most important design is “solar tree” which requires very less land area to establish and could produce sufficient amount of energy. The coupling of land use and energy generator could be a sustainable energy solution for farmers.

INTRODUCTION

Most of the population of India live in rural area and is mostly dependent on agriculture. There are so many agricultural products being produced every year by rural population. These agriculture products require a lot of human resources as well as energy inputs. A ladder approach and three levels of classification may be used to understand the energy needs of the agricultural industry Dupraz, et al., 2011. Basic human energy, which is utilized for cultivation and harvest processing without the assistance of an external fuel source, is the main energy input into agriculture. The use of energy from other living organisms or from natural resources is the next stage of energy usage Kumar, M., 2014 and Nonhebel, 2005. Agriculture leads to production as well as consumption of energy. As the world’s population is increasing, the demand of agricultural products is also increasing. To produce agricultural products at such a large scale, there is requirement of a large amount of energy. India still depends heavily on Coal as the major source of energy. During the FY:2020-21(P) energy generated from Coal accounted for about 73% of the total energy generated followed by Crude Oil (8.59%) and Electricity (from Hydro, Nuclear and other Renewable energy sources)(8%) (Fig. 1). The estimated electricity consumption increased from 7, 85,194 GWh during 2011-12 to 12, 27,000 GWh during 2020-21(P), showing a compound annual growth rate of 5.09%. Out of the total consumption of electricity in 2020-21(P), industry sector accounted for the largest share (41.09%), followed by domestic (25.67%), agriculture (17.52%) and commercial sectors (8.31%)

Components of solar tree

Photo voltaic modules:

Most of the solar cells produced for domestic and commercial use are made up of silicon because of its high efficiency. Mono-crystalline and polycrystalline solar cells were the first generation of solar cell technology, whereas amorphous silicon and thin film technology comprised second generation of solar cell technology. The third-generation solar cell technology includes Copper zinc tin sulfide solar cell (CZTS), Quantum dot solar cell, Organic solar cell, Polymer solar cell etc. Sugathan 2015.

Cables for connecting modules:

Solar tree has to withstand under harsh environmental conditions during different seasons like rainfall, snow accumulation, high temperature etc. So, it is very important to have secure connection between the modules with the help of high strength wires which are capable of holding high mechanical tension in different weather conditions.

Inverter:

Solar panel produces DC voltage and inverter is used to convert this DC voltage into AC voltage and power optimization. Every panel in a solar tree receives a distinct amount of irradiance, which causes it to have a distinct I-V and P-V curve. As a result, the voltage set by the inverter will cause significant conversion losses. Using a battery to store energy and provide steady power to the inverter can solve this problem Hyder, 2018.

Batteries:

Batteries are used to store the energy generated by solar grid. Lead acid batteries, lithium-ion batteries, lithium-ion polymer batteries, nickel-cadmium batteries, etc. are some of the batteries that are often used in solar PV system applications Sukumaran and Sudhakar, 2017.

Steel structure:

Solar panels are fixed on the branches connected to a steel structure. The solar tree doesn't have a specific structure; rather, it may be imaginatively constructed to look good, take up less space, and prevent shadowing of the leaves or panels. The height, width and no. of branches on steel structure could vary depending upon the space and requirement.



Fig. Structure of Solar Tree

Applications of solar tree in agriculture**Rural area and agriculture**

Many homes are still not connected into the main grid, which prevents them from meeting their daily electrical needs. A solar tree can also be placed simply to provide electricity to those homes as well as to power the water pumps, tractors, tillers, and other agricultural equipment. Conventionally, farmers dry the crops and grains by spreading them under sunlight, which makes the crop/grains exposed to elements such as wind, dust, and animals such as rodents. So, the energy generated by solar tree can be used for drying grains or crops to avoid contaminations.

Streetlights

Numerous accidents occur on highways and in the surrounding areas because of lack of light at the night hours. Therefore, it is very important to install streetlights along the roads, solar tree is the greatest alternative to prevent accidents by giving street lighting on the dividers on the center of roads and nearby towns.

Public parks and gardens

Public parks and gardens are often visited by people in evening and early morning. During this period there is also danger of reptiles, muddy surface, other accidents etc. So, solar tree powered lights could be used to avoid such accidents. This will reduce the dependence on other conventional energy sources. Sometimes, as a result of inadequate maintenance, high voltage electricity current from the grid is present in the poles of parks lights, which results in unnecessary deaths. Whereas, there is no risk with Solar trees.

Universities and institutions

In universities and institutions, there is a huge demand of electricity. The solar trees can be installed in different parts of university/institutions such as hostel, playground, library, mess, parks, parking area, auditorium etc. The use of clean energy like solar energy can reduce the expenditure on electricity and there is no need of dependence on external supplier of energy.

Mountainous regions

In mountain areas, because of rough and sloppy terrain, there are huge problems like power cuts and difficulties in connecting each house to electricity. So, the solar tree can be utilized to meet the electricity needs of off-grid mountainous households because solar tree can be easily installed on the rough and sloppy mountainous terrain.

Advantages of solar tree

- Solar trees provide a way to deploy more than one layer of solar panels while still maximizing the productivity of the available space in locations with limited space.
- In comparison to the way conventional solar panels are arranged, the solar tree design is efficient and incredibly beautiful.
- Solar trees also appear to be much more eye catching.
- For locations where solar roofing doesn't seem feasible, solar panel trees might be a better substitute.
- They can be used as a resource to educate and help people understand why solar technology is important. Especially, in schools and other educational institutions solar trees could effectively serve this purpose.
- When compared to typical solar panels that are covering a similar amount of surface area, the solar tree produces a significantly larger quantity of electric power.

Future prospects

Sun light is essential for photosynthesis in plants as well as solar energy generation. Different studies have shown that solar energy is clean, renewable and low-cost energy source. Because of the sun's lifetime, it seems to be a sustainable energy solution with lots of agri-energy potential [5]. Geographic allocation of India indicates enormous potential for solar energy production. India has begun working toward its goal of producing 100,000 MW of solar energy by 2022. Solar cells have been developed over many generations, but their practical efficiency is still low around 20 to 30 percent which leaves a lot of room for improvement. These losses, which result from physical processes including spectrum absorption, sunlight reflection and transmission, particle collision, etc., are the cause of the poor efficiency. Different environmental factor like temperature, spectral distribution, and resistive load also affects the efficiency of solar cells. The majority of people in India rely on agriculture for food, livelihood, and income. Solar energy is one of the sustainable alternatives among the several creative Agri-energy models that have been proposed for producing Agri-energy. One of these models is "solar tree". Various solar panel designs have been developed to enhance the efficiency of harvesting the solar energy. There are now a few solar photovoltaic-thermal (PV/T) devices on the market that

simultaneously capture light and heat. All of them reduce the effects of problems like spectrum loss, sun tracking systems, incident angle, and other factors. Intense research is required to overcome all these barriers and increase the efficiency of solar panels.

CONCLUSION

The use of clean, low-cost, renewable energy like solar energy could reduce our dependence on other non-renewable sources of energy such as fossil fuels, petroleum, electricity etc. Solar energy is sustainable as it depends on sunlight. Solar energy could be harvested using solar panels, which are very easy to install and could easily be placed anywhere. Different designs of solar panels have been designed keeping space and efficiency in mind. One of these designs is “solar tree”. Utilizing such sun trees in agriculture can result in enormous gains. The huge potential of solar tree-based renewable technologies to satisfy various energy needs and agricultural energy demands. As a result of its decreased reliance on fossil fuels, cheaper operational costs, less impact on agricultural land, and long-term energy potential, it is a sustainable energy option. The solar tree gives farmers a stable source of revenue and allows them to capture energy without harming their crops.

REFERENCES

- Dupraz, C., Marrou, H., Talbot, G., Dufour, L., Nogier, A. and Ferard, Y., 2011. Combining solar photovoltaic panels and food crops for optimising land use: Towards new agrivoltaic schemes. *Renewable energy*, 36(10), pp.2725-2732.
- Energy Statistics 2022, Central Statistics Office Ministry Of Statistics And Programme Implementation GovernMent Of India New Delhi
- Hyder, F., Sudhakar, K. and Mamat, R., 2018. Solar PV tree design: A review. *Renewable and Sustainable Energy Reviews*, 82, pp.1079-1096.
- Kumar, M., 2014. Taming waste via laws of physics. *International journal of Sustainable energy and environmental research*, 3(3), pp.164-170.
- Kumar, M., Rana, L. and Pattnaik, A., 2021. Solar tree—a sustainable energy approach for farmers. *Journal of University of Shanghai for Science and Technology*, 23(7), p.410.
- Nonhebel, S., 2005. Renewable energy and food supply: will there be enough land?. *Renewable and sustainable energy reviews*, 9(2), pp.191-201.
- Sugathan, V., John, E. and Sudhakar, K., 2015. Recent improvements in dye sensitized solar cells: A review. *Renewable and Sustainable Energy Reviews*, 52, pp.54-64.
- Sukumaran, S. and Sudhakar, K., 2017. Fully solar powered Raja Bhoj International Airport: a feasibility study. *Resource-Efficient Technologies*, 3(3), pp.309-316.