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Building Integrated Photo Voltaics : Solar modules that integrate into the Building Envelope

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ABSTRACT

Building Integrated Photovoltaics, commonlyabbreviated as BIPV, which accredits the combination ofphotovoltaic panels into the envelope of building itself. It isone of the foremost emerging technology world-wide with anaverage yearly growth of 15 to 25 of worldwide. BIPV isassumed to cross US $ 26 billion mark by the year 2025,which will bring out tremendous gains within the global growth. But still there are some factors where this technology is not acceptable in some areas of the planet. One of the major factors that effects this technology is Cost. In this research study analysis, we come across the BIPV panels over the standard glass facades of building model, its working and methodology and its applications. This might bring out some awarenessabout the value effectiveness of the system and should increase the acceptance of technology over the world. BIPV is a system having multiple advantages, also focus a positive impact on the environment and has proved to be environment friendly for the generation of electricity.

KEYWORDS:Building Integrated Photovoltaics (BIPV), Efficiency, Effectiveness, Envelope, Glass Facade.

1. INTRODUCTION

Most Building integrated photovoltaics, commonly known as BIPV, is one of the emerging technologies worldwide. BIPV is one of the developing technologies in the field of solar energy generation techniques i.e. the solar panels. It can be recognized as the upgraded version of the conventional solar panels, which are integrated into the building walls, windows, roof for the purpose of generation of electricity directly from solar energy received by the sun.

Building Integrated Photovoltaics are the solar modules that are designed to integrate into the building envelope itself, replacing the conventional glass or other standard building materials. BIPV panels can be installed in the building envelope part such as roofs, facades and skylights. BIPV serves as building envelope materials as well as power generator. The major reason in the construction industry have started incorporating the BIPVs into their building material and infrastructure is that the initial investment cost can be reduced by the electricity produced and the cost of labor and other materials is saved. This technology has multiple advantages, due to this reason this technology is accepted more around this planet by construction industry.

The photovoltaics were firstly installed and integrated on the rooftops of the houses in USA around 1970s. They were installed in the areas where there is no reach of electricity from the grid. Initially, these systems were inefficient. These systems were unable to produce desired and required amount of electric power. After that era, some technological advancement in the photovoltaics have been developed and due to this, the products performance was gradually increased and also there was a remarkable decrease in the cost of system. Initially during the early phase of PV systems and panels, they were way too expensive and hence due to this, it has raised an issue that PV systems were not accepted by the people.

1.1 WORKING OF BIPV

BIPV commonly used as a rooftop mounted solar systems is an advancement of photovoltaics solar cells. The working of the system is completely based on the solar radiations falling on it directly from the sun. The solar panels are adjusted and fitted in proper direction, such that it receives the utmost amount of sunlight throughout the year. Solar panels make the employment of solar rays and covert the sunshine energy into electric energy. When solar rays strike the panels and solar rays gets absorbed by the panel that is subject to its efficiency. This solar power is then sent to the inverter which converts the direct current into alternating current (AC). Once the direct current is converted into alternating current, the electric energy enters the grid and from the grid, the energy reaches houses, offices, schools, etc. and is ready for use. Connections of all these components of BIPV are done through wired connections and cable connections.

1.2 BIPV Products:

Building Integrated Photo Voltaic are broadly classified into three main types:

1.2.1 Crystalline silicon solar panels
1.2.2 Thin-film based technologies
1.2.3Organic photovoltaics (OPV)

1.2.1 Crystalline Silicon solar panels:

Crystalline silicon solar panels mainly used for ground-based and rooftop power plants.

1.2.2 Thin-film based technologies:

Thin-film based technologies such as amorphous crystalline silicon, CIGS (Copper Indium Gallium Selenide) or Cadmium Telluride. Which could be partially transparent, light, red, blue yellow, and could be integrated on roofs or in glass that can be mounted on curtain wall and skylights.

1.2.3 Organic photovoltaics (OPV):

Organic photovoltaics (OPV), such as the ASCA® film, which encompasses thin films characteristics low cost, and it is the new, latest generation of versatile flexible, ultrathin semi-transparent solar film.

2. METHODOLOGY

PV module is the standard element of BIPV system. Module is prepared by interconnecting and encapsulating individual solar cells on various material. Modules are strung together in an electrical series with cables and wires to make a PV array. Direct or diffuse light (usually sunlight) shining on the solar cells induces the photovoltaic effect, this generates unregulated direct current (DC) power. This unregulated DC power will be used, stored in an exceedingly battery system, or fed into an inverter that transforms and synchronizes the facility into alternating current(AC) electricity. The electricity may be employed in the building or exported to a utility company through a grid interconnection.

2.1PROCESS

1. **Erect the scaffolding**

Erect the scaffolding is for the safety of the installation team. It is done for checking out the installation and scaffolding and we need to ensure that there is enough room outside your house for the scaffolding tower.

2. **Attach roof anchors**

To hold the frame for the solar panels the roof anchors are used, and based on the type of roof tile fitted, the type of anchor choice will be done. Lifting some of the tiles on your roof and fixing the roof anchors to the rafters is done by the installation team. The installer should has to check that the roof and the rafters are suitable for installing solar panels.

3. **Attach the frame**

To the anchors, which run horizontally and vertically across the roof, the aluminium frame (or solar panel rails) is attached .

4. Install the solar panels

Finally, we need to attach the solar panels onto the frame. Once the installer has positioned them in their optimal angle, the panels clamp loosely to the frame and then they are tightened.

5. Solar panel wiring

We need an authorized solar installation team in solar array wiring. Although the panels usually come prewired from the manufacturer, but they still have to be connected to an inverter. While the installation team are busy in installing solar panels onto the roof, the inverter in your house (usually within the loft) is ready by the electrician. The inverter converts generated electricity –Direct current (DC) – into usable electricity (AC). After that, your free electricity is prepared to be employed by electrical appliances within the house.

2.2 METHODS

2.2.1 Direct BIPV attachment

"All attachments are done through a two-piece clamp. The bottom attaches to the standing seams, and also the BIPV attaches to the L-flange on the highest of the clamp." Gather all necessary tools including a drill, measuring device, deep well socket,line and spanner. A laser and an angle driver are optional specialty tools. Determine where the primary clamp are visiting be installed. Start screw aboard by hand so tighten to recommended torque. Measurement of the roof edge makes to use that measurement to put in the clamp furthest away. Use a balkline to line up additional clamps within the first row. Create a jig to make sure clamps are evenly spaced across roof to form a grid. Use the L-flange and therefore the bevel guide to align the primary BIPV panel. Screw a footing grab on top of both the panel and clamp to secure the panel to the roof. Use wire clips to further tighten the clamps. Lay the subsequent BIPV panel down next to the primary one and screw down a field grab to carry both panels in situ. Continue this process until all panels in your grid are installed. Make electrical connections in accordance with manufacturer instructions.

2.2.2 Peel-and-stick BIPV panels

A cardboard template of the module is created, and mark the perimeter with a pencil after placing it on the roof panel. Backing of the paper is pull off from the peel-and-stick modules and is made to expose about 2 feet of adhesive. By ensuring the correct end of the module straight and down with the metal roof panel, complete the lining up of PV modules with pencil. Pressure is applied to the module by one person, when BIPV panels stick to metal roof while another person pulls the paper backing away, working their way down the module length.Use a roller to smooth any bubbles.Install metal roof panel in the traditional way.

2.3 SOLAR ROOFING:

Rather than traditional roofs, solar roofs will be installed using individual solar tiles or interconnecting solar sections. Few BIPV manufacturers have developed aesthetically appearing solar tiles, when viewed from street level that appears to be the same as traditional roofing. With varying generation capacities solar tiles are installed together to construct solar roofs. To form them stronger solar tiles are made with tempered glass rather than standard roofing tiles. Like asphalt or concrete tiles these materials tend to not degrade over time.

2.3.1 Solar roofing connections

Solar roofing connections requires the tiles or individual solar sections, for the purpose of dwelling we need toconnect electrically for generation of power. Few manufactures design these tiles or solar sections using plug-in connectors and wires to be electrically connected. To connect one tile to another tile polymer paste is used, in this aspect the Tesla's solar tiles makes it unique. The polymer paste allows the electricity to flow from tile to another tile and bonds the two overlapping tiles. This type of connection is designed to be more resistant to weather conditions and temperature changes than soldered metal connections between cells.

2.3.2 Solar array orientation

Orientation of solar arrays are done ideally in south and within angle of 20° of the sun produces 95% of their full power. Flat roofs are tilted up towards actuality of south direction and are mounted on frames. When a array set is oriented in an exceedingly direction apart from South, less solar power is received. Reduction of this orientation, increases with larger tilt angles and at higher latitudes, more critical orientation is observed. The effect of orientation is far less, at lower latitudes with arrays installed at lower tilt angles. The tilt angle relies on the latitude of the geographic location of the solar panel, although it will vary by month. For determining the correct angle supported location, online calculators are available.

Solar arrays need unobstructed access to sunlight from 9 am to three pm throughout the year. Solar arrays is optimized for either summer or winter gain by changing their angle. to require advantage of the sun's high arc through the summer sky, the array should be positioned at a smaller angle to maximize summer energy production. this could be advantageous for a system that needs plenty of energy within the summer, like cooling loads. The array should be positioned at a greater angle to get more energy when the sun is lower within the winter sky to spice up winter efficiency. This may well be best for a system that uses more electricity within the winter, like artificial lighting or heating.

2.3.3 Solar roof costs

The cost of a solar roof is predicated on the estimated square footage of the roof, which has the price of materials, installation, and also the removal of the old roof. Additional costs can include gutter and skylight replacement. Other cost considerations include the quantity of daylight hours per annum where the dwelling is found, solar battery efficiency, and federal solar tax credits.

3. APPLICATIONS

Photovoltaics is also integrated into many various assemblies within a building envelope:

a.Solar cells is incorporated into the facade of a building, complementing or replacing traditional view or spandrel glass. Often, these installations are vertical, reducing access to available solar resources, but the big expanse of buildings can help make amends for the reduced power.

b.Photovoltaics could also be incorporated into awnings and saw-tooth designs on a building facade. These increase access to direct sunlight while providing additional architectural benefits like passive shading.

c.The use of PV in roofing systems can provide a right away replacement for batten and seam metal roofing and traditional 3-tab asphalt shingles.

d.Using PV for skylight systems is both a cheap use of PV and an exciting design feature.

e.Use of transparent PV panels in building façade.

f. Use of transparent PV panels in railing and fence.

g. Solar photovoltaic modules integrated into a canopy.

h.Use of Photovoltaic modules with vision light integrated into a skylight.

4. FIGURES

Fig:1. crystalline silicon solar panel

Fig: 2. Thin filmed based technologies

Fig: 3. Organic photovoltaics

Fig : 4. Instead of traditional roofs, aesthetically similar solar roofs can be installed using interconnecting solar sections or individual solar tiles.

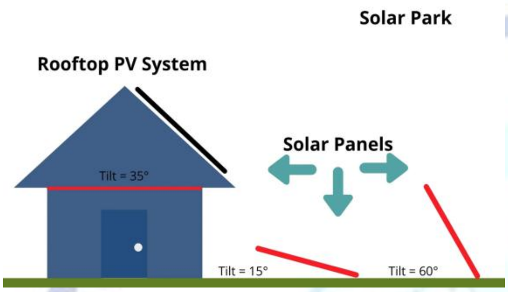

Fig : 5. solar array orientation

5. ADVANTAGES

Solar power systems are in use for many years. Now, a comparatively new application of solar generated power is making inroads and competing directly with conventional building construction methods. It's called building integrated photovoltaics (BIPV). With BIPV, the combination of solar energy in roofing, building envelope or canopy systems adds building performance to solar generated power. Besides the twin performance advantage, let's speak about 3 more genuine benefits of BIPV.

1. Adding BIPV may cost you nothing compared to traditional artifact costs.

Every approach to assembling design should satisfy needs and price you less within the future. Take whatever your current conventional construction material and labour budget is for roofing, building envelope, canopies, thermal heating and cooling. Then double it. That's what adding BIPV will cost you within the short term. However, BIPV with its incentives and unique tax advantages costs you but conventional building materials within the long term. "A penny saved may be a penny earned." Once in situ, conventional building materials are revenue static, offering little or no savings over time. By adding BIPV versus the value of conventional construction materials and labour, the building envelope, roof or canopy now becomes a revenue centre with up to 30 years of savings from system generated electricity.

2. Peak power consumption is offset simultaneously by peak energy production.

During the day, maximum solar energy system energy production and daylight generally correspond with peak electricity demand. This can be even more important because when utility prices are highest, peak production from the system is realized during daytime.

3. With BIPV, architectural design isn't sacrificed for integration of solar power systems.

Many have said, "I want to feature solar, but I don't want to work out it." So when does solar not appear as if solar? The void in solar integration that BIPV fills is done by blending into building architecture using BIPV. Architectural canopies, facades, roof and skylight systemscurtain walls, are all samples of how BIPV aesthetic look rather than a design compromise. Unlike the subjective social and environmental benefits of other energy which are hard to quantify, BIPV's economic benefits are unique, real, and easily measured to the BIPV approach of building design and architecture. No other integration of solar or energy generation can make that claim. Limitation of BIPV and building performance concepts are done by innovative applications and imaginative design concepts of today's solar products.

- ◎ A true renewable energy source Low maintenance cost,provides insurance against rising power prices and reduce in electricity bill .
- ◎ They operate quietly, with no moving parts. BIPV modules can be used onany building.
- ◎ Thermal insulation. By filling air or any non-conductive gas, the BIPV panels to be sandwiched by double or triple glazing structures.
- ◎ Solar energy is supplied by natureit is thus free and abundant and Solar energy can be made available almost anywhere there is sunlight.
- Building integrated photo voltaic produces no noise at all

- No emission of harmful greenhouse gas, environment friendly.

6. CONCLUSIONS

a. State-of-the-art building integrated photovoltaic (BIPV) products existing on the market today offer a wide range of integration of photovoltaic (PV) systems into buildings. Research and development is continued withboth BIPV and PV technologies and material will yield better and better.

b. Better improvement technologies in BIPV solutions in the years to come, e.g., with respect to increased environmental aspects, reduced production costs, improved building integration and solar cell efficiency. New and innovative solutions may increase the market share and reduce costs, e.g., in the retrofitting market. Solutions that are choosen should be easily applicable,paint applications of PV cells is an example of future vision. It is crucial that all new solutions and technologies are thoroughly approved and tested in accordance with existing standards. There is also a need for improvement and development of new methods and standards, e.g., regarding long-term durability versus climate exposure.

c. Reduce in the stress of non-renewable and polluting sources of energy.

d. Advancement in buildings' sustainability BIPV systems can provide savings in materials and electricity costs, reduce use of fossil fuels and emission of ozone depleting gases, and add architectural interest to the building.

e. With the learnings from existing implementation around the world this technology would be replenished in India by working with the best in the industry in the near future. With the right support from the Government of India, the BIPV market can take off like it has abroad and mission of The Jawaharlal Nehru National Solar Mission JNNSM would be accomplished too.

7. FUTURE SCOPE

Future of BIPV in India- from learning of existing implementations and accomplishment of Jawaharlal Nehru National Solar Mission(JNNSM)

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Gholami, H., Rostvik, H.N. and Muller-Eie, D. (2019). Holistic economic analysis of building integrated photovoltaics (BIPV) system: Case studies evaluation. Energy and Buildings, 203, p.109461.

[2] Salem, T. and Kinab, E. (2015). Analysis of Building-integrated Photovoltaic Systems: A Case Study of Commercial Buildings under Mediterranean Climate. Procedia Engineering, [online] 118, pp.538–545.Availableat: https://www.sciencedirect.com/science/article/ pii/S1877705815021281.

[3] Baljit SSS, Chan H-Y, Sopian K(2016) Review of building intergrated applications of photovoltaic and solar thermal systems. J Clean Prod 137:677-689.

[4] Bharath, V., Mathur, A. and Prasad, N. (n.d.). Life Cycle Costing of a 100kWp Solar PV System.[online]Availableat: http://ijiet.com/wpcontent/uploads/2015/10/3.pdf [Accessed 18 May 2020].

[5] Gunarathna, C., Weerasinghe, N., Yang, R. andMudiyanselage, P.(n.d.).A Comprehensive Review on the Cost Reduction and Uptake of BIPV through the Integration of PV and Prefabricated Building Industries. [online] Available at:http://apvi.org.au/solar-researchconference/wp content/uploads/2018/11/061_DI_Gunarathna_C _2018_PAPER.pdf [Accessed 18 May 2020]

[6] Ijrer.org. (2020). [online] Available at: https://www.ijrer.org/ijrer/index.php/ijrer/article/view/1328/0

[7] Choudhury, I. (n.d.). BIPV Roof Tiles: Effect of Locations on Energy Cost Savings. [online]Availableat: https://peer.asee.org/20124.pdf [Accessed 18 May 2020].

[8] International Research Journal of Engineering and Technology (IRJET) Building Integrated Photovoltaics (2020).