



ASPEN WOODS
GROUP INC.

HCPV SOLAR MODULE



60 Unit Module HCPV = up to 7,200 watts
120 Unit Module HCPV = up to 14,400

1. HCPV PROFILE

HCPV (High Concentration Photovoltaic System) refer in particular to a system whose concentration multiple is greater than 300 (ratio of the lens areas to battery area).

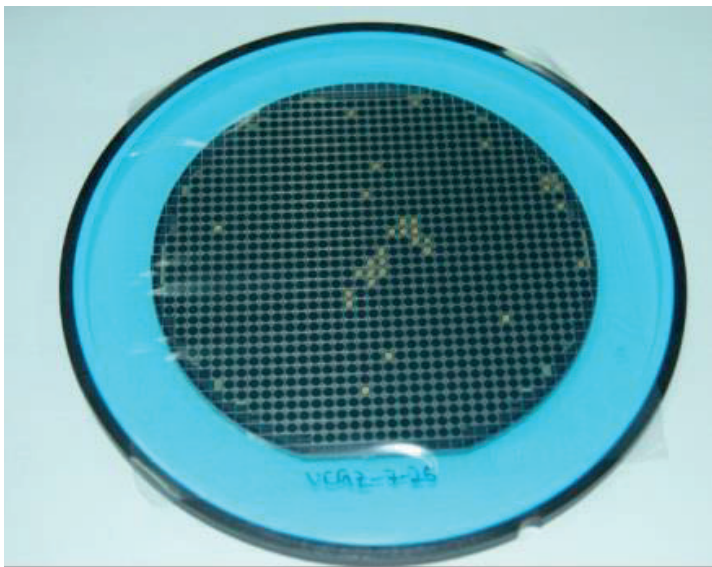
Concentration photovoltaic focuses a large area of sunlight on a tiny area heat-resisting photovoltaic battery chip of high conversion efficiency, using a photovoltaic element such as the optical lens and the like, and converts the light energy directly into electricity through the photovoltaic principle.

Due to the requirements of a light-gathering optics system, it is very strict in the direction of the incident light for the module. It requires the solar tracking system to ensure that the surface of the module will always be perpendicular to it the sunlight during work.

2. THE MAIN FEATURES OF ASPEN WOODS GROUP INC HCPV

Aspen Woods Group inc HCPV, using multi-section gallium arsenide compound semiconductor battery chip applied in aviation as the core and adopting Fresnel lens as the condenser, realizes an efficient concentration and uniform distributions of the luminous power on the chip through micro-prism; it ensures the accuracy of the solar tracking in different conditions with a highly accurate solar tracking system and achieves high reliability, high efficiency, high power generation capacity, low energy consumption during the production process, low environmental load for installation, and low electricity cost in large-scale deployment.

The conversion efficiency of the battery chip is over 40%, the static conversion efficiency of the module (CSTC) exceeding 32%, the maximum efficiency up to 36%, and the dynamic conversion efficiency (CSOC) more than 28%.



Characteristic data of the chip (750 times concentrated):

Size of the chip: 2.7 x 2.7 x 0.2mm;

Isc = 0.43A

Voc = 3.15V

FF = 89%

Pm = 1.2W



Characteristic data of the module (850DNI, Am1.5D):

Size of the chip: 884 x 630 x 136.4mm;

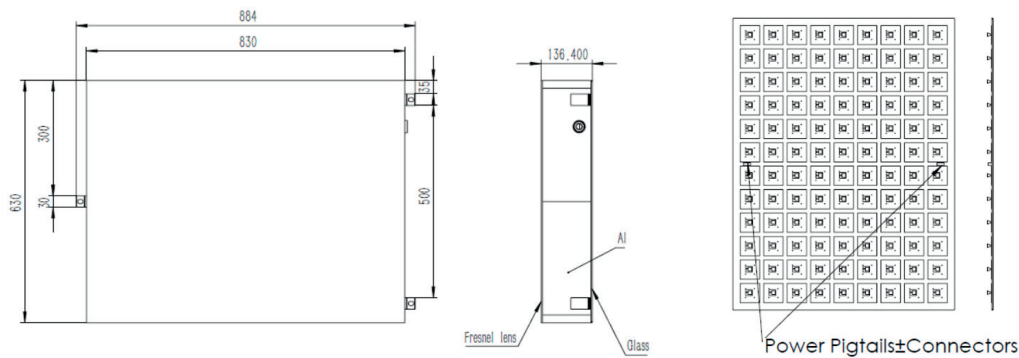
Effective lighted area: 0.48m²;

Isc = 4.5A

Voc = 37.3V

Pm = 120W

MS-HCPV120W-750X Module Diagram



Performance Characteristics (CSTC: Tcell=25, DNI=1000W/ m)

Power(Pmax)	120W
Max Power Voltage (Vmp)	24.5V
Max Power Current (Imp)	4.9A
Open Circuit Voltage (Voc)	26.5V
Short Circuit Current (Isc)	5.7A
Module Efficiency	27.8%
Acceptance Angle	0.9 (Power drop less than 10%.)
Optimized Work Temperature	-40 to 50

Temperature Coefficient

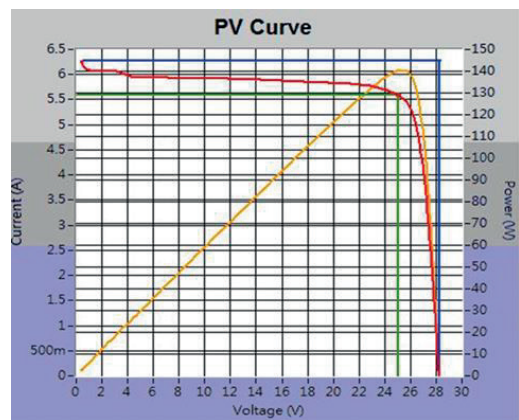
Power	-0.2%
Voltage	49mV/°C
Current	0.98mA/°C

Mechanical Specification

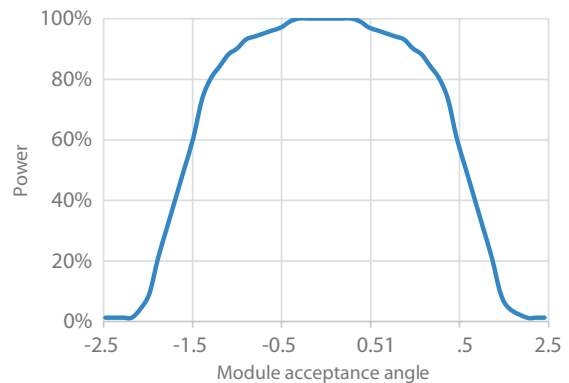
Dimensions (L x W x D)	884mm x 630mm x 136.4mm
Weight	13KG
Connector Termination	4mm ² Plug & MC4 photovoltaic connector
Material	Al + Glass
Fresnel lens	Silicone on Glass (SOG)

Standard

Qualification	IEC 62108
Safety	IEC 62688
Electrical	IEC 62670



I-V Characteristics of MS-HCPV120-750X



wide acceptance angle results from multi-level optics design

3. TECHNICAL HIGHLIGHTS OF ASPEN WOODS GROUP INC SOLAR HCPV

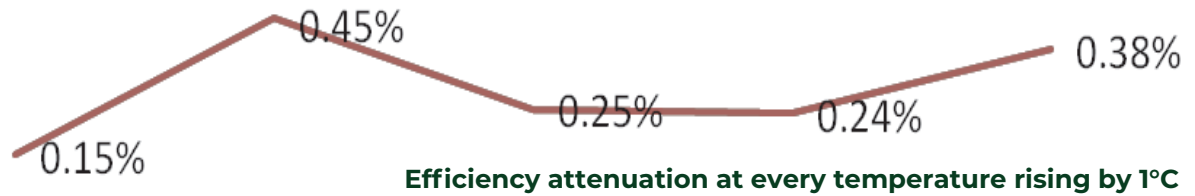
Based on the independent development of the whole industry chain solutions, Aspen Woods Group inc HCPV achieves a significant breakthrough in the following areas:

3.1 THE CHIPS:

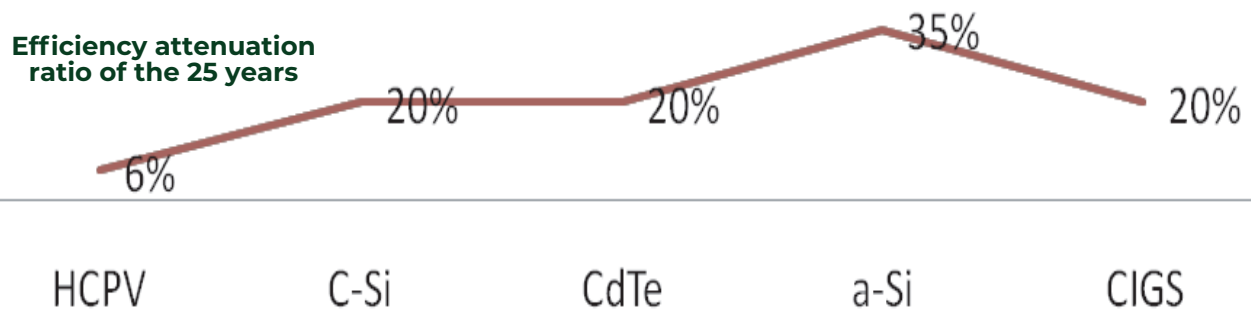
Aspen Woods Group inc HCPV realizes a large scale production in applying HCPV on the ground, based on the design and production capacity of multi-section gallium arsenide compound semiconductor battery chip applied in aviation.

A) High conversion efficiency of the chip: the conversion efficiency of the chip is at present more than 40% and the maximum production efficiency up to 44%, which is far higher than the production ability of current photovoltaic products such as crystalline silicon, thin-film, and the like. Moreover, the production efficiency is now going beyond 44% with the development of chips of more sections;

B) Strong heat adaptability of the chip: decline in the conversion efficiency of the chip is slow as the temperature rises, whose temperature coefficient takes only about half of that of crystalline silicon;



C) Low-efficiency attenuation of the chip: owing to the advanced nanometer film-forming technique, the efficiency attenuation of the chip declines less than 8% upon being used for 25 years of ageing, far less than other batteries does.



3.2 THE MODULE

Aspen Woods Group inc HCPV achieves a high efficiency of solar radiation energy harvesting and conversion and improves the adaptability of the module to the environment through the unique design of Fresnel lens and delicate structure of the second optical device.

A) Light concentration efficiency: relying on the self-designed lens, the average light concentration efficiency of the Fresnel lens has exceeded 85% and even up to 89% maximally, which is far more than that of the products of the similar kinds;

B) Radiation distributing performance: by introducing secondary optical elements, the unevenness of radiation energy distributed on the chip surface has been dramatically reduced, the burden on partial of the chip been reduced, the overall conversion efficiency of the chip been enhanced, and the working life of the chip been effectively extended;

C) Temperature adaptability: the impact on the laser efficiency of the optical system from low and high temperature has been reduced due to the combinational optimization of Fresnel lens and secondary optical device, and the conversion efficiency of the module has been improved either at high or low temperature;

D) Thickness of the module: the thickness of the module has been reduced to only about 100mm through optimization of the optical design, which has lowered the transportation cost and installation difficulty;

E) Light transmittance performance: because the front and back of the module are both made of glass, the scattered light can penetrate the module, which enhances the light at the shade of the module and does well to the plant growth inside the environment.

3.3 THE SOLAR TRACKING SYSTEM

Aspen Woods Group inc HCPV realizes a high accuracy in solar tracking and a good power generation productivity through an independently developed tracking system.

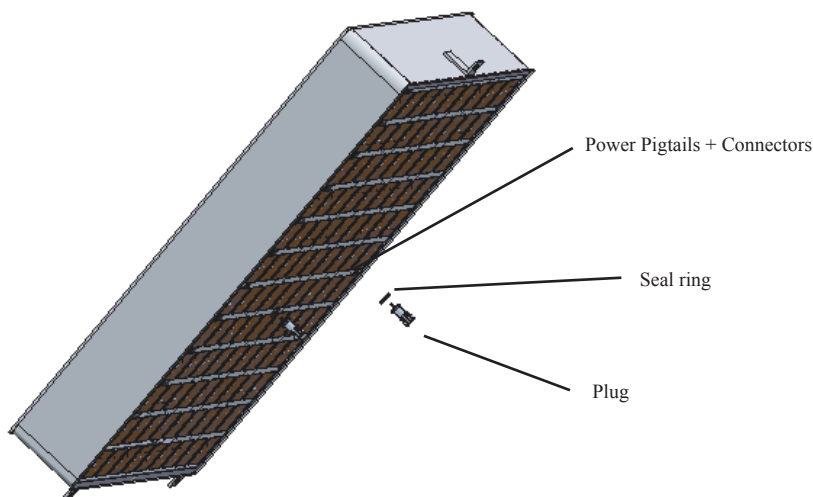
A) High accuracy of solar tracking: high accuracy of solar tracking of 0.1 is guaranteed by high precise bracket machining process control, optimized installation technologies for bracket and module, and combined solar tracking strategies;

B) High survival wind speed of the system: the system survival wind speed can achieve 40m/s and more, based on the high strength bracket and status control mode optimized according to the field condition;

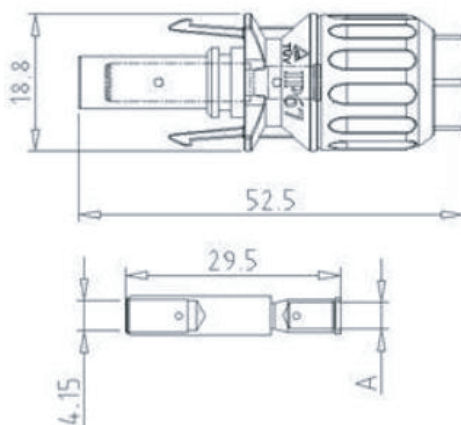
C) Easy installation: viewing from the point of field installation, the module installation process can be simplified, and the system installation efficiency can be improved through a combination optimization of the module and bracket;

D) Large power generation capacity: in sunny days, the daily generation capacity of HCPV can be 30% more than that of crystalline silicon in power stations near the electricity load centre;

E) Small solid floor area: Aspen Woods Group inc SOLAR HCPV modules are over 0.5m above ground, which can be further elevated according to the customer's requirements to reduce the impact on crops on the environment so that the comprehensive utilization and benefit of the land can be improved.



Module Plug Installation



MC4 photovoltaic connector

MATERIAL OBJECT PHOTO OF HIGH POWER CONCENTRATING POWER GENERATION SYSTEM



Gallium arsenide CPV power generation method is gradually becoming the focus of solar energy field. PV power generation has experienced 1st-generation crystalline silicon cells and 2nd-generation thin film cells; currently, industrialization process is gradually turning to power generation of high efficiency gallium arsenide CPV system. Comparing with the previous two generations of cells, gallium arsenide CPV adopts multijunction III-V family compound cell, has the advantages of high photoelectric conversion efficiency, wide spectrum absorption range, high land utilization rate, stable electricity generation, minimal impact of temperature rise on efficiency, low attenuation within the total life cycle.

1) High photoelectric conversion efficiency: Comparing with the 1st-generation and 2nd-generation solar power generation technology, gallium arsenide CPV has higher conversion efficiency, conversion efficiency of its multijunction gallium arsenide cells is 68% theoretically. Actual conversion efficiency of module mass production at the current level is 32% at most (static test data).

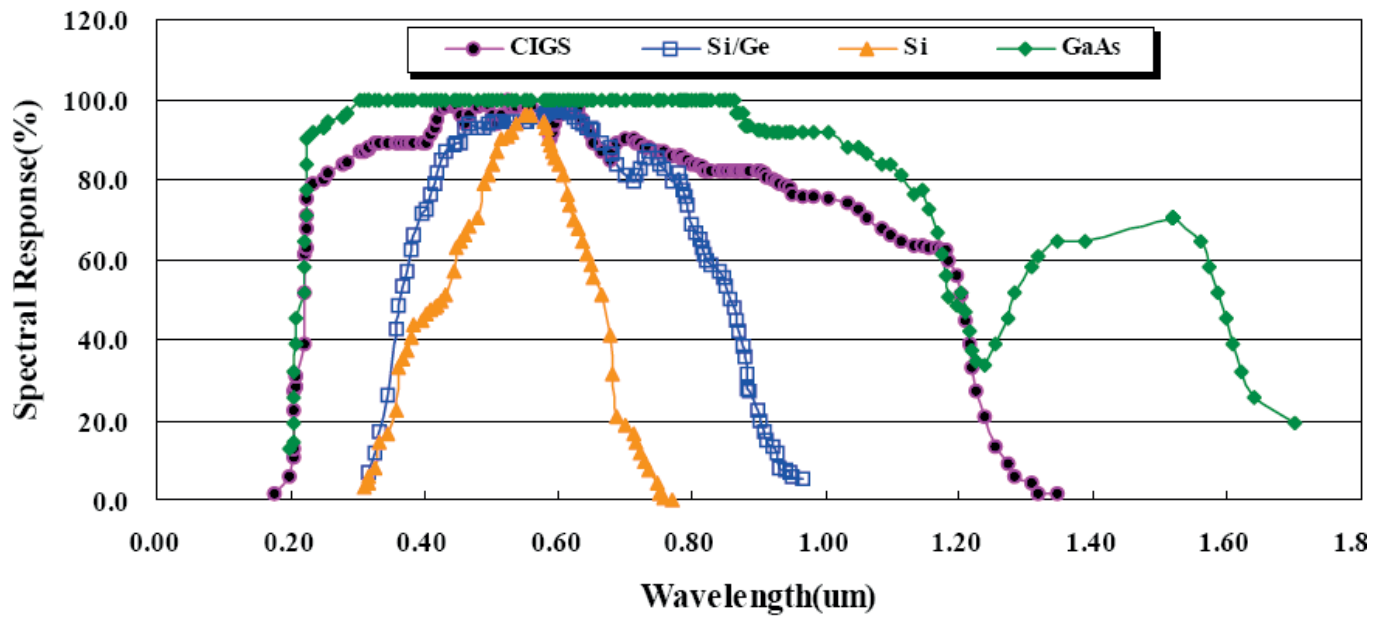
COMPARISON OF CONVERSION EFFICIENCY OF DIFFERENT MODULES

2) WIDE SPECTRUM

Photovoltaic type	HCPV	Monocrystalline silicon SI	Film (a-si)	Photothermal CSP
Module conversion efficiency	32%	19%	12%	13%
Theoretical conversion rate of chip	68%	29%	20%	≤35%

Absorption range: GaAs belongs to III-V family compound semi-conductor material, its energy gap matches solar spectrum well, can realize wider spectral response comparing with other solar cells, and withstands high temperature.

COMPARISON OF ABSORPTION WAVELENGTH OF DIFFERENT CELLS



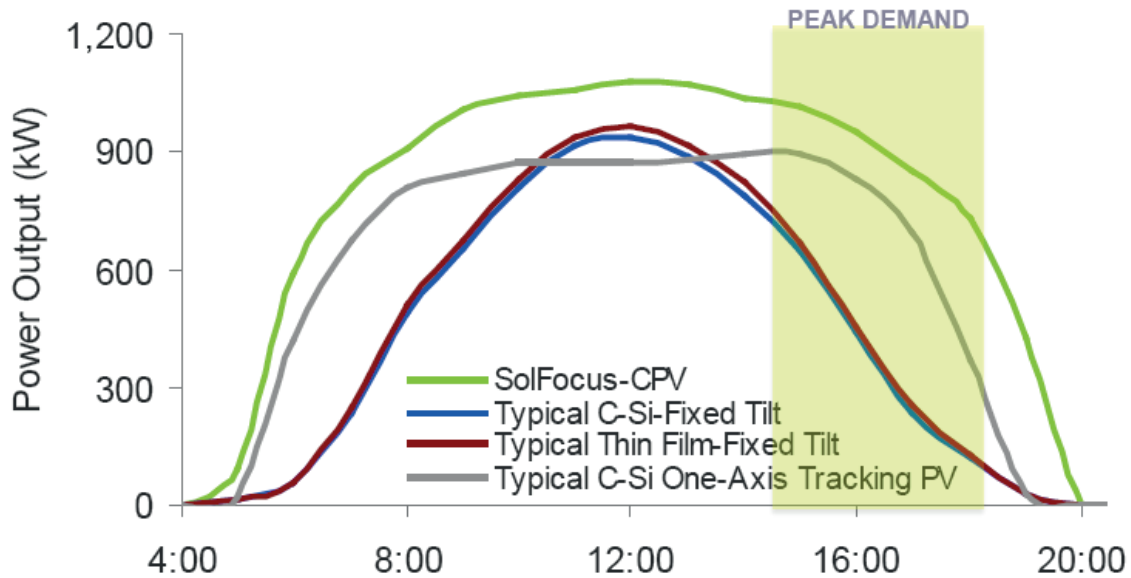
3) High land utilization rate: Gallium arsenide CPV power generation system adopts dual-axis tracking, the land is multipurpose, is suitable for all kinds of terrains. The land can be expropriated by points, floor space is extremely small, the vacant land can be used for planting and breeding.

COMPARISON OF ABSORPTION WAVELENGTH OF DIFFERENT CELLS



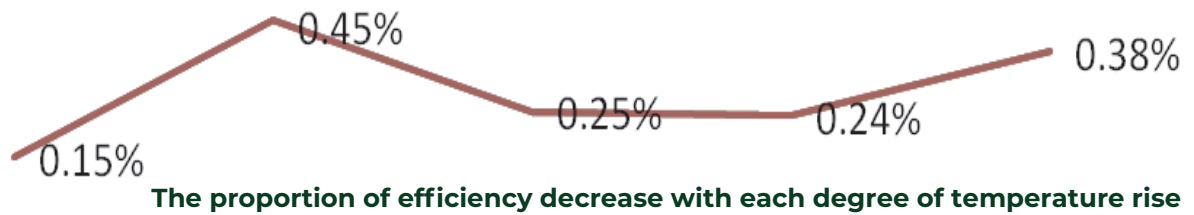
4) Stable electricity generation: Gallium arsenide CPV power generation system adopts dual-axis tracking, the module aims at sunlight and generates power when the sun rises, electricity generation of the whole day is stable, is more friendly for power grid.

COMPARISON OF ELECTRICITY GENERATION OF DIFFERENT MODULES



5) Minimal impact of temperature rises on efficiency: Gallium arsenide CPV modules adopt gallium arsenide solar cells and reasonable structural design, temperature coefficient is lower comparing with other types of solar modules, is more advantageous in the environment of larger temperature difference and higher temperature comparing with other solar modules.

COMPARISON OF TEMPERATURE COEFFICIENT OF DIFFERENT MODULES

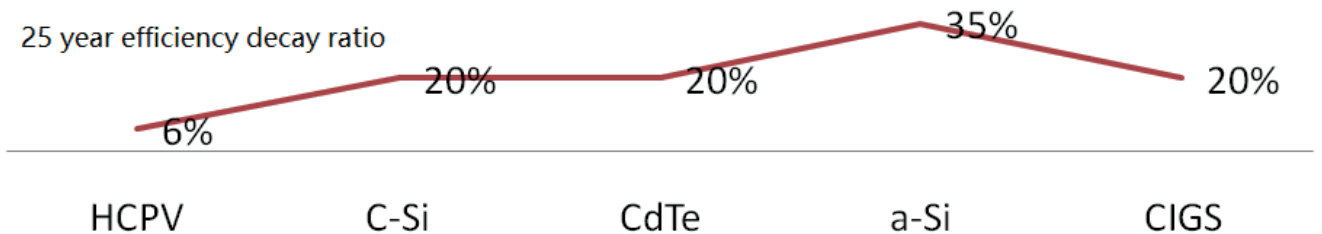


The proportion of efficiency decrease with each degree of temperature rise

HCPV C-Si CdTe a-Si CIGS

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COMPARISON OF ATTENUATION RATIO OF DIFFERENT MODULES



HCPV C-Si CdTe a-Si CIGS

APPLICATION OF GALLIUM ARSENIDE CELL CPV TECHNOLOGY

Since gallium arsenide CPV system is relatively complex, its economical efficiency is not high for small-scale and commercial PV projects; it is generally used for large-scale PV power station which installed capacity is 1MW-1000MW in the area with sufficient luminous energy. High efficiency gallium arsenide CPV solar power generation system which is made up of Fresnel lens concentration, triple-junction solar cells, polar type or base type tracking system and integrated control method, has the advantages of strong power generation capacity, easy for production, sealing protection of moving parts, easy to maintain, is very suitable for large-scale PV power station.

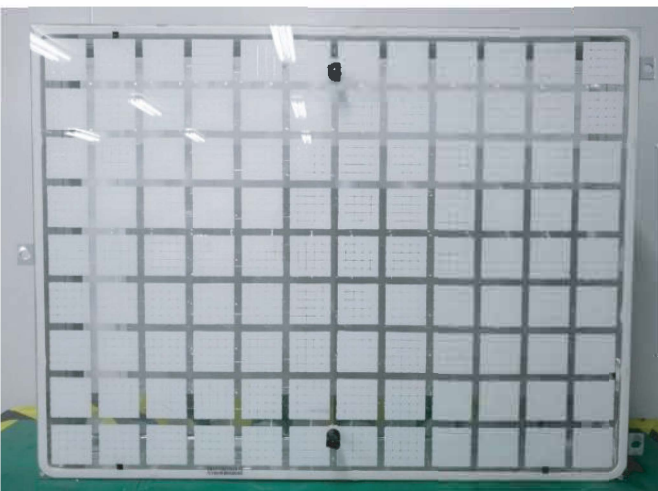
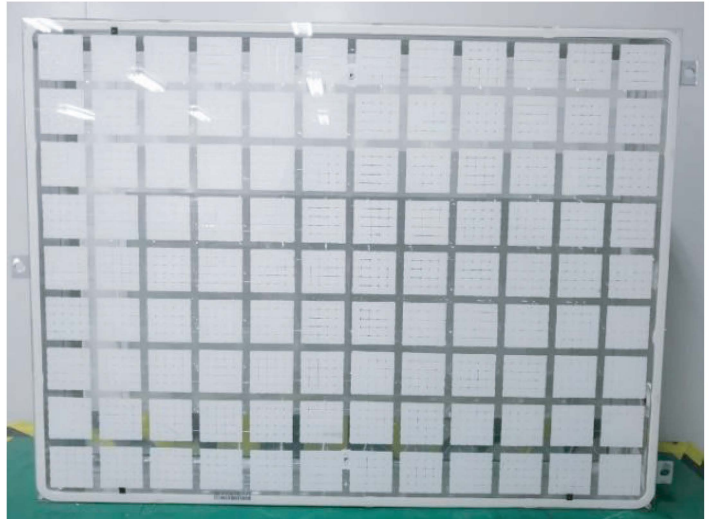
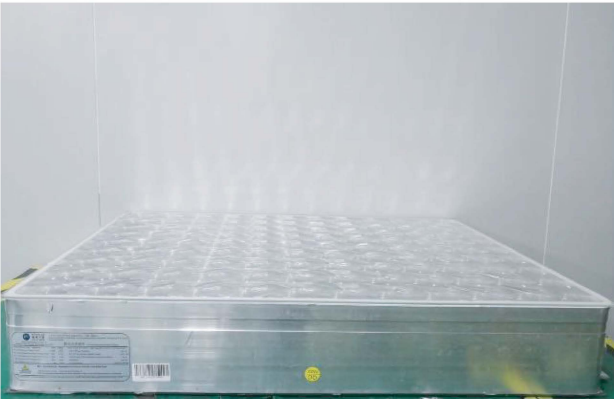
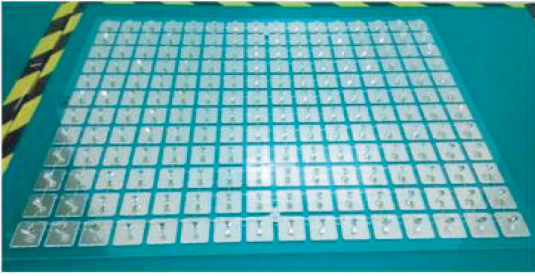
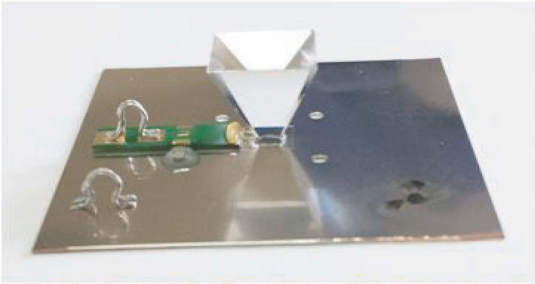
REAL SCENE OF QINGHAI 50MW PV POWER STATION IN LANZHOU CITY, GANSU PROVINCE



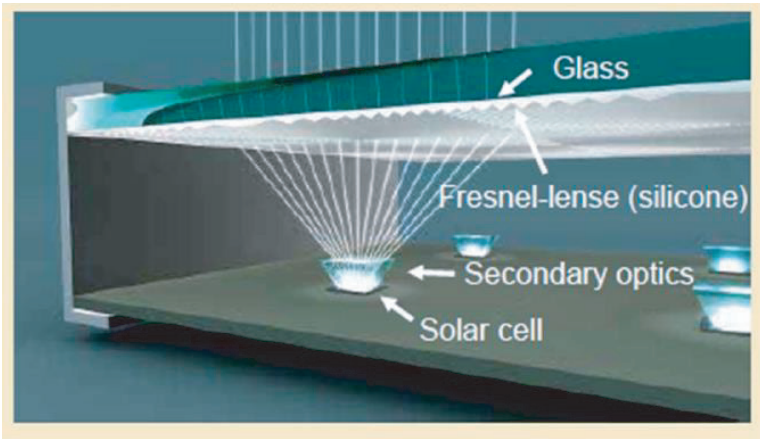
III. INVESTMENT BUDGETARY ESTIMATE OF 3RD-GENERATION GALLIUM ARSENIDE CELL CPV

REAL SCENE OF PRODUCTION WORKSHOP OF HIGH POWER CONCENTRATING MODULES





AWG-HCPV120W-750x Module Physical Photos & Wire Connection





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