Singyes Solar Office

Aesthetic integration

A product named ceramic glazing panels, developed by Singyes Solar R&D team, was installed on the façades to achieve the BIPV module appearance, where to integrate real BIPV modules would have been neither economic nor reasonable because of the lack of solar radiation. The ceramic glazing was widely used on the northern façade of this building and some specially-shaped or long-shadowed locations to ensure the overall consistency and aesthetics of the building.

Energy integration

The BIPV systems generate about 150,000 kWh power per year, for this office building with a building area of 23,546 m2, accounting for 12.7 % of the total energy consumption of the building. The annual generating capacity of the PV roof shading, the PV curtain wall, the PV carport and the PV louver parapet respectively is 77,287 kWh, 56,003 kWh, 14,501 kWh and 2,520 kWh power, contributing to 51%, 37%, 10% and 2% of the total generating capacity of the PV systems. Furthermore, the average daily thermal yield from two other PVT systems is about 10,832 kJ and 13,253kJ, which can provide about 60,000 litres of hot water for the building each year.

In this project, the microgrid uses two sets of energy storage inverters to run in parallel to form an AC dual-ended hybrid micro-grid redundant system. The energy management system can effectively regulate and control power resources by energy storage, and can well balance the difference in electricity consumption between day and night as well as different seasons by adjustment to ensure grid security, realizing the traditional UPS function to protect the load side power.

Technology integration

The BIPV modules are integrated in different components, including a curtain wall, a double skin roof, a double skin canopy, a louver parapet, and other configurations form.

The BIPV curtain wall combines the two functions photovoltaic power generation and natural ventilation in one element. A 180° rotatable ventilator is installed on the façade. The system opens the outer channel in summer. The hot air is exhausted by the wind pressure and thermal pressure to increase the power generation of the photovoltaic modules. In winter, the inner channel is opened to bring warm air in, which can improve the interior comfort. When it comes to the transitional seasons, the function can be freely adjusted according to the indoor and outdoor temperature, humidity, air quality and other conditions. The BIPV modules are installed with a plug-in frame type, which can be directly mounted on the corresponding keel to achieve the purpose of rapid installation. At the same time, replacement and maintenance cycles can be shortened without affecting power generation.

The double skin BIPV roof (78.8 kWp) on the roof garden greatly improves the comfort and functionality of the area below. The modules are in the form of an overhead roof, which develops a sunshaded place to walk on. A large number of green plants grow beneath the modules.

The double skin BIPV canopy (17.5 kWp) achieves both the role of rain protection and sun shading. The spacing design of the modules ensures that the lighting effect at the entrance is not affected.

The BIPV louver parapet (8.5 kWp) provides shade to the rest area, improving the comfort, and reduces the roof wind speed.

Photovoltaic thermal modules are installed on the external protective structures, awnings, and roofs,

together with photo-thermal components, so that the building has both the function of power generation and a hot water-supply.

Decision making

To transform every building into a miniature power plant is part of Singyes Solar enterprise culture. At the meantime, it's their duty to spread the green concept of energy saving (Mr Liu, Singyes Solar). In order to reach the goal of an ultra-low-energy, green building in the climate zone with hot summers and warm winters, it was decided to adopt the BIPV technology to increase the self-sufficiency in energy sources (Arch. Luo). Moreover, the BIPV system is a multifunctional component. It can not only generate power, but also support shading and ventilation, which can make a great contribution to energy savings for this project. A balanced design of the BIPV system is seen as a perfect win-win solution, able to both increase the PV power generation efficiency and optimize the building performance.

Lesson learnt

On the one hand, the structural stability and safety of the curtain wall should be considered, which means that the BIPV modules must be able to withstand moderate wind pressure and deformation. In addition, the multi-functionality of the curtain wall was taken into account, which refers to energy generation, ventilation and cooling of the modules in the design. When the ventilator is turned off in summer, the hot air generated by the BIPV modules can be easily exhausted to the outdoor space by the chimney effect. On the contrary, the hot air in the summer would come inside if the devices were turned on. All of the above behaviour can increase the yield of the BIPV modules and reduce the building energy consumption at the same time. (Arch. Luo)

Although it took two years to do research for the application of BIPV in this building, there are two ongoing topics that may have other lessons. One thing are the challenges they faced when they wanted to control the ventilation in the open offices. The people have different feelings about comfort. The other lesson is, in order to reduce the cost and for the convenience of manufacturing, the BIPV modules have transparent plastic backing, which has not been verified in real circumstances before and this may bring some uncertainty of durability for the BIPV modules.

The installation of the BIPV systems on the façades was the most difficult part of the project. On the one hand, the shape of the building is a curved profile, which means that the installation method cannot be followed step by step, and every irregularity and the inclination of the modules should be taken into account. On the other hand, when it comes to the wiring of the BIPV system, the cables must be concealed in the curtain wall and then be led to the interior to be combined within the group of PV modules in the string design. The high-altitude location increased the installation difficulty. Through communication and discussion with the architects, a façade design scheme that met the aesthetic criteria was found and an efficient solar energy system was created. (Mrs. Mao, installer)

The original architectural design scheme was not retained. After optimization of the buildings, the façade area of solar energy utilization increased by 18.34% compared to the previous scheme, effectively increasing the installation area of PV power generation systems and solar hot water systems. What the architect considered was tend to ensure that the artistry of the building was not affected by the addition of the PV systems. The goal of beauty was pursued while still meeting the functional needs. Sometimes it is very hard to have it both ways but Singyes did it. It is a very successful and typical case. The structural safety and electrical safety of building are all very well designed. (Arch. Huang)

Currently, the incremental cost of BIPV is very high, but from the analysis of the entire life cycle of the building, the payback period in BIPV system construction is very short (Mr Liu, Singyes Solar). Considering the annual estimated PV production, the peak electricity price for self-consumption (1.322 RMB/kWh), the regular electricity price for self-consumption (0.8012 RMB/kWh), the subsidy (0.42 RMB/kWh), the average incremental price of the PV system (about 10.5 RMB/W), the investment recovery period of the BIPV systems is about 11.3 years.

About the integration of ceramic glazing imitating the BIPV modules appearance, it significantly reduced the investment cost, while assuring a uniform appearance to the surfaces.

In December 2016, the China High-tech Industrialization Research Association confirmed the Singyes Solar Office building to embody the identity of scientific and technological achievements. It has reached an advanced international level considering the controllable ventilation integrated into the curtain walls, the sun shading and the power generation technology. It achieved China's three-star green building design certificate and the US LEED BD+C NC platinum certification. In addition, it also received the International Eco Design Award, the 2016 First National Distributed Photovoltaic Application Innovation Gold Award, and the SBDE 2015 Challenge Cup Solar Construction Competition Design Award. Singyes Solar is committed to build the most representative green building and ultra-low energy building in the same climatic region in South China and even in the world.

PROJECT DATA

Project type	New construction
Building function	Office
Integration system	Semi-transparent flat roof
Location	Zhuhai, Guangdong, China

BIPV SYSTEM DATA

Module type	Custom made modules
Solar technology	Monocrystalline silicon
Nominal power [kWp]	236
System size [m²]	-
Module size [mm]	-
Orientation	Several
Tilt [°]	Several

BIPV SYSTEM COSTS

Total cost [€]	-
€/m²	-

€/kWp	-

PRODUCER DATA

Producer	Singles Solar
Address	9 Jinzhu Road, Zhuhai City, China
Contact	+86-756-6916666
Web	http://www.sfsyenergy.com/index.php/

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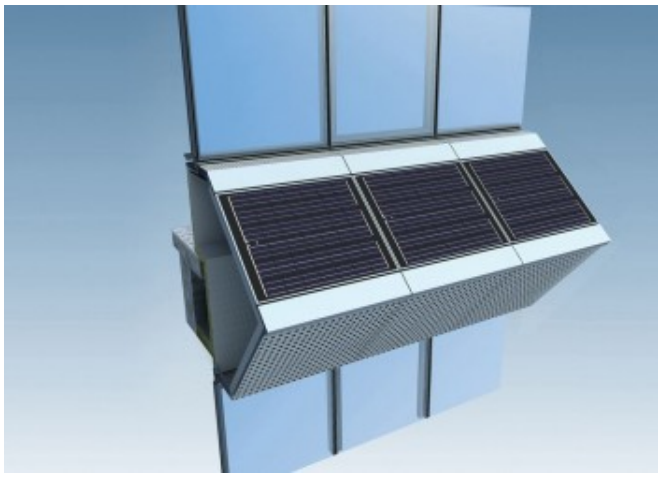

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1. BIPV façade of the building
2. BIPV façades and roofs
3. Aerial view of the main building
4. PV roof structure from the inside
5. Artist's impression of the BIPV façade elements
6. BIPV canopy
7. South-West view of the building