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A Novel Hybrid DC-AC Configuration for Apartment Complexes with BIPV

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Abstract: The emergence of Apartment complexes in urban areas has certainly helped in better utilization of space but at the same time, it has put additional load on Electric utilities that supply power towards Green power/ building realization, BIPV has emerged in recent times to benefit from solar power. In this article we are proposing segmented BIPV so that power can be drawn independently for each Apartment .The rooftop area can be utilized for solar panels to power the lighting of the common area only .Thus it is possible to have Apartments with hybrid combination of both AC bus/ DC bus which will help to boost the utilization of DC appliances and also reduce the load for electric utilities. It will hopefully lead to new (novel) Green building / Apartments. Essentially, it has potential to have a local DC bus in each apartment for lighting circuit and small DC appliances. Hence also becomes easy as it gets localized. AC bus continues as before for heavy duty appliances but DC bus becomes available.

Keywords: *BIPV, DC bus bar, AC bus bar, Apartments, Rooftop solar*

1. Introduction

The relationship between light and architecture was addressed by Louis Kahn, one of this century's most well-known architects. "Giver of all presences" is how the light is described [1]. Only when natural light from a natural setting is used to illuminate a room in architecture does its significance become clear.

Not only do windows allow for the passage of the energy known as light. By gathering and transforming solar energy into a form of energy that can be utilised to power daily life, a photovoltaic (PV) module is another technique that can permanently link the interior and external environments.For years, since the first pioneering applications in the 80's, the use of PV systems has been merely thought of as a solution to generate electricity.

But now is being thought of as a technological method to be applied onto multi-storeyed buildings and residential apartments. Rooftop solar power generation is one of the options today.

The concept of photovoltaics as a means of generating energy has recently been completed by the concept of considering solar components as integrated parts of structures and actual construction materials. This transformation has taken place in just over 40 years. Since Thomas Herzog's experimentation with building integrated photovoltaics (BIPV) in 1982, the concept of integration as well as aesthetic principles, technology, and social customs have gradually changed.

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Figure.1. Data centre at Mumbai with BIPV

Figure.2. BIPV building in Dijon, France

The best way to make building skins active nowadays is to apply PV to them, including their roofs, façades, and accessory systems. This is a real innovation in modern architecture and PV. New BIPV materials are now being developed in Mumbai, India, including PV roofing shingles, façade glazing, and curtain walls, as depicted in Fig. 1.The BIPV products developed today inverted the trend and made a breakthrough approach available: PV can become a conventional construction element. A solar cladding looks like a traditional non photovoltaic cladding and a solar tile appears like a traditional tile as seen in Fig2 which shows a BIPV building in France. A curtain wall is a typical example of this kind of architecture, shown in Fig3.

Figure.3. Application of BIPV as a curtain wall for a building.

2. Experimentation of BIPV

Solar houses have been built in western countries using thin-film and passive solar technologies, producing both electricity and heat, thereby representing the most technologically advanced solar house in existence .Electricity was used in the house itself, stored in batteries or fed back to the local grid.

Glazed semi-transparent BIPV solutions with thermal properties are being sought after nowadays. The concept of transparency and de-materialisation of building can characterise the architectural scenario, especially for high-rise and administrative buildings, inducing designers to investigate innovative technologies and products with increasingly high technological performance levels. The high transparency rate gives brightness and diffusion of light inside the spaces. The thermal protection, gives the users' comfort. In addition, the PV cells sandwiched between the glass panes soften the overheating effect during the summer by controlling the direct solar radiation through the shading of the building envelope. In multi-storeyed apartments, the rooftop solar power would be consumed by the common area in each floor of the apartment. The BIPV on the walls of the building would generate power, which is now an additional power to the building and can be tapped from every house in each floor to get the power.

Building Integrated Photovoltaics (BIPV) are becoming popular today in building structures. Residential apartments in urban cities can make use of this BIPV technology. The BIPV panels are mounted as small panels near windows or near spaces which can fit these panels. BIPV panels have been existing from quite some time now, but our study suggests the use of BIPV architecture to be adopted to the residential apartments. A new configuration of electrical circuit for the residential apartments is what we propose to deliver in our study.

A regular 2 BHK house would run on AC power supplied from the grid as shown in Fig 4. This is the conventional method following today. However a new configuration is being proposed for a house. This would have a DC bus bar which would supply power to all the DC appliances in the house and an AC bus bar would be used to supply 230 V to all the heating appliances such as geysers, washing machine etc. The concept of having both DC and an AC bus bar in the same house is the novel configuration proposed and this is termed as a Hybrid DC-AC home shown in Fig 5.

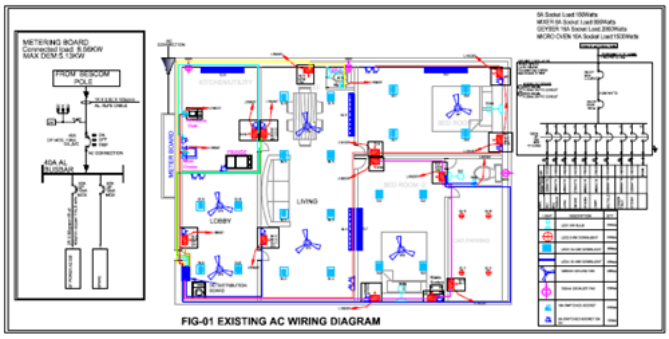

Figure.4. Electrical wiring for existing 2BHK home with AC circuit.

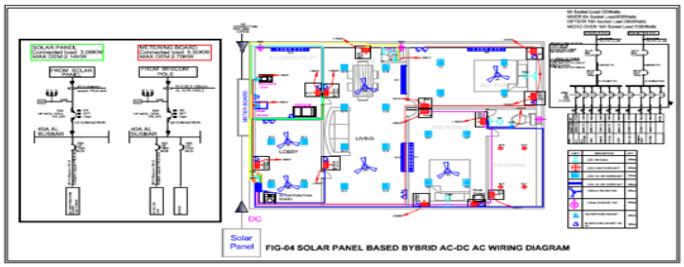

Figure.5. Electrical wiring diagram for a Hybrid DC-AC home.

This concept of a hybrid DC-AC home has been scaled up to a residential apartment and has been incorporated in each house with BIPV architecture also being considered.

The new configuration suggested will be to use BIPV in spaces near windows, walls which are facing south and hence capable of producing additional radiation to the building. This BIPV technology is being used for an apartment which has solar rooftop power. The DC power of 24 Volts coming from the rooftop panels is supplied to the DC appliances in the houses in each floor of the apartment. A DC bus bar would be needed for handling this DC power. The AC power source, which is the normal grid with 230 V remains the same. An AC bus bar would be needed for this. This circuit combination of DC and AC in the same house is the novel idea suggested in this study. Hence we are proposing a new configuration for an apartment with BIPV architecture which would be called as Apartments with BIPV architecture using Hybrid DC –AC configuration.

This concept which is thought about is the use of BIPV in multi-storeyed buildings and domestic residential apartments. As mentioned above BIPV can be used efficiently on the side walls of multi-storeyed buildings and apartments. This would facilitate a person residing in say third floor of an apartment to draw the DC power from these BIPV panels which are an abetment to the roof top solar panels providing DC power. The combined effect of BIPV with a hybrid DC –AC circuit in an apartment would be helpful in increasing the total amount of power generated and thereby reducing power consumption for the multi-storeyed building. We have considered a 10 storeyed building with a total of 40 houses and 4 houses in each floor. Fig 6 shows one such residential apartment with rooftop solar and BIPV panels fixed on to the walls.

The areas of high radiation falling on the building, which is usually the south side is earmarked for BIPV panels to be fixed on to the walls. This concept which is termed as segmented architecture would be a trendsetter to increase power generation in buildings

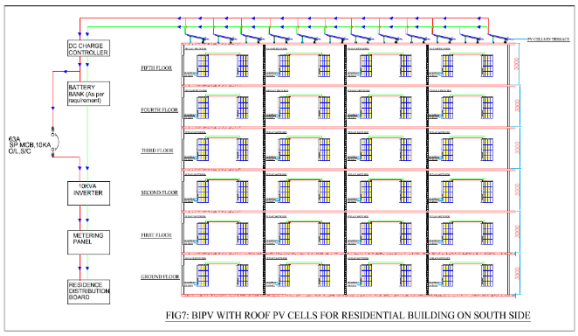

Figure.6. BIPV for a five storeyed building with rooftop solar power

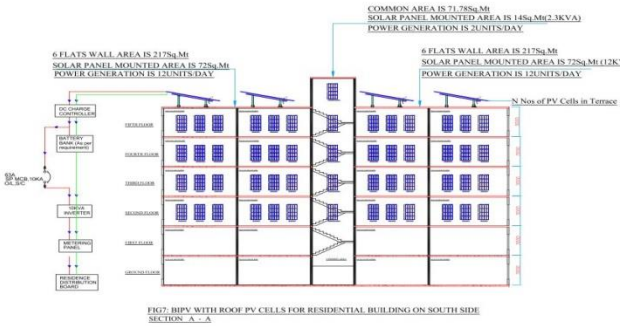

Figure.7. BIPV with rooftop PV cells for residential building

In Fig 7 we observe that the ground and first floor are not fitted with BIPV panels. This is due to the fact that these two floors are usually surrounded by trees and hence the shadow effect comes into picture. Hence we have avoided using BIPV panels in these two floors. The floor and terrace plan are shown in APPENDIX-A which is useful to calculate the total floor area available in an apartment and also the rooftop area.

3. Conclusion

BIPV technology exists today, but in our study we intend to propose a new electrical configuration for residential apartments with BIPV architecture. Rooftop solar panels and BIPV panels would together increase the total radiation falling on the apartment which would thereby reduce the power consumption in the apartments. This configuration which includes segmented BIPV architecture along with rooftop solar power together with hybrid DC -AC circuit is the novel idea brought out from this study. When this method is scaled up to a number of residential apartments, we would see a substantial decrease in power consumption in residential apartments.

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