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The examination and use of Solar Energy PV Power

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Abstract - *Based on the use of solar power in high-speed rail stations and canopy architectural design, PV power application has become a major research topic. Solar power is a key strategy to enhance the energy structure. This study analyses the PV power in domestic railway stations, compares independent and grid-connected systems, and solar battery systems. It then suggests two grid-connected systems using monocrystalline silicon panels and amorphous silicon thin film panels. The second plan is ultimately chosen, and engineering practice confirms its correctness and sanity. This is done while taking into account economic, energy-saving, environmental protection, and aesthetic concerns.*

***Key Words*: PV power, independent system, grid-connected system, monocrystalline silicon panels, amorphous silicon thm film panels**

1.INTRODUCTION

Solar PV energy is secure and dependable, with benefits such as minimal disruption, low failure rates, and simple maintenance. In order to reduce the severe energy crisis and environmental damage, this is crucial. Since the energy crisis of the 1970s, every nation in the world has focused more on the development of PV power generation. Examples include the Million Solar Roofs Initiative of the United States, the Sunshine Programme of Japan, the Million Solar Roofs Programme of Germany, and the Bright Project of western China's provinces without electricity[1]. A type of optoelectronic device known as a solar battery uses the PV Effect to convert solar energy into electrical energy. The PV effect, which occurs when a device is exposed to light and produces voltage in the cell between its electrodes and electrolyte[2], was initially identified in 1839 by the French experimental scientist Edmund Becquerel. Currently, the world's new solar battery research and development is concentrated on two areas: efficient crystalline silicon solar batteries and various forms of thin film solar batteries. The conversion efficiency of efficient silicon solar batteries is close to 25%, and that of efficient polysilicon solar batteries is now near 20%. Better low-light performance and relative affordability are thin-film solar battery advantages, but its major drawbacks are low efficiency and light-induced deterioration.

2. PV APPLICATION MODES

The power generation capability is unstable due to sunset, bad weather, and other natural limitations. The independent PV system and the grid-connected PV system are the two application modes for solar PV systems.

(a) Independent PV Systems

The solar component, controller, battery, inverter, and other components make up the independent PV system. Figure 1 depicts the independent PV system's structure. The power unit of the solar component can convert solar energy into direct current[3]. The DC electric energy from the solar component is stored in the battery, which is an energy storage unit. The controller's primary responsibility is to control battery charge and discharge. And an inverter will convert D.C. into AC in order to supply an AC load. Independent power systems' primary flaws are their extremely low storage capacity, increased volume, increased weight, and expensive battery cost. It typically has a 3–5-year operational life and substantial maintenance costs. Battery recycling after damage is another issue.

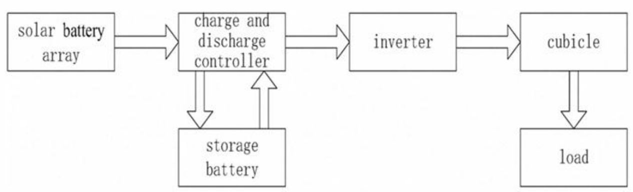

Figure 1: Independent PV System

(b) Grid connected system

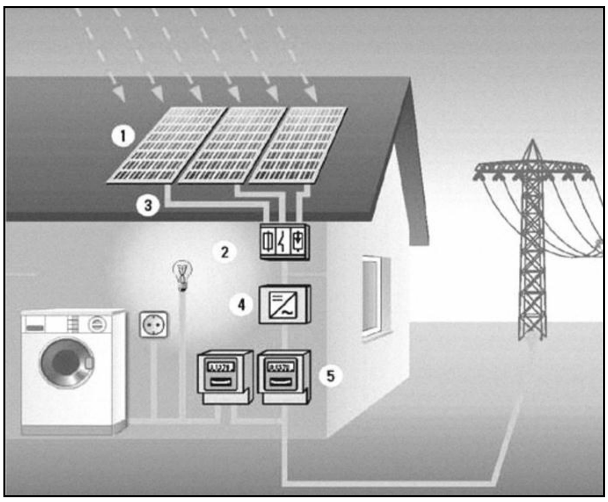

Figure 2: Grid-connected PV system Schematic diagram

The primary trend in PV power generation systems is grid-connected systems. According to Figure 3, a grid-connected

PV power generating system typically consists of a solar battery array[4], a grid-connected inverter, as well as monitoring and data sharing and data collecting tools. Assemble several solar battery modules in series and parallel in accordance with the necessary DC voltage and power generation, then install them on the roof or the ground to create the solar battery array. Inverter and grid-connected protection are the two main components of a grid-connected inverter. The inverter plays a part in electricity regulation by converting the output DC from the array into AC at the same voltage and frequency as the power network. The back-net-connected inverter returns any excess electricity to the grid when the PV system output exceeds the load power demand[5]. The grid system's cost is cheaper than that of a stand-alone system and its operating and maintenance costs are substantially lower because it lacks a battery.

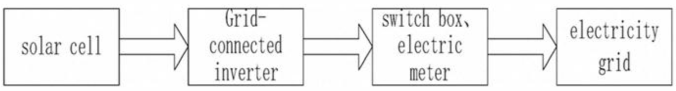

Figure 3: Grid connected PV System structure

The use of solar PV technology ought to evolve in a direction that is scientific, environmentally friendly, useful, new, organic, healthy, progressive, and future-focused. Therefore, using a grid-connected PV system for a solar energy project at a train station is appropriate. This system is more cost-effective, pollution-free, and energy-efficient. It also requires less room for back-end equipment and has lower operation and maintenance costs than a standalone system.

3. PROGRAM COMPARISON AND ANALYSIS.

This article compares the two solar PV schemes based on the design of a rail station house roof in an example of some station, taking into account the present domestic high-speed rail station house and canopy architectural design and the requirement of supplemental solar energy power supply.

1) Grid-connected monocrystalline silicon solar panel system

A. Grid-connected monocrystalline silicon solar panel system composition and operation:

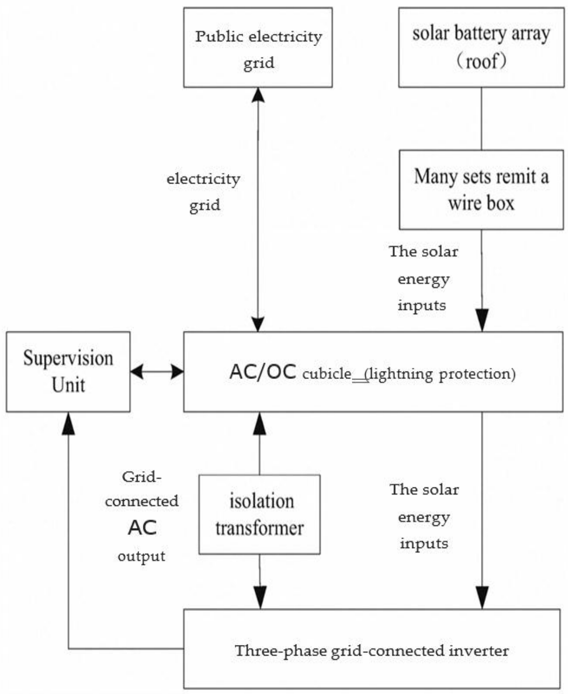

Figure 4: Composition and working principal diagram

Solar arrays, wire boxes, AC/DC cubicles, three-phase grid-connected inverters, remote monitoring units, and other parts make up a grid system. Solar battery arrays convert solar energy from light energy into direct current (DC), which is then changed into the same frequency and phase sine wave current as the grid by three-phase grid-connected inverters. Surplus electricity is then fed into the grid in part for the nearest local power supply. a) a grid-connected inverter, which is primarily used to convert DC power from PV panels into AC power (DC I AC), then supplies electricity to the grid and powers solar cells through an internal power regulator to maximise feedback to the grid; b) wire boxes, which have the function of converging several sun rays into one or more sets of output units to meet the needs of various grid-connected inverter inputs; Grid input, grid power inverter output, and energy distribution of solar panel array DC power input are all handled by an AC/DC cubicle. Grid output and public grid isolation are handled by an isolation transformer. Introductions to the primary components are presented in table I, table 2:

Item	Value
Nominal Power (W)	170
Operating voltage(V)	44.2
Open circuit voltage(V)	44.2
Operating current(A)	4.82
Short-circuit current(A)	5.27

Length / width / thickness (mm)	1593/790/50
Weight(kg)	15.4

Table 1: Parameters of Solar Panel

Item	Value
Maximum PV input power (kW)	145
Nominal AC output power (kW)	125
Maximum PV input voltage (V)	900
AC output voltage range (V)	198-260
AC frequency (Hz)	49.8-50.2
Maximum conversion efficiency	96%
Current harmonics THD (kg)	<4%

Table 2: Main parameters of Grid connected inverter

The principal DC power distribution scheme parameters are as follows: Maximum PV input specifications are 145KW, 1000V, and DC over-voltage protection. Note: Transformer for isolation: Model XNY-380 300G has a 300KVA output capacity and is grid-connected with grid isolation.

B).Definite designs

The electrical system is built to accommodate a grid-connected PV system. Array designed to ensure efficient use of the roof PV panels along the entire south side of the building centre of the layout of 1.620m wide by PV panel's band, choose 170WP monocrystalline solar modules, each of which has 18 cells connected in series to form a board array and has a power of 3.06KW, making up a total of 80 arrays. Eight arrays and 80 sub-arrays require ten exchange line boxes (XNY-HX-8 / I) to provide one exchange line. It contains two 125kW three-phase inverters that are connected to the grid. The system's overall power output is 244.8 KWP, with a laying area of 1858 rn2 and a 250,000-degree annual generation capacity. The triangular frame bracket, which has a strong wind resistance, convenient installation, and a simple structure, is used for the solar modules bracket in accordance with the characteristics of the railway station house. The bracket is made to be adjustable for elevation panels and appropriate for use at various latitudes. This system's features include network and data communication, autonomous and reset control, as seen in Figure 5.

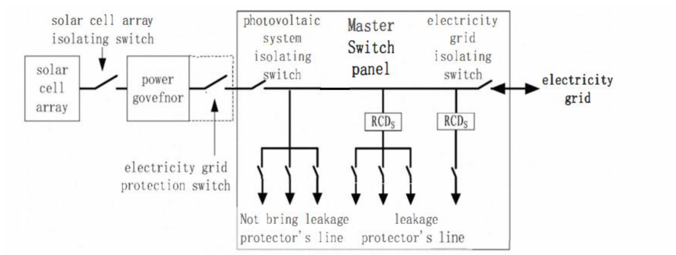

Figure 5: Grid System control diagram

(2) Composition of an amorphous silicon thin film panel grid-connected system, as well as a description of its parameters. The installation of PV panels on an amorphous silicon thin film solar system is unaffected by the original architectural design, and optical film can be adhered to fluorocarbon or polyester coated aluminium plate. Amorphous silicon has a lower photoelectric conversion rate in fine weather than polysilicon and monocrystalline plates, however three-layer membrane adhesion and a large absorption zone can compensate for this. When shielded from the sun's rays, bypass diode technology can nevertheless produce greater photoelectric conversion rates. In Figure 6, the overall system flow is depicted.

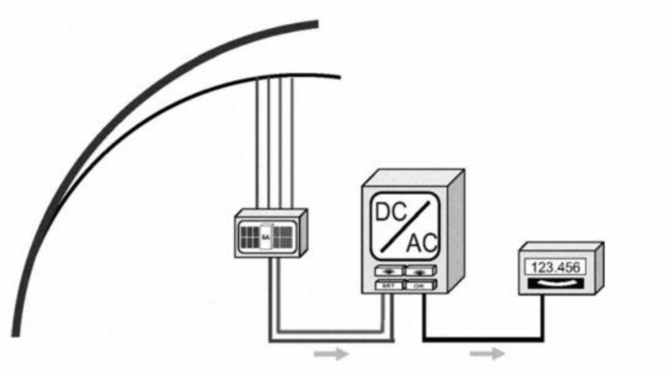

Figure 6: Amorphous thin film Solar system flow diagram

Figure 5 shows that the solar cell, junction box, and inverter make up the majority of this system; the solar cell differs from monocrystalline silicon cells in the grid system. Quick connect terminal DC water-resistant output line of 2.5mm2 with a 560mm length are the output lines; connection across each solar cell for bypass diodes; Durable ETFE (such as Tefzel) high transparent polymer for laminate encapsulation; Glue: microbiological inhibitor-infused ethylene propylene copolymer adhesive sealant; Battery type: ALUPLUSSOLAR PVL-136, which has 22 triple-junction amorphous silicon solar cells connected in series with a dimension of 356 x 239 mm.

Item	Value
Nominal Power (W)	136
Operating voltage(V)	33
Open circuit voltage(V)	46.2
Operating current(A)	5.1
Short-circuit current(A)	5.27
Length / width / thickness (mm)	5486/394/4
Weight(kg)	7.0

Table 3: Parameters of Solar Panel

The solar laminates' power production exceeds the ratings for the first 8 to 10 weeks of use. Perhaps the nominal peak watt output exceeds the 14% rating, the operating voltage exceeds the 11% rating, and the operating current exceeds the 4% rating. Power output specifications are based on the industry-standard test with 1000 W/m2 irradiance, 1.5 air masses, and 250°C cell temperature in a steady environment. Actual performance may differ by up to 10% in terms of output. Low temperature operation, the role of light intensity, and other associated operation may have an impact on the rated power output. The system's maximum operational open circuit voltage is limited to 600 VDC by UL standards.

The energy conversion is finished in a box with this programmed, making it a very comprehensive system. The system also performs network and data communication, as well as autonomous operation and reset control. Along with the following qualities: The use life of a film capacitor is four times longer than that of other capacitors, and sophisticated and combinatorial calculations are used to guarantee maximum power production every hour of every day; fewer standby energy losses to boost the efficiency of power transmission to the utility grid; live line areas to speed up installation and save money; no live connections required between the various components; When the system is in use, network control software restricts the flow of AC; extremely precise peak tracking, with amendments made through the back of each line; significantly more compact thorough system tracking; fast isolation of the defective PV line via the DC contactor.

Scheme Comparison

Item	Scheme 1	Scheme 2
Solar panel type	Monocrystalline silicon	Amorphous silicon thin film
Cell conversion efficiency	14% - 165	8% - 10%
Design power	244.8kWp	245kWp
Paved area	1858m^2	3885m^2
Module efficiency	1 year of decay <1%	1 year of decay 3 - 5%
Rate of decay	12 years of decay <10%	2 years of decay 5 - 7%
Weight (kg/m^2)	15.4	7.0

Table 4: Scheme comparison

3. CONCLUSION

This study introduces the PV power generation system based on the analysis and comparison of the application of typical PV power generation system and the real circumstances of solar power projects for the high-speed rail station building. The demand for economic and energy savings, as well as the functional qualities of scheme 2, encourage the ultimate selection of scheme 2 in this project because there is a lot of paved space in the roof design and the radiation intensity is relatively low where the station building is located. Engineering practise not only validates the correctness and logic of scheme 2 but also demonstrates that the grid-connected system of amorphous silicon thin film solar panels is capable of supplying reliable electricity to high-speed rail station buildings. In the meanwhile, implementation of the programme is highly optimistic for the long-term growth of the PV industry, especially as it is a government policy to get around the energy bottleneck caused by domestic demand and economic growth. The solar PV business has a vast amount of room thanks to national infrastructure designed to enhance the energy structure and fully utilise renewable resources.

REFERENCES

[1] Wu Zhengjun. New and efficient solar cell design and performance [D]. Wu Xi: Jiang Nan University, 2009:

[2] Martin Green Solar Works, processes and system applications [M]. Xiuwen, Xie Hongli, Zhao Haibin, etc. Beijing: Electronic Indyustry Press 1987

[3] Lu Huayong, Yuan Yue. Solar power technology [J]. Jiangsu Elec- trical Engineering, 2008,27 (I) :81-84

[4] Zhao. Solar PV power generation system [D]. Hefei: Hefei University of Technology, 2003:9

[5] Wang Changgui, Rong-Qiang Cui, Zhou Huang The new energy gen-eration technology [M]. Beijing: China Electric Power Press, 2003:129

[6] Hemadez-Como.N,Morales-Acevedo. A. Hetero-junction(HIT)silicon solar cell model for AMPS-ID simulation[C]. In: Electrical Engi- neering, Computing Science and Automatic Control, 2008. CCE 2008. 5th International Conference on, Mexico, 2008, 449-454.

[7] Tanaka, M, Okamoto. S, Tsuge. S, et al . Development of HIT solar cells with more than 21 % conversion efficiency and commercia- lization of highest performance HIT module[C]. PV Energy Con-version , Proceedings of 3rd World Conference on . Osaku , Japan,2003, 955-958.

[8] M.Powalla,M.Cememjak , J.Eberhardt , et al . Large-area CIGS modules: Pilot line production and new developments[J]. Solar Energy Materials and Solar Cells, 2006, 90(18-19): 3158 '3164.

[9] Inyong Moon, Kyunghae Kim, M. Thamilselvan, et al . Selective emitter using porous silicon for crystalline silicon solar cells[J]. Solar Energy Materials and Solar Cells, 2009, 93(6-7): 846-850.