

An Introduction to Solar Roof Tiles

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Abstract

The Sun has been honored as a life-giver to our globe since time immemorial. We learned how to use sunlight as a form of energy throughout the Industrial Revolution. India has a massive capacity for solar power generation. Every year, India's landmass gets around 5,000 trillion kWh of energy, with most portions receiving 4-7 kWh per sq. m. In India, solar photovoltaic power can be harnessed efficiently, allowing for tremendous scalability. Solar energy also enables distributed power generation and rapid capacity growth with short lead times.

Solar energy has enormous potential because it provides roughly 200,000 times the world's total daily electric-generating capacity every day. Regardless of the fact that solar energy is free, the high cost of gathering, processing, and storing it prevents it from being used in many areas. Solar energy can be converted to thermal energy (heat) or electrical energy, with the former being the easier option.

The goal of this research is to talk about how important solar energy and PV roof tiles are, as well as their future possibilities.

Keywords: Solar Tiles; PV roof tiles; natural Fibre.

1. Introduction

Such huge regions are especially appealing in metropolitan locations where land space is limited. Roofs, in particular, are an excellent location for solar power generation. In general, they are big, flat surfaces that are less prone to shadowing than walls and have more suitable solar gain orientations. For maximum sunlight collection, solar panels should be angled perpendicular to the sunrays. Because a roof-mounted structure can't meet these requirements, a slant angle of about 45 degrees is considered to be an acceptable option.

Solar tiles work in the same way as photovoltaic panels, which are currently common in building. The main difference between them is how they are put together: Solar tiles are built into the roof from the ground up, replacing regular tiling, whereas photovoltaic panels are affixed to an existing roof.

The tiles are made of photovoltaic cells, which when subjected to sunlight form an electric field capable of delivering electrical energy for use within the building. Each tile is connected to the power distribution board via cables.

For the tiles to work effectively, an inverter must be installed that turns the energy captured by each tile into power. Another method is to hire a professional to build a solar diverter, sometimes known as a "home solar system."

The amount of solar energy absorbed is proportionate to the amount of sunlight that the tiles are exposed to, which is significantly influenced by the project's environment and location. Sunny days are, without a doubt, more energy efficient than gloomy days.

2. Literature Review

Wajs J et al. (2019): Their main goal has been to use heat recovery to optimize the performance of PV tiles as a whole. The two tactics studied were to determine the operational performance of the pv tiles and to enhance construction to optimize cooling impact while using air as the working medium. A detailed experimental examination was done to evaluate these effects. The findings suggest that a total electrical and thermal efficiency of 24% could be obtained.[1]

Ferreira R et al. (2018): This study presents statistics on a double roman shaped roof tile with solar cells embedded in the tile. The working temperature of a solar cell, the solar irradiance that the cells get from the sun, and the composition of the solar cells are all factors that affect its efficiency. In this study, monocrystalline silicon solar cells were used. Because natural cooling is not possible due to the nature of the solar tile, which has a clear double roman PVC cover and a thick black opaque PVC backing, the cells work at a much higher temperature, decreasing the output power.[2]

Dondariya C et al (2018): “The goal of this study is to see if a grid-connected terrace solar pv system for a housing complex in India's holy city of Ujjain is feasible. The study uses simulation tools including PV*SOL, PVGIS, Solar GIS, and SISIFO to evaluate the performance of a grid-connected rooftop solar pv system. In order to predict the solar power plant's performance, the study assesses its energy generation, performance ratio, and solar component.”[3]

Kanchikere J et al (2017): “The real-time and simulation analysis of an 8KW grid-connected photovoltaic solar roof top power plant in Davangere is carried out in this research work employing PV syst. Real-time meter readings are recorded on both the export and import sides, and simulation results of inverter energy output, energy delivered to the grid, and energy delivered to the user are displayed.”[4]

Bahaj A et al. (2020): Their article looks at many solar roofs tile styles, patterns, and installation procedures. The photovoltaic (PV) roof tile structures can contribute to the generation of power. A PV roof tile design is developed that will allow for seamless integration with regular tiles. This requirement's limits, as well as aesthetic, commercial, and regulatory difficulties, are examined. In this approach, a new form of photovoltaic building integration may be seen.[5]

3. Different Kinds of Solar Tiles [6]

The two most common varieties of solar tiles used for home solar energy are:

1. Solar Tiles made up of silicon.
2. Solar Shingles made up of Copper – Indium – Gallium – Selenide (CIGS).

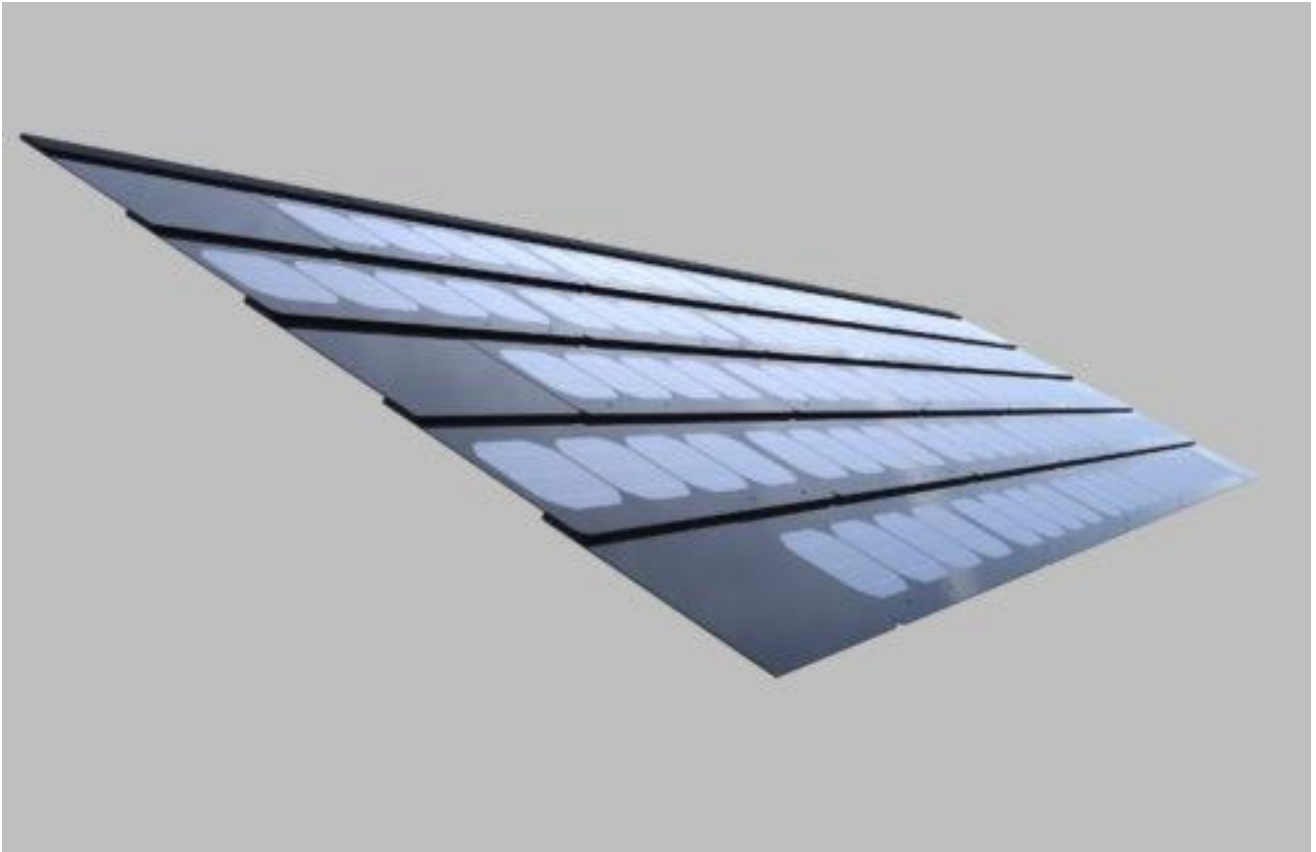
3.1 Silicon Solar Shingles

These are comparable to solar panels in that they are stiff and have a frame. These are thin and have a size that is comparable to traditional roofing materials.



3.2 CIGS Solar Shingles

This sort of shingle makes use of modern film technology to generate solar energy for the residence. These shingles are meant to be more flexible and light so that they mix in better with an existing or new roof.



4. How do solar tiles stack up against solar panels?

There are three major aspects to consider:

- Aesthetics

Solar roof tiles are less apparent than solar panels, making them a better alternative for listed buildings or residences in conservation zones.

- Expense

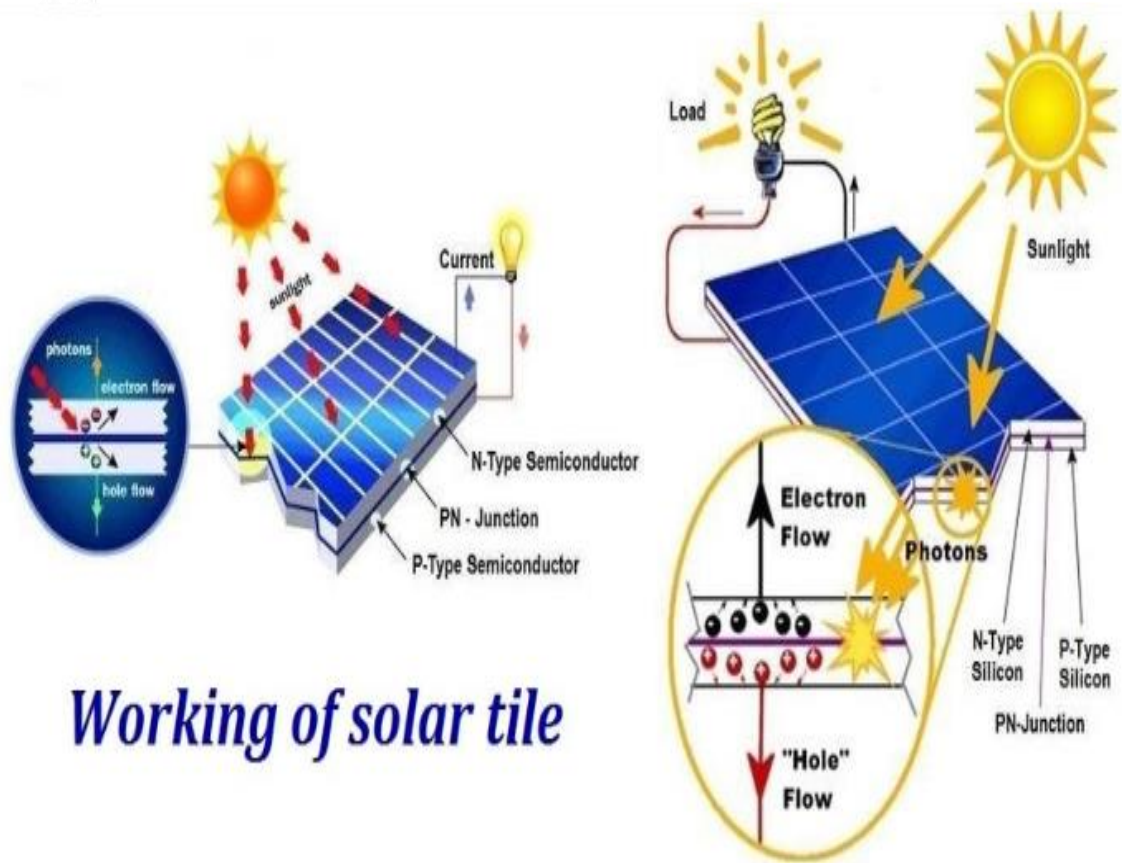
Solar roof tiles cost around twice as much as solar panels. They are also very difficult to adapt, which means that a whole roof would most likely need to be rebuilt in order to install solar roof tiles, making it a significant expenditure.

- Effectiveness

They are less efficient than solar panels and generate less power from the same surface area.

5. Working of Solar Roof Tiles

Solar tiles operate in the same way as solar panels do. Solar tiles are built of the same material as standard solar panels. These solar tiles are then wired together to gather and store power. The actual amount of generation is determined on the amount of sunshine available. Obviously, productivity is higher on sunny days than on overcast days. When sunlight strikes solar tiles, an electric field is created that can provide electrical energy for use within the structure. Electricity is produced by the flow of electrons within the solar cell. To create a large amount of electricity, each tile is connected to the power distribution board through solar wires.



Working of solar tile

6. Advantages of Solar Roof Tiles

- Solar tiles are a great approach to encourage people to use sustainable energy.[7]
- Solar tiles have a more appealing appearance.
- Solar tiles come in a variety of designs that resemble regular slate stone or ceramic tiles.[7]
- It is a cost-effective solution for rehabilitation or new construction projects.
- They can compliment practically any building decor because they appear like ordinary shingles and available in a variety of sizes and shapes.[8]
- They do away with the need for a vast installation space, which is required by standard solar panels.[8]
- It's easy to set up and doesn't take long.
- To cover vast or complex roofs, they can be coupled with traditional shingles.
- They are competitive with regular panels as a newer technology, producing roughly 13-17 watts of electricity.[8]
- They can endure high winds, heavy snow, and hail when correctly built.

7. Disadvantages of Solar Roof Tiles

- They will not offer power at night or during storms because they are unable to store energy.[8]
- For the shingles to catch the sun, the roof must be at the proper angle.
- Solar shingles must be installed on a large enough surface area to collect enough light to generate electricity.[8]
- Solar shingles cost more than traditional solar panels.[9]
- The slope and placement of your roof determine the type of solar roof tiles you can use.

8. Future Scope of Solar Roof Tiles

- Solar shingles have just been on the market for a little more than a decade, therefore there are no real-world life-time data, only estimations.
- Solar shingles are predicted to last at least 20 years, which is comparable to the typical lifespan of many regular roof tiles but lower than that of conventional PV modules.
- Because of the current cooling issues that contribute to the cost/ yield ratio of solar shingle systems, faulty solar shingle installations produce less power and degrade more quickly, making them a potentially pricey option when power yields, not aesthetics, are the primary concern.[10]
- However, combining solar shingles with emerging solar cell technologies like PERC (Passivated Emitter Rear Contact) has the potential to reduce the heating issue, making solar shingles a more serious rival to traditional PV modules as technology improves.

9. Conclusion

- If you're building from the ground up, photovoltaic tiles should be taken into consideration.
- Solar roof tiles are widely utilised in corporate buildings that seek sustainability certifications due to their high installation cost (which results in significant savings in about 5 years). They are, however, currently installed in some high-end multi-family homes with the goal of lowering conventional electricity prices.
- Personal energy generation decreases living costs and provides any family more control. It's possible (and desirable) that this type of solution will one day be found in all types of structures, including dwellings.

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