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Analysis of Building Integrated PhotoVoltaic (BIPV)

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Abstract:-- **Renewable Energy utilisation and correspondingly solar installations is not about fashion but about survival in today's world. Going Green has become the watchword. In such a scenario the use of solar photovoltaics for the building illumination or utilisation for domestic purposes can significantly reduce the loads on grids as buildings account for more than 30% of total energy consumption. But growing consumer interest in distributed PV technologies and industry competition to reduce installation costs are stimulating the development of multifunctional PV products that are integrated with building materials. This emerging solar market segment, known as building-integrated PV (BIPV), continues to attract the attention of many stakeholders. BIPV offers a number of potential benefits, and there have been efforts to develop cost competitive Products for more than 30 years. In This dissertation, we examine, analyse and evaluate the performance of BIPV. With a focus on residential rooftop systems, and explore key opportunities and challenges.**

Keywords: **component; formatting; style; styling; insert (key words)**

I. INTRODUCTION

Building Integrated Photovoltaic (BIPV) is the integration of photovoltaics (PV) into the building envelope. The PV modules serve the dual function of building skin—replacing conventional building envelope materials—and power generator. By avoiding the cost of conventional materials, the incremental cost of photovoltaics is reduced and its life-cycle cost is improved. That is, BIPV systems often have lower overall costs than PV systems requiring separate, dedicated, mounting systems.

A complete BIPV system includes:

a) the PV modules (which might be thin-film or crystalline, transparent, semi-transparent, or opaque);
b) a charge controller, to regulate the power into and out of the battery storage bank (in stand-alone systems);
c) a power storage system, generally comprised of the utility grid in utility-interactive systems or, a number of batteries in stand-alone systems;
d) power conversion equipment including an inverter to convert the PV modules' DC output to AC compatible with the utility grid;
e) backup power supplies such as diesel generators (optional-typically employed in stand-alone systems); and
f) appropriate support and mounting hardware, wiring, and safety disconnects.

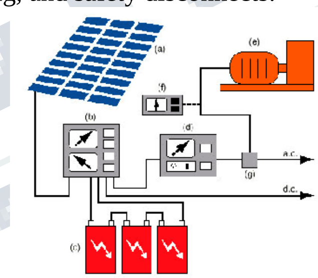

Fig .1: Bipv
Domestic pv study:durge residence

Fig 2: Durge Residence

LOCATION: DURGE RESIDENCE
SAMRAT NAGAR
Latitude and Longitude: 16° 6' 0" N, 78° 18' 0" E

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Fig 3: Solar Panels

The load calculations were done based on which the panels were put up. Both for residential building and a small office in the same building of the owner.

Panels were installed 7years ago i.e. in the year 2008

NO. OF PANELS=20, 100W each

Radiations: 713W/m^2

DC Input

Isc=17.6A

Voc= 57.8V

Output

Voc= 58.8V

Isc= 18A

PANEL SPECIFICATION:

P_{max}= 100W

V_{oc}=21.9

I_{sc}=6.0

V_{MPP}= 17.5

I_{MPP}=5.75

Efiiciency of panels (Actual)=9%

Efiiciency of panels (Theorotical)=11.5%

BIPV

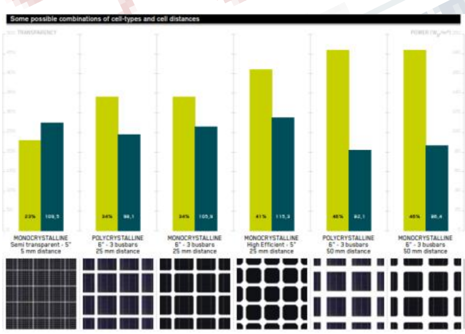

Fig. 4: Possible cell types and their combination with efficiencies

Module design

Various parameters can be taken into account in the design of the modules. Examples of possible options are:

1. Module size
2. Module shape (e.g. rectangles or special shapes)
3. Covering glass
4. Glass quality
5. Strength
6. Structure
7. Coating
8. Colour
9. Tinted glass
10. Coloured printing
11. Cell background or reverse side of module
12. Semi-transparency
13. Arrangement of solar cells in the module
14. Interconnections
15. Multi-layered superstructures such as
16. insulated glazing
17. Cell colour

Design of a base building using the bipv principles

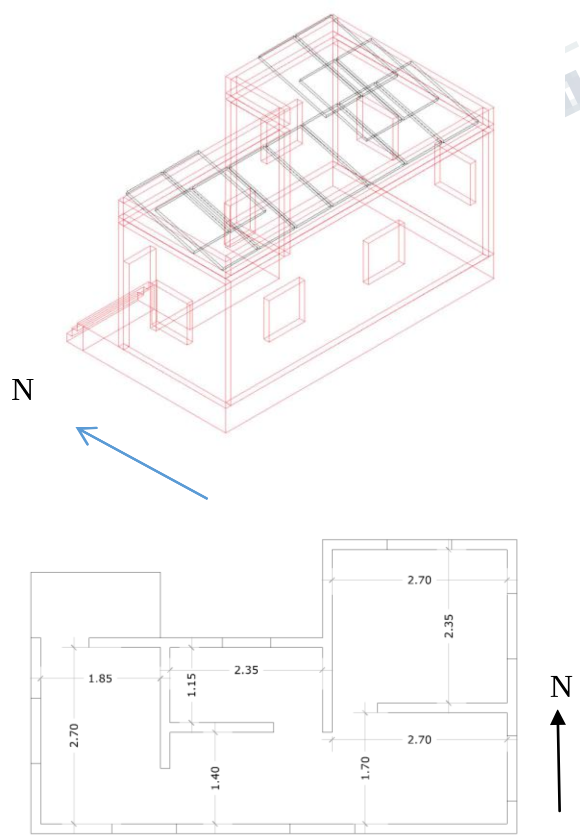

Fig 5: 3d And Layout Of Base Building

Latitude: 16.6765.

Longitude: 74.2517.

Altitude: 564 m
Albedo: 0.20
Time zone: UTC+5:30 hours
Pune, Kolhapur and Bengaluru are examples of cities that fall under this climatic zone. Areas having a moderate climate are generally located on hilly or high-plateau regions with fairly abundant vegetation. The solar radiation in this region is more or less the same throughout the year. Being located at relatively higher elevations, these places experience lower temperatures than hot and dry regions. The temperatures are neither too hot nor too cold. In summers, the temperature reaches 30–34°C during the day and 17–24°C at night. In winter, the maximum temperature is between 27 to 33 ° C during the day and 16 to 18°C at night.

The relative humidity is low in winters and summers, varying from 20 – 55%, and going up to 55 – 90% during monsoons. The total rainfall usually exceeds 1000 mm per year. Winters are dry in this zone. Winds are generally high during summer. Their speed and direction depend mainly upon the topography. The sky is mostly clear with occasional presence of low, dense clouds during summers. The design criteria in the moderate zone are to reduce heat gain by providing shading, and to promote heat loss by ventilation.

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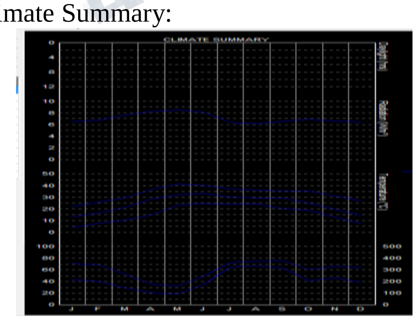
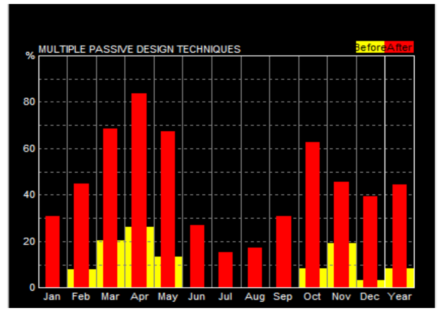
OBJECTIVES	PHYSICAL MANIFESTATION
1)Resist heat gain	
• Decrease exposed surface area	Orientation and shape of building
• Increase thermal resistance	Roof insulation and east and west wall insulation
• Increase shading	East and west walls, glass surfaces protected by overhangs, fins and trees
• Increase surface reflectivity	Pale colour, glazed china mosaic tiles, etc.
2)Promote heat loss	
• Ventilation of appliances	Provide windows/ exhausts
• Increase air exchange rate (Ventilation)	Courtyards and arrangement of openings

Analysis and evaluation

Fig. 6: Climate Summary:





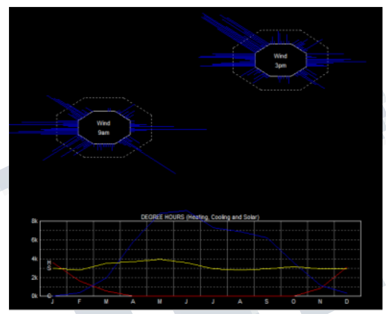


Fig. 7 Annual Windrose (speed distribution)

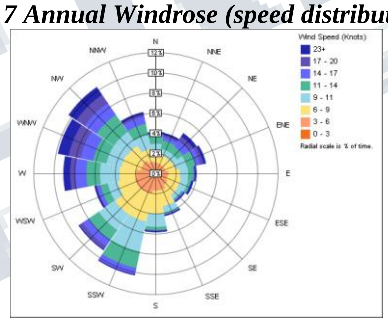


Fig. 8 Annual Windrose (Frequency Distribution)

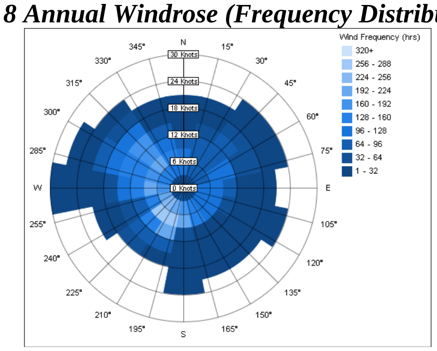


Fig 9 NASA surface meteorology and solar energy: RET screen data: Kolhapur

Fig 10: Sunpath Diagram:

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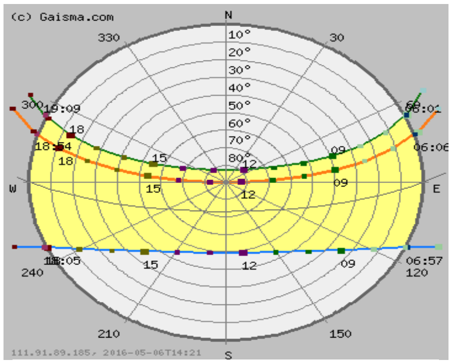

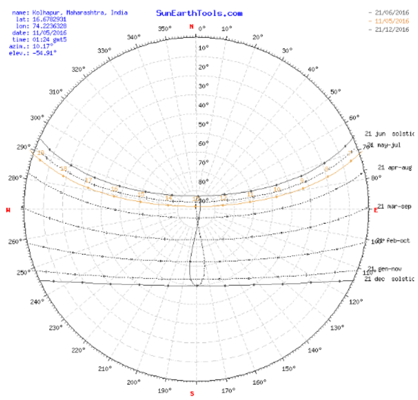

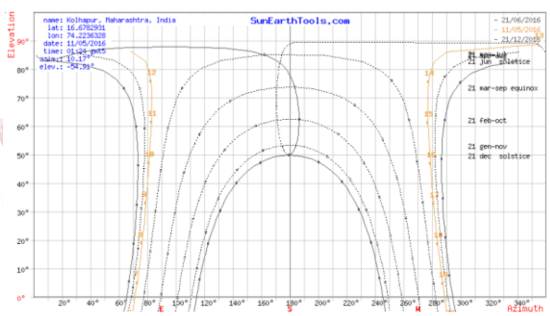

Data Evaluation

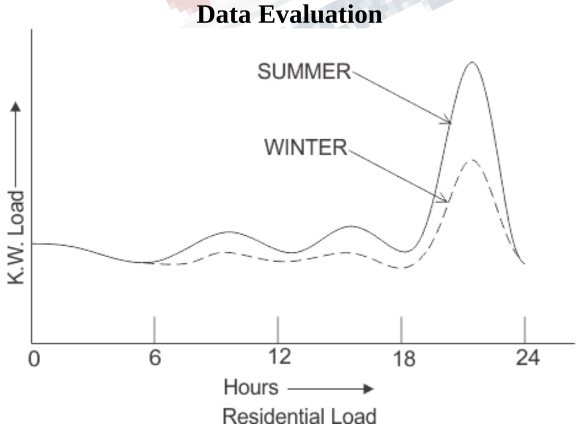

Fig. 11: Daily load curve

Total requirement is 850W
Roof area= 27m^2
Panel area=2m^2
Therefore no of panels required= 13.4~12 panels
Wattage of a single panel= 250Wpeak
Total watts of energy generated on roof=12x250=3000W=3kW
Efficiency of panel is designed for 90% output for 10 years
And 80% output for next 25 years
Panels for windows: **Transparent solar panels**
Wattage of a single panel= 250W
Panel area=0.9906~1m^2
Window area is 1m^2
Therefore installing it on the south side east side and west side windows
No of panels to be installed= 5
Total watts of energy generated= 5x250=1250W
TOTAL GENERATED POWER=3000+1250=4250W=4.250kW

The building was analysed in Ecotect so as to see how climate repsonsive it is by inputing the data of material, panels and weather in the software and analysing its behaviour to each month of the year with the help of solar path.

Fig 12: Comfort: Thermal Neutrality (Ecotect)

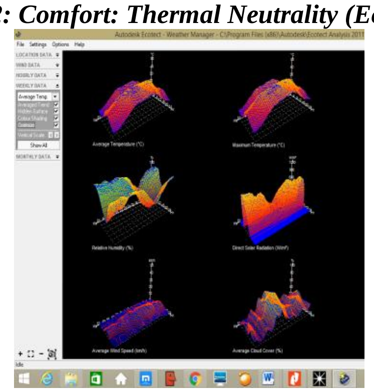

Fig. 13: Analysis of Weather Data (Ecotect) (a)

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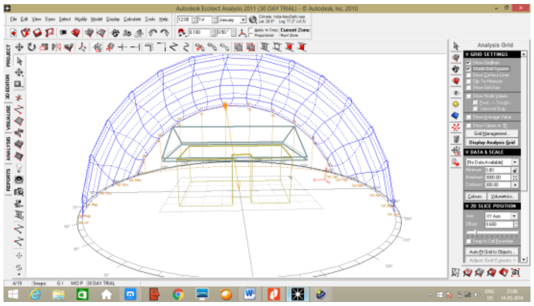
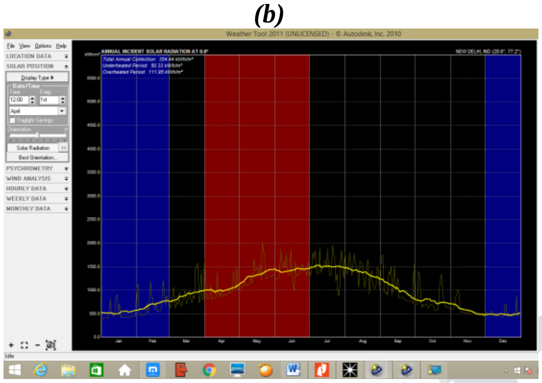
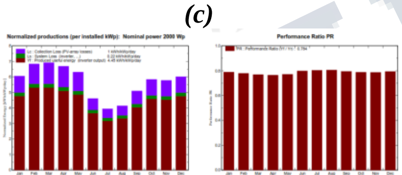


(b)



(c)



New simulation variant

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	EffArrR %	EffSysR %
January	156.6	23.13	187.7	182.1	310.0	295.8	12.62	12.04
February	167.4	24.78	191.4	185.7	311.5	297.7	12.43	11.88
March	202.6	27.05	214.5	207.9	344.7	329.5	12.27	11.73
April	202.0	28.03	200.5	194.1	321.2	306.3	12.23	11.67
May	209.0	28.03	195.4	188.1	316.5	301.4	12.37	11.78
June	149.0	25.06	138.1	132.1	232.7	220.2	12.87	12.18
July	129.6	24.42	122.4	117.0	208.6	196.4	13.02	12.26
August	132.5	23.83	128.4	122.9	218.8	206.7	13.01	12.30
September	149.6	24.03	152.8	147.2	255.7	242.9	12.79	12.14
October	165.2	25.09	180.9	175.3	298.7	284.7	12.61	12.02
November	148.1	23.98	173.1	168.5	285.4	272.2	12.59	12.01
December	152.9	22.91	186.4	181.3	309.6	295.6	12.69	12.12
Year	1964.4	25.03	2071.4	2002.3	3413.4	3249.6	12.58	11.98

Legends: GlobHor Horizontal global irradiation; T Amb Ambient Temperature; GlobInc Global incident in coll. plane; GlobEff Effective Global, corr. for IAM and shadings; EArray Effective energy at the output of the array; E_Grid Energy injected into grid; EffArrR Effic. Eout array / rough area; EffSysR Effic. Eout system / rough area

Fig14: Simulation in PVsyst for panels

Loss diagram over the whole year

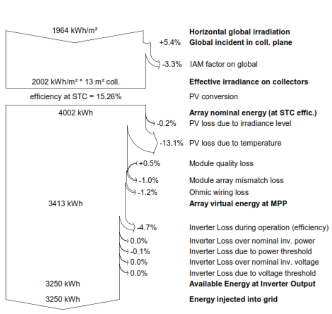


Fig15 : Losses over the year

PHYSICAL SPECIFICATIONS:

Dimensions Length: 1949mm

Width: 976mm

Depth: 70mm

Weight: 43kg/pcs

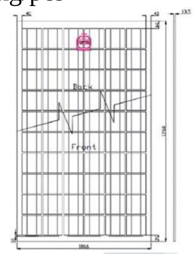


Fig 16: Panel specification

Analysis for zeroing out energy use using south roof

An analytical study was conducted to see if the home could be net zeroed in terms of energy use by implementing standard BIPV elements on the roof and windows. The PV products chosen are two PV system.

Each product was selected for the study and the analyses were quantified in the output for roof of the case study home or every month of the year. It is important to note that every products have the same simple packback, even though the others like MegaSlate have higher efficiencies, this is offset by higher initial cost as well.

However it was observed that a more typical array particular in the BP system has by far the best That is why, it was clear that a more typical PV system such as the BP product, produces more electricity with the same area. Through the data collected, it was also observed that the home could go "zero energy" by certain passive designs which could reduce the load on the grid. If only the south roof surface had to be designed for PV then it would not have met the "zero energy" goals.

Analysis: Zeroing out energy use with multiple surfaces

By adding BIPV system on the south roof and windows, dual surfaces were analysed in softwaes like Ecotect, PV syst. Efficiencies for various forms of PV systems have been given before in the Chapter 4. Orientation deals with the magnetic direction of the surface. In other words, a south facing wall would have an orientation of 180°, while an east wall would be 90° and west at 260°. In regards to the surface, the tilt angle is also needed.

Using local information from the case study area and home, a analysis using south facing arrays angled at a 16 degree tilt proved the choice to be optimal. Next it was determined that the south and east walls of the case study home had an average solar output per day per unit of 2.8 kWh/m day for vertical faces in the Kolhapur area. The respective areas of the walls gave a material efficiency of 0.06 for amorphous silicon (PVa-Si) and respective orientation efficiency for each wall (0.67 for South wall and 0.53 for East wall) was determined. Plots of tilt and angle orientation for solar radiation are important in this decision process (Figure27). Once these parameters were known, total energy generation could be determined. Additionally, the sun hours per day were important in that it allows for more energy production in an attempt to create a home that only relies on the grid to provide power during critical times, but allows the self-generation to compensate for the use during high self-generation periods when energy potentially could be placed back on the grid.

CONCLUSION

- This preliminary study has presented a state-of-the-art review of the literature and products on BIPV in relation to general industry domain and specific to residential construction. Concepts were presented here that home owners and contractors can use to add enhancement in selecting BIPV for single-family dwellings while maximizing their efficiency. These systems provide home owners with the ability to utilize a sustainable and power producing material as a renovation or replacement building component. The ability to provide a simple installation for common component replacement could prove to be a valuable to not just the owner but to the community and more broadly to sustainability initiatives.
- One of the fundamental steps in designing a solar system of BIPV is an initial feasibility study, in which designers evaluate all the aspects of the design. This includes site evaluation, shading and radiation studies, system engineering configuration, equipment integration, and of all the issues associated with installation and system integration. Based on results from Chapter 4, it is more efficient to assess PV panels in the preliminary design stage.
- Economic feasibility
  Although it is assumed that it is possible to operate PV panels anywhere solar radiation exists, in some areas it is not economically viable. The geographic region determines not only the amount of sunshine but also the cost of grid-supplied electricity. Yet, the very high initial costs of PV panels make them an unattractive alternative for building designers even though life-cycle analyses show some amount of saving over the whole lifetime of the BIPV project. An integrated building energy system is generally procured through a construction budget. Electricity generated by the BIPV power system creates savings that reduce operating budgets.
- Reducing the cost of materials
  Although the cost of BIPV is high, if it is designed and installed in the construction phase of the building then it replaces the building material and hence the difference between the after construction installation is reduced. The cost of building materials is also reduced and also the extra installation frames won't be an issue.
- Reducing installation costs
  Though only 30% of the whole project may be specified for PV panel installation, this may be a more feasible solution. A prototype system may be installed prior to a large-scale installation. Working on a prototype first may increase the efficiency of installers and field crews and help them to estimate the scope of work, allowing them to finish the job in a timely manner with less risk of faulty installation. This approach can allow in-house designers to simply follow the standards of the existing prototype to increase the efficiency of their work designing PV panels.

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