Building Mobile Energy

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Hanergy
Thin Film Power

# HANERGY THIN FILM POWER GROUP



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# COMPANY PROFILE

**Hanergy Thin Film Power Group, one of the leading thin-film solar companies in the world, is regarded as forerunner of global thin-film solar industry. Hanergy is committed to its mission of "Change The World With Thin-Film Solar ".**

Since 2009, the group has been focusing on the thin-film solar industry and has pioneeringly created the “mobile energy” industry through robust investment and R&D in thin-film solar technology. In 2017, “mobile energy” strategy, as a significant part for promoting the supply-side structural reform, was for the first time brought up in the documents of the State Council.

Focusing on the strategic pipeline of thin-film solar power, Hanergy engages in the integration of the entire industry chain ranging from technology research and development, high-end equipment manufacturing, component production and application product development, etc. based on its world-leading thin-film solar technology. Today, Hanergy leads the way in scale and technology in the thin-film solar industry.

**Leading Technology:** Hanergy has successively acquired the German company Solibro as well as American companies MiaSolé, Global Solar Energy and Alta Devices. Setting up eight R&D centers around the world, Hanergy maintains five world records in the efficiency of thin-film solar generation by means of global technology integration and continuous independent innovation. Among those world records, the GaAs module has been certified by the National Renewable Energy Laboratory (NREL) with a maximum conversion efficiency of 31.6% and has broken the world record for several times.

**High-end Equipment:** Hanergy has consistently taken the lead in meeting that end and promoted the localization and mass production of thin-film solar equipment. Currently, it already possesses super GW-class equipment delivery capabilities and has become the leading “turnkey provider” of thin-film solar production lines around the globe. Through cooperation with a number of mobile energy industrial parks, sales of thin-film solar production line solutions have been realized and large-scale delivery has been started.

**Product Application:** Hanergy has been centering upon customers’ needs and carrying out product layout in the key area of residence, travel and application. It constantly carries out research and development in innovative high-quality products and solutions that allow every ordinary item to become a solar power generator, enable the application of solar power to break through the boundary of imagination, and put ubiquitous solar power into free use. At present, thin-film solar products of Hanergy have been widely used in the fields of building roofs, walls, roads, automobiles, ships, shared bikes, UAVs, satellites, portable outdoor chargers, electronic equipment, special equipment, etc. In response to the need of reducing energy consumption in cities, Hanergy has launched a holistic solution to help with the construction of “eco-cities, low-carbon cities and beautiful cities”.

The energy revolution has begun. Hanergy will seize the opportunity presented by global energy transformation and low-carbon development, focus on the thin-film solar industry chain, and continue to promote the industrialization and marketization of thin-film solar technology, so as to make thin-film solar technology a real “green” solar technology that benefits all and gradually achieve the great mission of "Change The World With Thin-Film Solar”.

(Photo) Hanergy Mobile Energy Holding Group Headquarters at the Olympic Forest Park in Beijing

SOLIBRO
A Hanergy Company


Germany-based Solibro was founded in 2006. In September 2013, Hanergy Thin Film Power Group completed the acquisition of Solibro's CIGS technology intellectual property and its Swedish technology research company Solibro Research AB. Through this acquisition, Hanergy grasped the most efficient glass-based copper indium gallium selenide(CIGS) thin film solar technology, obtained the mass production champion module(AA), which broke the world record in the efficiency and thus, became the world's leading thin-film solar cell enterprise for basic research and development, production line delivery and battery and module production.

Solibro has more than 10 years of continuous production and operation experience, with capabilities and experience in delivering a fully integrated, turnkey production line, namely, equipment-process-industrialization. Solibro is also capable of integrated control of construction and production costs in order to deliver low-cost production lines. Currently, Solibro has capabilities to deliver holistic support for the turnkey project from designing the CIGS POWER LINE to operating production line.



MiaSolé
A Hanergy Company


The US-based MiaSolé was established in Silicon Valley in 2004. In September 2013, Hanergy Thin Film Power Group acquired the entire intellectual property rights of MiaSolé. Through this acquisition, Hanergy obtained the world's most advanced copper indium gallium selenide (CIGS) flexible thin film solar cell magnetron sputtering deposition technology and broke the world record in the efficiency of its mass production champion module (AA).

MiaSolé is one of the pioneers of copper indium gallium selenide (CIGS) flexible thin film solar cell technology. As the representative of solar energy companies in the Silicon Valley, United States, MiaSolé could continuously complete all the CIGS cell thin film deposition processes without breaking the vacuum with the support of the world's only CIGS one-stop automatic winding magnetron sputtering coating system, which makes it become the world's leading manufacturer of high efficient flexible thin film solar cells and modules.

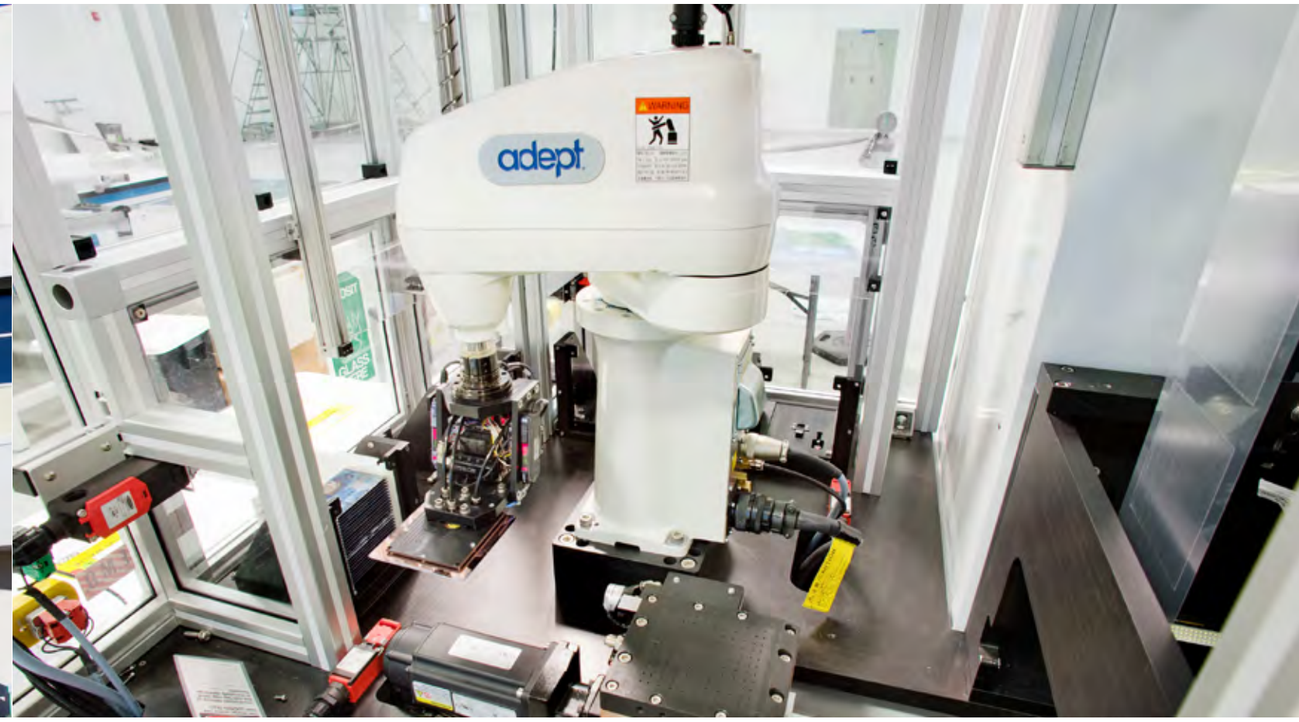
GLOBAL SOLAR
A Hanergy Company


The US Global Solar Energy (referred to as "GSE") was founded in 1996 and was wholly acquired by Hanergy Thin Film Power Group in December 2014. Through this acquisition, Hanergy could mass produce the world's most efficient flexible co-evaporated copper indium gallium selenide (CIGS) products, making it possible to become the world's leading provider of flexible copper indium gallium selenide (CIGS) thin film solar energy production solutions and product manufacturers.

GSE is one of the world's pioneers in flexible thin film solar energy and has devoted itself to the research and development and mass production of flexible film products for more than 20 years. Back in 2002, GSE developed the first portable commercial product based on flexible film CIGS cell. As early as 2011, GSE flexible module series PowerFlexTM was certified by the international authorities and mass production was achieved. After being acquired by Hanergy, GSE revolutionarily developed the new ICI (Integrated Cell Interconnect) technology, which has effectively reduced the production cost of the product while improving production efficiency and raw material utilization rate. Today GSE has become the most mature enterprise in the commercialization of flexible thin film technology with the most proven track records in the installation of flexible CIGS thin film solar projects.



ALTA DEVICES
A Hanergy Company




On January 27, 2015, Hanergy Thin Film Power Group acquired the entire issued share capital of US Alta Devices. Through this acquisition, Hanergy obtained the GaAs technology, the most efficient flexible thin film technology. Moreover, Hanergy further consolidated its technological edge, which enabled Hanergy to become an undisputed leader in the technology of solar PV industry. Alta Devices is a world leading solar cell manufacturer, manufacturing the most efficient GaAs solar cell, which empowers the widespread mobile power application. Hanergy Alta Devices holds the new single junction solar cell record at 28.9% efficiency certified by the National Renewable Energy Laboratory.

# GLOBAL PRESENCE

# DEVELOPMENT MILESTONE

## 2009

Ushered into the solar energy industry after acquiring Apollo Precision Ltd. and its subsidiaries, to become a leading global supplier on manufacturing thin-film modules and on providing with integration solutions led by technology.

## 2013

Emerged as a leader in the thin film solar industry with production capacity of 3GW through acquisition of MiaSolé in the US, Solibro's CIGS technology intellectual property, and technology research company Solibro Research AB.

## 2014

Acquired Global Solar Energy of the United States, to emerge as the thin-film solar energy enterprise with the maximum market value in the world.

## 2015

Acquired Alta Devices of the United States, continuously running ahead of global photovoltaic enterprises. Subsequently, became first company in the world to advocate the concept of “Mobile Energy”, unveiling green and smart life in the future.

## 2016

Released an all solar-powered vehicle, a whole new option for green transportation, based on the technology and components of Hanergy Thin Film Power Group.


## 2017

Released a new product HanTile, reducing the energy consumption of relevant buildings to zero.


## 2018

Released new generation HanTile and developed some other brand new mobile energy products, including Humbrella and HanPack.

# CHANGE THE WORLD WITH THIN-FILM SOLAR

From satellites in outer space and unmanned aerial vehicles in the sky to cars, trucks, shared bikes, boats, backpacks, tents, mobile phones, houses, roads, etc. on the ground, all these can generate electricity with solar energy, and store, trade and share the solar power. Thus, we intend to offer energy at anytime and anywhere through our path-breaking thin-film solar technology to usher in a new era of mobile energy.

# A LEADER OF THE GLOBAL THIN-FILM SOLAR INDUSTRY

1.Lead Energy Trends

2.Global Technology Integration

3.Five Technological Roadmaps

4.High-end Equipment Manufacturing

5.Continuous Independent Innovation

# LEAD ENERGY TRENDS

Solar energy offers the greatest advantages in renewable energy, and thin-film and flexible solar modules represent the general trend and future of the global solar industry. At present, thin-film solar cells of the third generation represented by copper indium gallium selenide (CIGS) are known for their features such as flexibility, lightness, good performance in weak light, color tuning, shape plasticity etc.

Focusing on the thin-film solar roadmap, Hanergy has formed a whole industry chain business model covering upstream core technology research and development and high-end equipment manufacturing, midstream solar cell modules manufacturing, and downstream thin-film power generation system integration solutions through active industrial layout, and has become the No.1 thin-film solar enterprise in the world in terms of scale and technology.

## Hanergy's thin-film solar industry covers three of the key development fields in "Made in China 2025"


## Hanergy's thin-film solar industry covers six major fields in the "eight national strategic emerging industries"

# GLOBAL TECHNOLOGY INTEGRATION

## Establishment of technology and application product development centers across the world:

Hanergy has successively acquired Germany-based Q-CELLS's subsidiary Solibro, US-based MiaSolé, Global Solar Energy (GSE) and Alta Devices, and has established eight technology research and development bases in Beijing, Sichuan, Jiangsu, Silicon Valley of the United States, Germany and Sweden.

In addition, Hanergy established Global Application Product R&D Headquarters in early 2018, and set up four R&D centers in Beijing, Shenzhen, Silicon Valley of the United States, Munich of Germany and Milan Design Center, forming the 4+1 application product R&D system.

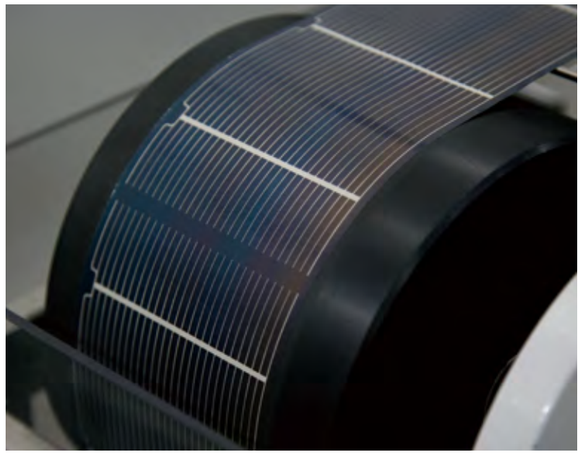
## Integration of global leading thin-film solar technologies:

Before being acquired by Hanergy, Solibro, MiaSolé and GSE all engaged in the CIGS technology, boasting world-leading core technical advantages respectively and competing with one another. After merger and acquisition, Hanergy convenes a quarterly technical meeting of CTOs of global branches, to maximize the advantage of technology synergy, break technical barriers, and let technical experts share technical solutions integrating raw materials, equipment, patents, etc. Thus, GSE contributes its safest flexible encapsulation technology to MiaSolé; GSE benefits from Solibro's co-evaporation method, to improve the conversion efficiency of mass production; the integrated cell interconnection (ICI) encapsulation technology that Hanergy is proud of is developed jointly by MiaSolé and GSE, forming complementary advantages.

Hanergy's integration of global technologies in the thin-film solar field accelerates innovation in thin-film solar technology, and dramatically improves improving conversion efficiency, which has been increasing by at least 1% each year.

# FIVE TECHNOLOGICAL ROADMAPS

Hanergy has five technological roadmaps covering all the cutting-edge technologies in the field of thin-film solar and converts the technological superiority into applications in all walks of life to upgrade the power supply of products in the fields of buildings, public facilities, transportation, aerospace and consumer goods, leading disruptive transformations in the energy industry.



## CIGS flexible film (co-evaporation method)

US-based Global Solar Energy's Technology

### Product Features

Conversion efficiency of 18.7%.

With the features such as light weight, ultra-thin appearance, flexibility, direct adhesion and low installation cost, it is suitable for lightly loaded and curved roofs, and applicable for the development of civil products.

### Target Markets

Mass consumer goods, thin-film solar BIPV, vehicle applications, special products, and electronics.

## CIGS glass-substrate film (co-evaporation method)

Germany-based Solibro's Technology

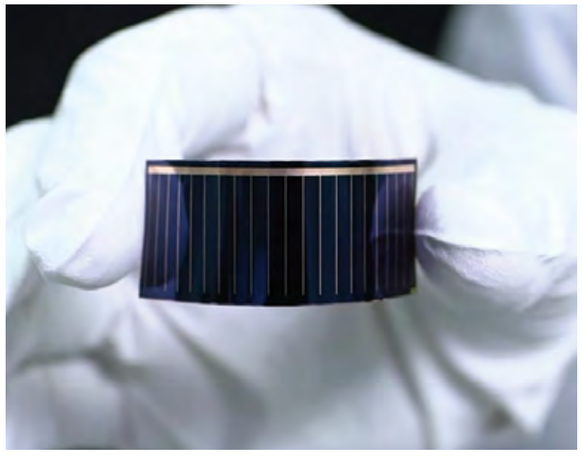
### Product Features

Conversion efficiency of 21%; the module (AA) with the highest conversion efficiency of 18.72% sets a world record.

Beautiful appearance, excellent high-temperature performance, convenient installation, excellent self-cleaning function, and easy maintenance.

### Target Markets

Household systems, BIPV glass thin-film solar walls, distributed and ground-mounted power stations.



## GaAs Flexible Film

US-based Alta Devices

### Product Features

With conversion efficiency of single-junction solar cells being 28.9%, and that of double-junction solar cells being 31.6%, the mass production conversion efficiency of single-junction solar cells is 25.1%, the highest in the world.

Ultra-light, ultra-thin, flexible and easy to shape, with high conversion efficiency, and especially good performance at high temperatures and in weak light.

### Target Markets

Mobile, portable or wearable products, outdoor products, consumer electronics and the high-end solar applications such as unmanned aerial vehicles and satellites.

## CIGS flexible thin-film (sputtering method)

US-based MiaSolé's Technology

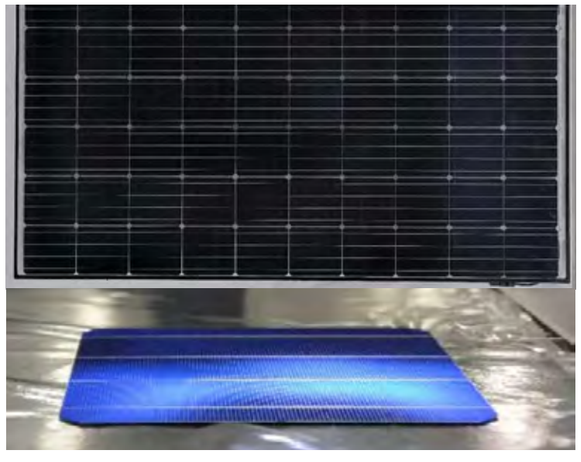
### Product Features

Conversion efficiency of 19.4%; the module (AA) with the highest conversion efficiency of 17.44% sets a world record of CIGS sputtering technology.

With the features such as high conversion efficiency, light weight, ultra-thin appearance, flexibility, direct adhesion and low installation cost, it is suitable for lightly loaded and curved roofs, and applicable for the development of civil products.

### Target Markets

Mass consumer goods, thin-film solar BIPV, vehicle and vessel applications, special products, and electronics.



## High-efficiency Silicon Heterojunction Technology (SHJ)

### Product Features

Conversion efficiency of 23.7%.

Such modules with stable performance, low temperature coefficient, high power output at high temperatures and double-glass panels can be used for more than 30 years, and both panels can generate electricity, dramatically improving the capacity of power generation.

### Target Markets

Widely applicable in the markets of distributed power stations, BIPV, acoustic insulation, agricultural applications, fishery/livestock combined with solar power generation, sewage treatment plant power generation, and mobile energy.

# HIGH-END EQUIPMENT MANUFACTURING

## Localization and large scale of thin-film solar technology:

Hanergy not only has "thin-film solar cell" manufacturing technology, but also has “thin-film solar cell production equipment (high-end equipment)”.

From a global perspective, the core equipment for manufacturing thin-film solar cells is basically non-standard, and there are no independent equipment manufacturers or general technology and equipment. Hanergy is the first to progressively and completely realize the localization of auxiliary equipment, peripheral equipment and some core equipment parts, significantly improving production efficiency and reducing costs through the large-capacity upgrade of core equipment.

## One-stop production line delivery:

As the world’s largest “thin-film solar production line” turnkey provider, Hanergy is second-to-none in the industry with the capability to manufacture and deliver “thin-film solar equipment” production lines, and provide partners with integrated solutions such as integration, installation, debugging and technical services.

# CONTINUOUS INDEPENDENT INNOVATION

Hanergy believes that the secret of an evergreen enterprise is “continuous reformation and innovation”, so attaches great importance to R&D and investment, to take up the leading position in technological advancements.

## Talent: The R&D team of nearly 2000 staff around the world constitutes the core competitiveness of Hanergy.

### Lars Stolt — Hanergy Academician

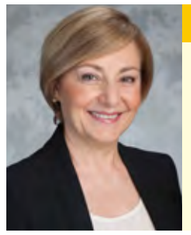
The founder of Solibro and current Chief Technology Officer of the company, member of the Scientific Advisory Committee of Helmholtz Center in Berlin, engaged in the study of raw material and energy. He has led the thin-film solar technology research group of Uppsala University to break a world record in 2000, by increasing the conversion rate of thin-film photovoltaic modules to 16%. Under his leadership, Solibro's technology has been world-leading. By now, Lars has obtained 21 patents and has published more than 130 papers in authoritative journals at home and abroad. Due to his outstanding contributions, he was awarded the Chemical Science and Technology Award by the Swedish Association of Chemical Engineers in 2007.

### Li Yuanmin — Hanergy Academician

Current Chief Technology Officer of Hanergy Solar Union, advisor member of SEMI China, with 30 years of research experience in the field of semiconductor film and solar cells. Under his leadership, Boyang has made world-famous achievements in the development of silicon solar cells, and has originated several advanced technologies in the development of amorphous silicon photovoltaic modules, setting a world record as well. He has obtained more than 40 patents at home and abroad. Over 70 of his academic papers have been published in several international authoritative journals such as APL, Physical Review B and MRS.

### Xu Xixiang — Hanergy Academician

As Chief Technology Officer of Hanergy Solar Union now, he has been engaged in the study and development of semiconductor material and silicon-based thin-film photovoltaic technologies for more than 30 years, with a lot of inventions and technological breakthroughs in silicon-based alloy thin-film material properties, high-frequency plasma glow thin-film deposition technology(VHF and microwave), and laminated solar cell devices. Personally participated in and led the R&D team to obtain several world records for silicon-based thin-film solar cells: from 2007 to 2010, set a world record for “the conversion efficiency of widespread amorphous silicon and amorphous silicon germanium triple-junction cells” (confirmed by the National Renewable Energy Laboratory (NREL)). He has published more than 110 technical papers in international journals and academic conferences.



### Atiye Bayman — Hanergy Academician

Current Chief Technology Officer of MiaSolé, who has made great contributions in the fields of thin-film solar technology and equipment, improving the conversion efficiency of products and realizing scale production. Under her leadership, MiaSolé has become an enterprise with the highest scale production efficiency in the field of thin-film solar energy. She has won 9 US patents and 9 patents of other countries, and has been invited to major international conferences of the solar industry.

### Harry Atwater — Hanergy Scientist

Founder and Chief Technical Advisor of Alta Devices. He obtained his Doctor of Science in electrical engineering from MIT. He is currently a Howard Hughes Professor and Professor of Applied Physics and Materials Science at the California Institute of Technology, and has been appointed as director of the Resnick Sustainability Institute Science, Energy and Sustainability recently, which is the biggest research program focusing on energy sponsored by the California Institute of Technology. He has written or co-authored more than 200 publications. Besides, he is also Director of the Energy Frontier Research Center at the US Department of Energy (DOE), mainly engaged in the study of optical interactions during solar energy conversion.

### Scott Wiedeman — Hanergy Scientist

Currently acting as the chief scientist of Global Solar Energy, with nearly 30 years of solar cell R&D experience mainly in material and equipment technology, improvement of efficiency, development of new technology, etc., and has obtained 4 patents in the United States. He led the development of the integrated cell interconnection technology, designed high-efficiency and low-cost interconnection methods and products for thin-film photovoltaic cells, and recommended maximizing manufacturing costs with ICI.

Eli Yablonovitch

Ding Jian

Brendan

Melissa

Eric Wallin

Olle Lundberg



## Patents and Standards:

As of August 26, 2018, Hanergy already has a total of 3700 effective patents, out of which 900 are granted patents. This further re-instates Hanergy's continuous technological innovation and market development in thin-film solar industry. Hanergy participated in the drafting and compilation of more than 10 national standards and industry standards for thin-film power generation; and has the title of national “High-tech Enterprise” .

Hanergy’s patents

MIT Technology Review

### 50 SMARTEST COMPANIES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 Illumina | 2 Tesla Motors | 3 Google | 4 Samsung | 5 Salesforce.com | 6 Dropbox | 7 BMW | 8 Third Rock Ventures | 9 Square | 10 Amazon |
| 11 Tencent | 12 Snapchat | 13 Cree | 14 Box | 15 BrightSource Energy | 16 Wal-Mart Stores | 17 General Electric | 18 Qualcomm | 19 Kaggle | 20 Second Sight |
| 21 SpaceX | 22 Kickstarter | 23 Hanergy Holding Group | 24 Siemens | 25 1366 Technologies | 26 Uber | 27 Evernote | 28 Baidu | 29 GitHub | 30 Xiaomi |
| 31 Oculus VR | 32 Qihoo 360 Technology | 33 Monsanto | 34 Aquion Energy | 35 IBM | 36 Jawbone | 37 Medtronic | 38 Valve | 39 Genomics England | 40 D-Wave Systems |
| 41 Siluria Technologies | 42 Kaiima Bio-Agritech | 43 Datawind | 44 Freescale Semiconductor | 45 Upworthy | 46 LG | 47 Expect Labs | 48 AngelList | 49 Arcadia Biosciences | 50 Ripple Labs |

Diagram source: The official website of MIT Technology Review

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## Awards:

Won the World’s Most Influential Technology and Business Awards for three consecutive years:

MIT Technology Review

- Hanergy’s subsidiary Alta Devices was successively awarded the Most Disruptive Enterprise in 2012 and 2013
- In 2014, Hanergy was included in the World’s Most Innovative Enterprises, ranking 23rd ahead of Siemens and IBM

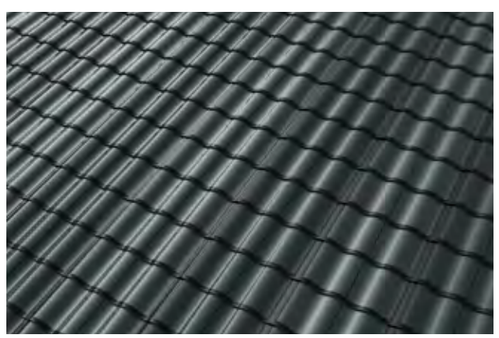
# UBIQUITOUS THIN-FILM SOLAR PRODUCTS

# HANTILE

## The ecology of HanTile is inheriting the heritage and glorifying the present

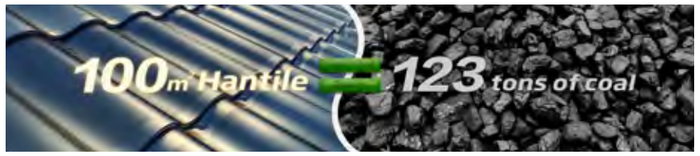
HanTile encapsulates flexible thin-film solar generation cells into curved glasses with high transparency and polymer composite. HanTile is a mixture of the traditional tile design and modern technology to create brand new green building tiles that can replace traditional tiles as a part of energy-saving building materials.

The name “HanTile” is derived from “Qin bricks and Han tiles” implies respect for and inheritance of the Chinese culture. HanTile, through Hanergy’s world-leading technologies, embodies the harmony between technology and art, and between human and nature.



## HanTile initiates the change of roofs globally

The creation of HanTile change the traditional way of mounting photovoltaic modules on building roofs by innovatively integrating thin-film solar cells with traditional roof tiles. The HanTile makes the architecture no longer rely on external energy, and possible to achieve zero energy consumption. HanTile matches various architecture styles in the world through Hanergy’s world-leading flexible thin-film solar technology.






## One HanTile equals One Green Tree

The effect of a house installed with 100m$^2$ HanTile is equivalent to reduce 123 tons of coal-burning within 30 years, which means to reduce 322 tons of carbon dioxide emission, 1,045kg of sulfur dioxide, and 910kg of nitrogen oxides, and is equal to plant 340 trees. Consequently, for each piece of installed HanTile, the reduced carbon emission in a year equals to the environmental value of a green tree.

## Every shining house needs HanTile

While inheriting the artistic sense of glazed tile, single-glass HanTile and double-glass HanTile from the HanTile family will be available in the market in different sizes, modellings, colors and powers. These products meet the different needs of customers and can apply to various styles of architecture.

# HANWALL

## Hanergy thin-film solar power wall system solutions with a sense of professionalism and quality

Hanergy's thin-film solar power wall system solution is a whole set of Building Integrated Photovoltaic (BIPV) solution from project research, design and consultation to installation and implementation. Based on different application scenarios, functions and ways of installation, the thin-film solar power wall system is mainly divided into walls, lighting rooftops, sunshades, etc., and also includes some innovative applications such as agricultural greenhouses, expressway soundproof walls and bus stops.

### Landmark Building Customized Solution:

Hanergy is capable of delivering integrated customized solution for the architecture field from design, construction to after-sales.

**Design:** improve architectural concept, optimize design structure, efficiently deploy modules and well organize power generating system.

**Construction:** provide technical support at the construction site and fully participate in the system commissioning and acceptance.

**After-sales:** 10-year warranty is provided.

## Solutions

1 As sunshades mounted on the upper facades of buildings through combination or integration

2 As rooftop material integrated and mounted on the lighting rooftops or skylights

3 As building components mounted on rooftops through combination or integration

4 As wall integrated with and mounted on walls (can be made into translucent or nontransparent walls)

5 As building material or components mounted on rooftops or facades through combination or integration

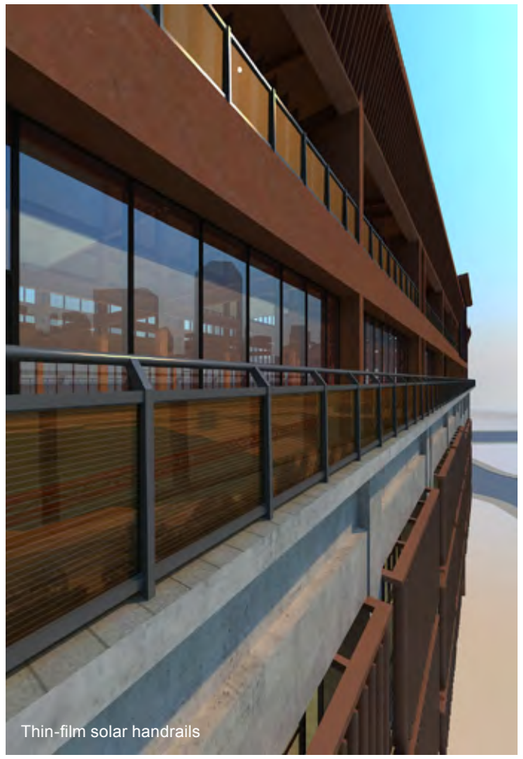
6 As building components mounted on and combined with steel structures

7 Thin-film solar LED illuminated buildings

## Practical applications


Thin-film solar lighting rooftop


Colored thin-film solar power wall


Thin-film solar handrails


External hanging thin-film solar power wall between storeys/windows

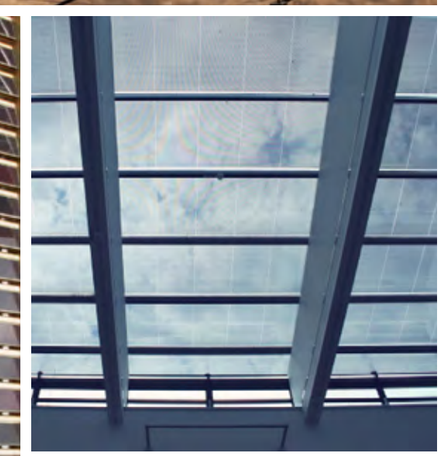

Point supporting thin-film solar power wall

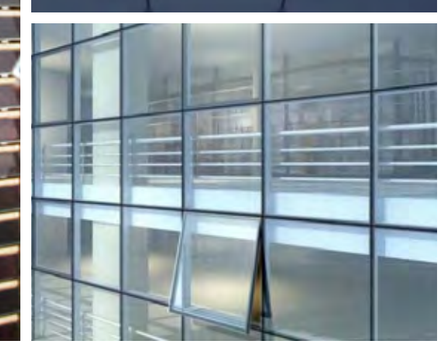

Facade thin-film solar power wall


Thin-film solar carport


Thin-film solar rooftop


Thin-film solar blinds





# HANROAD

## Hanergy Thin-film Solar Road Solution

Hanergy thin-film solar road is a new application giving play to the “light, thin and flexible” characteristics of the thin-film solar technology, which can not only replace traditional roads to meet basic traffic needs, but also get clean electricity directly from sunlight, to provide mobile power supply for innovative technologies such as “vehicle battery charging, unmanned driving, intelligent road, accurate positioning, the Internet of Vehicles, the Internet of things and big data”, promote the development of smart cities, and meet the infinite imagination in our life.

In 2014, the world’s first “SolaRoad” came out in a small town named Krommeie in the Netherlands. The road surface can absorb and convert sunlight into electricity, and directly power the colorful lights in it, looking like the starry sky at night, which is so mysterious and beautiful that the road caused a sensation around the world. This road is equivalent to a large solar panel, of which the solar cells are the PowerFlex modules provided by Hanergy’s GSE, so Hanergy also enters this brand new field and sees the broad space for the application of thin-film solar technology in road building. The project is of greater value as it arouses more imagination about “smart roads”, opens a brand new direction for the development of road works and is of epoch-making significance to progress in human civilization.

At the end of 2017, the first thin-film solar road developed and designed by Hanergy in China was completed in Olympic Forest Park in Beijing, which can absorb and convert sunlight into electricity and store it to power other electrical equipment in the day and illuminate itself at night, as well as melt ice and snow through a sensor controlled self-heating system...

Hanergy’s thin-film solar road solution is the first to be put into practice, with the largest number of cases and the longest term of tests on real roads. At present, Hanergy has attracted wide attention from the government and people from all walks of life and received a lot of cooperation invitations, so please stay tuned for more innovative solar roads.

# HOUSEHOLD APPLICATION • THIN-FILM SOLAR SOLUTION

## Hanergy thin-film solar household power generation system

Based on leading thin-film solar generation technology, Hanergy has launched a family-oriented series of household power generation systems that install high-performance thin-film solar cell modules on one-storey buildings, sunrooms and villas with independent property rights and rooftops, converting sunlight into electricity for home use and selling surplus electricity to the national grid.


## How it works

High-performance solar modules are installed on the rooftops, to form solar cell matrices after series and parallel connection, which can absorb sunlight and generate direct current, and convert the direct current into alternating current for home use through the converter, with surplus electricity transmitted to grid companies to earn incomes at a corresponding price.

## Technical advantages

- Good performance under weak light and long power generation of 10 hours per day
- Low temperature coefficient and good performance under high temperature
- Low power loss under shadowing
- The three series of products boast leading advantages in environmental protection, safety and service life respectively

## Provide standard scenarios and customized solutions

### Household Solar Rooftop System

It is specially designed for ordinary families, adopting the thin-film solar system supporting private power generation for private use, sale of surplus electricity to the national grid, and government subsidies.

#### Product Features

- A power generation system specially designed for household use
- Private power generation for private use, sale of surplus electricity to the national grid, and government subsidies
- Modular installation, quick and convenient
- Made of glass, beautiful and elegant
- Raise awareness about environmental protection and improve living quality

### Sunroom Solar System

Hanergy's thin-film solar sunroom series of products are a new BIPV system combining Hanergy's translucent thin-film BIPV components with a special aluminum alloy profile system organically, which do not only provide owners with a beautiful, safe and reliable architectural space but also use solar energy to create clean energy.

#### Product Features

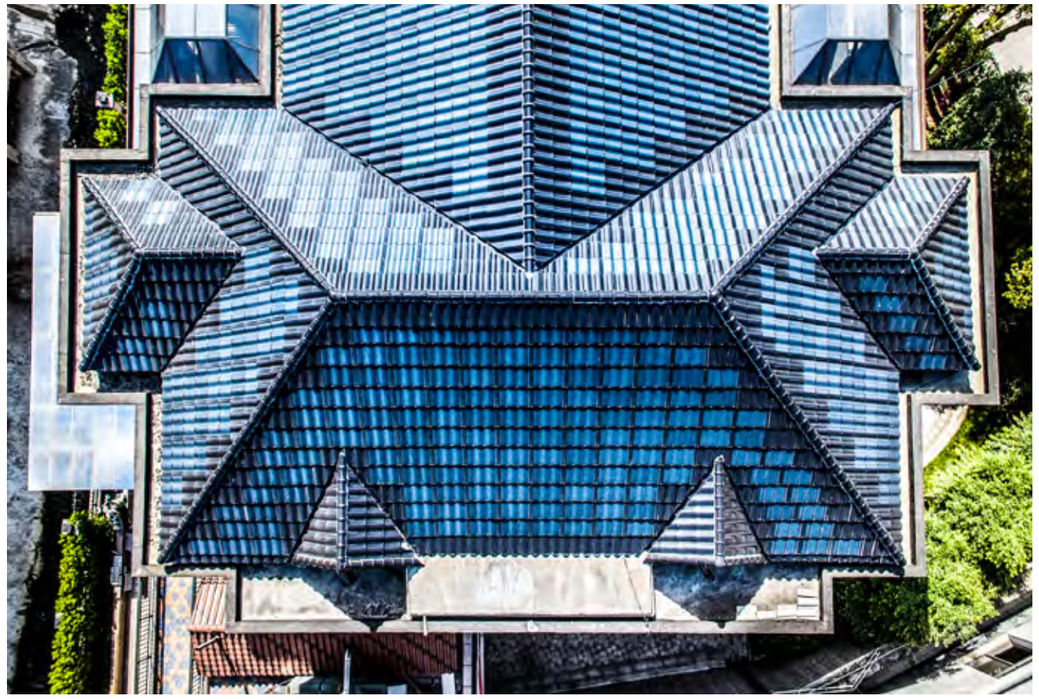
- Safe and comfortable
- Adopting Hanergy's translucent hollow laminated thin-film solar modules, the glass structure is highly safe, sound proof, insulated and comfortable
- With beautiful appearance, selectable color and light transmittance, and a special profile system for concealed wiring, the modules look beautiful as a whole, and are customizable
- Hanergy's off-grid energy storage system which is optional provides a more flexible system solution
- Universal standard thin-film modules are adopted, with a standardized and modularized structural system, which needs low costs for maintenance

### Carport System

Hanergy's carport system is a thin-film solar system designed specially for home/commercial carports, with two types of products for carports with one parking space and double parking spaces respectively, which are strong and stable and look beautiful and elegant with the combination of safe and stable solar modules and carports.

#### Product Features

- Professional design
- Safe and stable structure
- Beautiful and elegant
- Energy conservation and emission reduction
- Reduce the risk of direct exposure of vehicles to sunlight
- Provide clean energy for new energy vehicles in the process of parking



HanTile Villa Project in Changan Village, Yangjiaotang Town, Anhua County, Hunan Province (Installed capacity: 17.1kWp)

HanTile Project in Changshui Village, Huangshan Town, Yulong Naxi Autonomous County, Lijiang City, Yunnan Province (Installed capacity: 6.7kWp)

HanTile Project in Small Jewelry Village, Beiwu Town, Shunyi District, Beijing (Installed capacity: 10kWp)

The small house project in Yuen Long District, Hong Kong (Installed capacity: 5 kWp)

The EPC project in Yongxing Island in Sansha of Hainan (Installed capacity: 5.2 kWp)

The famous singer's residence project in Beijing (Installed capacity: 5 kWp)

The household solar project in Guoyuan Community of Xucheng Town in Xuyi County of Jiangsu (Installed capacity: 4 kWp)

The household solar project on No. 2 Huaxia Road of Pudong New Area in Shanghai (Installed capacity: 1.5 kWp)

The household solar project in Huadu District of Guangzhou (Installed capacity: 33 kWp)

The household solar project of Shoufu Villa in Huaibei of Anhui (Installed capacity: 264 kWp)

# COMMERCIAL APPLICATION • THIN-FILM SOLAR SOLUTION

## Hanergy's commercial thin-film solar generation system

On the basis of our several self-produced high-efficiency thin-film modules, Hanergy makes full use of various scenarios such as industrial workshops or commercial roofs, forming systematic solutions to the design, development, sale and maintenance of highly reliable and stable thin-film solar power stations, realizing the green upgrading of electricity used by companies and factories.

### Helps enterprises increase income and reduce expenditure

#### Reduce energy consumption, and save cost

Relieve the pressure on electricity of the building, decrease the energy consumption of the building and thus substantially reduce the cost for the company.

#### A comfortable and sweet space for enjoyment

With the special characteristics like thermal insulation, BIPV components can adjust the indoor temperature independently, bringing comfortable experience and visual enjoyment.

#### High returns on investment

Enterprises using photovoltaic modules can enjoy the support policies of China such as power generation subsidies, to get investment returns fast and earn stable profits for a long time.

#### In response to the government's call, be a model of environment-friendly and energy-saving enterprises

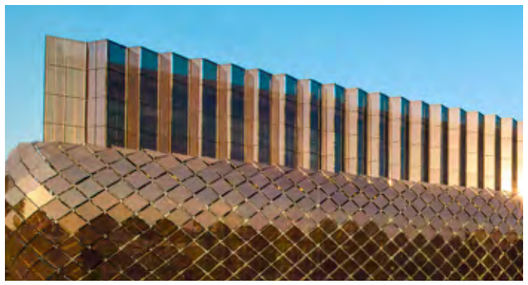
As a clean energy source, photovoltaic power generation conforms to the environmental protection orientation vigorously promoted by the government. Enterprises in active response have a good opportunity for publicity and improvement in their images.

## Golden Roof Campaign:

In March 2016, Hanergy launched "Golden Roof Campaign", collecting high-quality roof resources from the whole society, which aroused wide attention within just 2 months and created a "golden storm" in the whole new energy industry. By now, dozens of companies, including Evergrande Real Estate and Sinopec, have signed cooperation agreements with Hanergy.

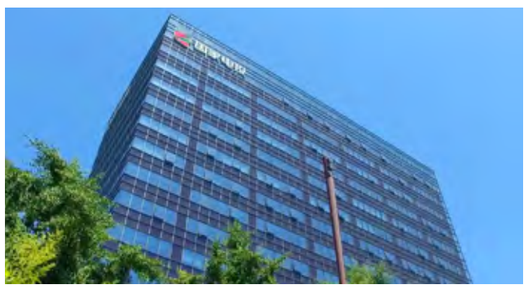
## Application Cases


Hanergy Renenable Energy Exhibition Center (Installed capacity: 270 kWp)



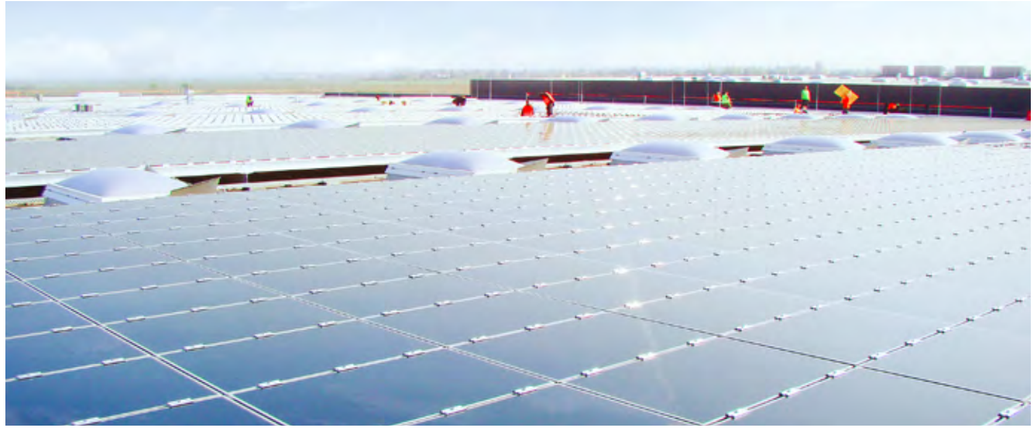
Hanergy Headquarters BIPV Demonstration Project (Total installed capacity of 3mWp and phase I installed capacity of 600 kWp)

The MARKBOX landmark container house off-grid system in Pat Heung, Yuen Long, Hong Kong(Installed capacity: 3 kWp)



SPIC Office Building (Installed capacity: 170.66 kWp)

The thin-film solar roof project in L'Aquila of Italy (Installed capacity: 837 kWp)

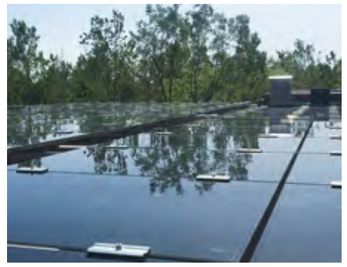


The thin-film solar wall project in Thalheim of Germany (Installed capacity: 25.6 kWp)

Beijing IKEA Roof Photovoltaic Power Station Project (Installed capacity: 416.24 kWp)

The thin-film solar generation project in Foshan Plant of FAW VOLKSWAGEN (Installed capacity: 10 mWp)

Guangqi Honda Distributed Thin-film Solar Project (Installed capacity: 17 mWp)



Show Flat in Longfor Lieche New city, Gaobeidian, Baoding City (Installed capacity: 10.44kWp)

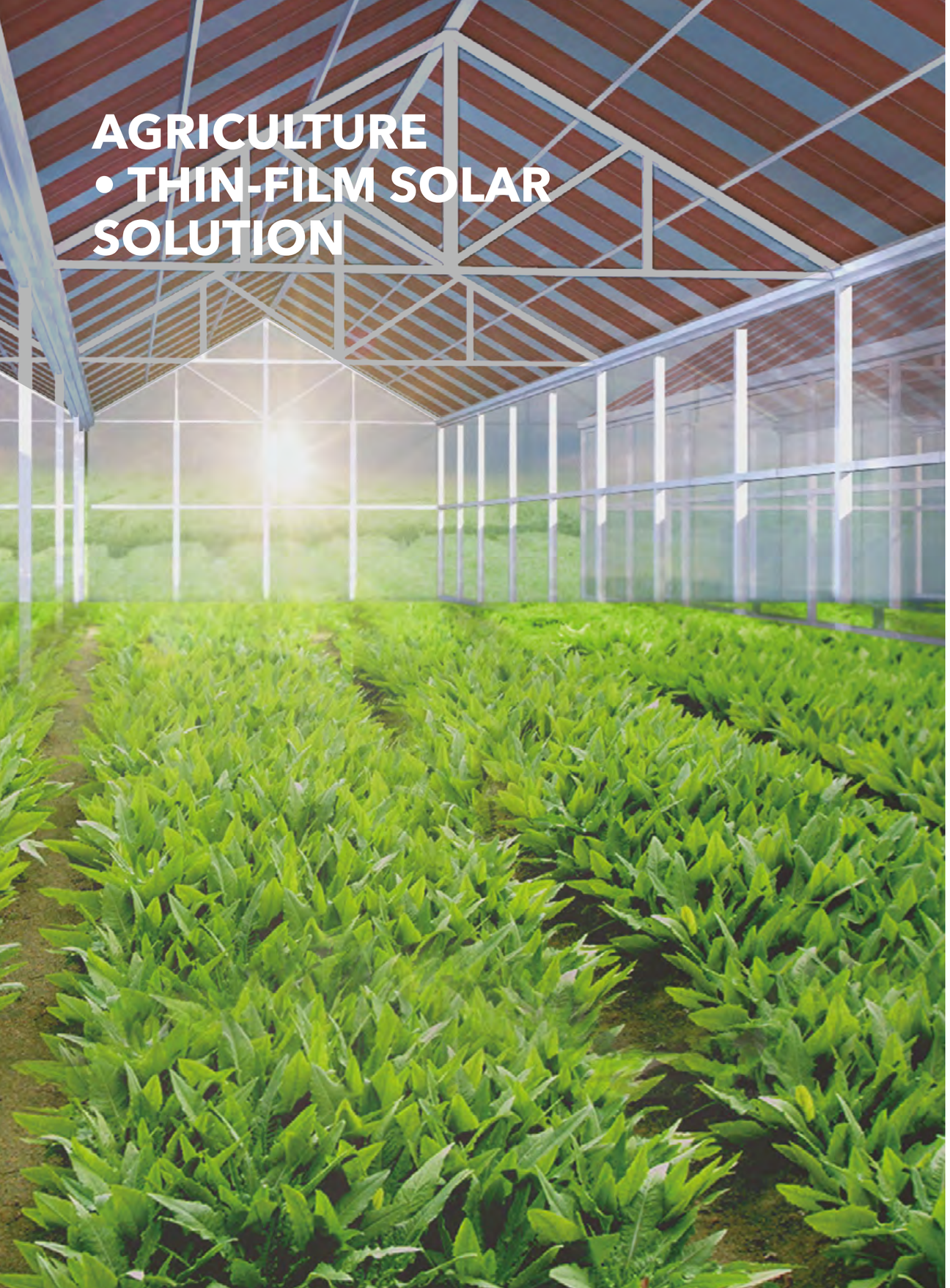
Thin-film Solar House in Beijing SIGM (Installed capacity: 35kWp)

The plant roof project in New Jersey of the USA (Installed capacity: 350 kWp)

The thin-film solar generation project of Nongfu Spring Guangdong Wanlvhu Co., Ltd. (Installed capacity: 4.82 mWp)

Thin-film solar wall project in OCT, Heyuan City, Guangdong Province (Installed capacity: 310kWp)

# AGRICULTURE • THIN-FILM SOLAR SOLUTION



## Hanergy's agricultural thin-film solar generation system

When applied in agricultural greenhouses, Hanergy's transparent back contact thin-film modules won't stunt crop growth, due to their even and high transmittance of red light and infrared light. They are widely applicable to greenhouses for growing flowers and vegetables, breeding and growing seedlings. In terms of weight, such components are equivalent to general agricultural materials, and can be perfectly combined with greenhouses, to provide proper shade and increase power generation income. Hanergy has created a brand new industrial pattern involving photovoltaic power generation, energy conservation and emission reduction, land saving, and increases in agricultural yields and farmers' incomes.

The construction of rural homesteads carried out vigorously in China is aimed to transform farmland, change the past scattered living situation of farmers, centralize management and adapt to large-scale mechanized farming. Homesteads covering a large centralized area are suitable for adopting the form of distributed rooftop power generation, with individual homestead or collective homesteads as units, to construct thin-film solar generation facilities during the construction of homesteads.

Moreover, with the future transformation of stock farming from the extensive pattern to the modernized and centralized pattern, high-tech sheds will provide a better growing space for livestock and poultry. Due to one-time high investment, installation of distributed power generation facilities on rooftops has become a new source of income for stock farming, realizing the energy conservation of farms at the same time. Fishery-PV complementarity is also one of the application patterns that have emerged in an endless stream in recent years.

## Overall agricultural solution

To boost the development of agricultural industries, Hanergy opens up the business pattern of agricultural thin-film solar generation, providing an overall agricultural photovoltaic solution, including agricultural consultancy, project application support, general project contracts, financial solutions, agricultural technology consultancy etc.

### Photovoltaic agriculture consultancy 1

Hanergy not only provides the most professional photovoltaic technology support, but also has developed various business cooperation models and technology implementation solutions for agricultural projects, assisting owners in calculating the cost and revenue of photovoltaic power generation and providing complete project ROI analyses for reference. For different regions and different needs, experts in photovoltaic agriculture can provide a variety of the feasible project plans for owners to select.

### Project application support 2

With rich experience in developing photovoltaic projects, Hanergy can assist owners in going through a series of project application and approval formalities for photovoltaic agriculture, such as project filing, government approval, grid access, and subsidy application.

### Overall project contract 3

Entrusted by owners, Hanergy can undertake the whole process or several stages of engineering projects, including design, procurement, construction and trial operation in accordance with contracts. Under lump sum contracts, the company is responsible for the quality, safety, cost and schedule of the contracted work. Hanergy provide owners with the turnkey general contracting business, to finally turn photovoltaic agriculture projects with practical working functions and conditions over to owners.

### Financial solutions 4

Hanergy has an excellent financing ability, and our financial service team can provide professional financing service support according to the project and financial conditions of owners.

### Agricultural technology consultancy 5

Hanergy has established long-term stable scientific research partnerships with agricultural universities and institutions, which provide a strong professional technical guarantee for agricultural planting and solution guidance. Meanwhile, Hanergy has extensive and deep cooperation with major media in the industry. Based on the successful cases of cooperation, we will help owners with a wider range of agricultural technology introduction, consultation and promotion.

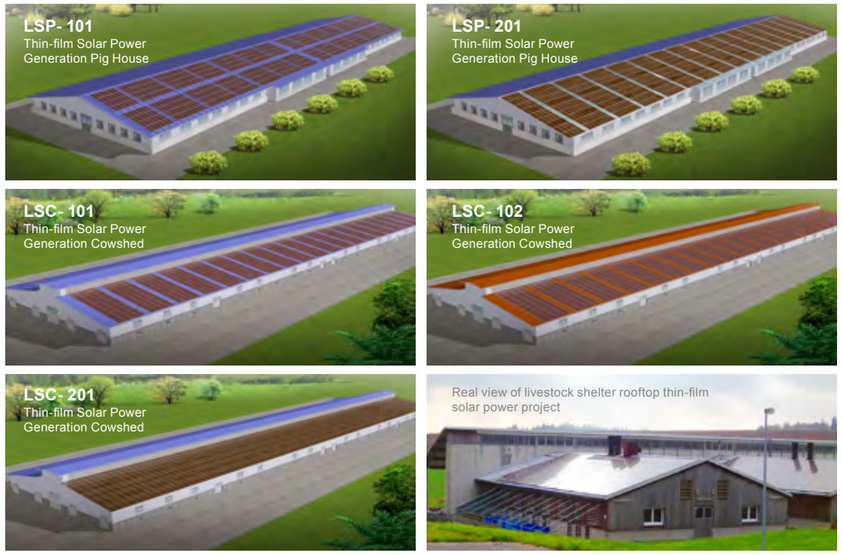


## Thin-film greenhouse shed structure

For different regions and plant characteristics, Hanergy can provide more than ten greenhouse structure solutions in line with specific conditions for owners to make the best choice. At the same time, owners can choose thin-film solar components of different transmittance according to different needs.

## Livestock house rooftop shed structure

With the transformation of stock farming from the extensive pattern to the modernized and centralized pattern, high-tech sheds will provide a better growing space for livestock and poultry. Due to one-time high investment, installation of distributed power generation facilities on rooftops has become a new source of income for stock farming, realizing the energy conservation of farms at the same time. Hanergy provides various livestock house rooftop solutions for owners to make the best choice.

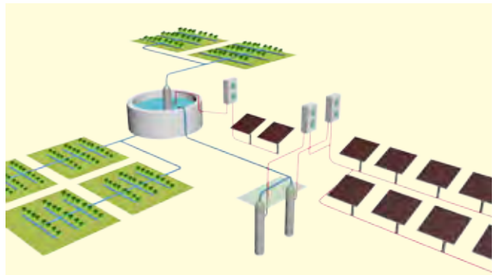


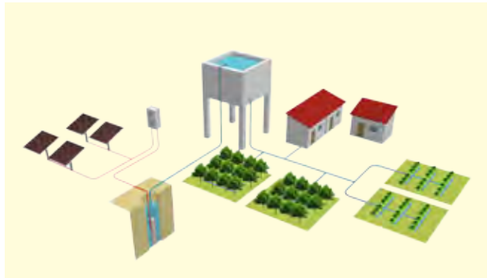
## Thin-film Solar Pump

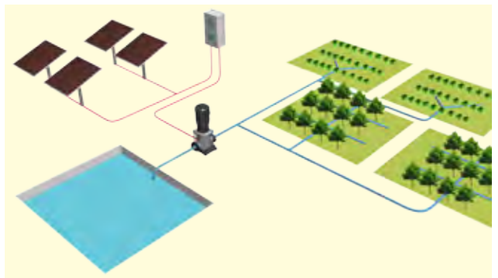
The thin-film solar pump solves the problems of lacking water for drinking and agricultural irrigation for people in areas without water and electricity. It plays an important role in rural poverty alleviation and bringing benefits to farmers.

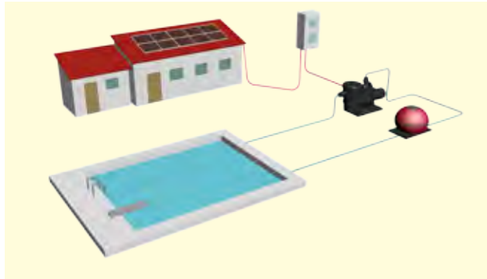
Compared with traditional pumps, the thin-film solar pump does not need fuel or the power grid, but can operate automatically “from sunrise to sunset”, with little need for maintenance. With a high standard, a long service life and low average cost, it is especially suitable for remote areas without sufficient water and electricity.

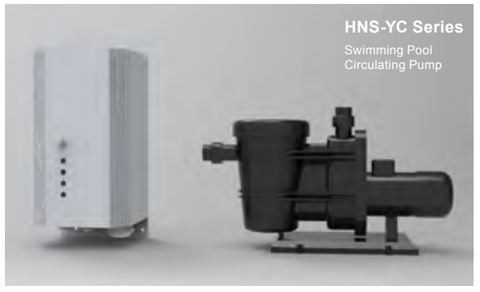
The thin-film solar pump is mainly applied in such circumstances as agricultural irrigation, water for daily lives, drinking water for livestock, fish pond water circulation, desert treatment, and water treatment.






## Other applications

In terms of products for agricultural use, Hanergy has launched thin-film solar modules with different characteristics to meet different needs of application.

These products are not only applicable to solar agricultural greenhouses, livestock shed rooftops and thin-film solar pumps, but also widely used in such projects as agricultural homesteads, fishery-PV complementarity, and livestock-PV complementarity.

### Application in agricultural homesteads

The construction of rural homesteads carried out vigorously in China is aimed to transform farmland, change the past scattered living situation of farmers, centralize management and adapt to large-scale mechanized farming. Homesteads covering a large centralized area are suitable for adopting the form of distributed rooftop power generation, with individual homestead or collective homesteads as units, to construct thin-film solar photovoltaic power generation facilities during the construction of homesteads.

### Application in fishery-PV complementarity

Through installation of thin-film solar generation systems above fishponds, the land resources of fishponds can be fully used to build thin-film solar stations, and the modules can provide shade. This makes fishponds more profitable, as well as helps fishes grow.

Fishery-PV complementarity is also one of the application patterns that have emerged in an endless stream in recent years.

### Application in livestock-PV complementarity

After the completion of ground-mounted power stations, the arrays of thin-film solar modules can shelter the ground from sunlight radiation, effectively reduce the evaporation of land, promote the effective recovery of vegetation in suitable areas, and improve the land use efficiency of power stations, to increase output from projects.

## Application Cases


The grid-connected farmland project in Sha Tau Kok, Hong Kong (Installed capacity: 5 kWp)

The thin-film solar seedling greenhouse project of CP Oreezyme in Nanping (Installed capacity: 270 kWp)

The agricultural vegetable greenhouse project in Eshan County (Installed capacity: 10 kWp)

The greenhouse project for the Modern Agriculture Exhibition Area of China-Arab States Expo (Installed capacity: 1.935 kWp)

Jinfeng PV Smart Greenhouse (Installed capacity: 71.28 kWp)

The greenhouse modification project of Wuxi Agricultural Technology Park (Installed capacity: 126.42 kWp)

# PUBLIC FACILITIES AND OTHERS • THIN-FILM SOLAR SOLUTION

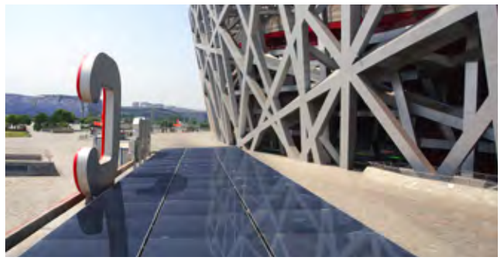
## Application Cases

Intelligent Solar Bus Stop in Dali, Yunnan,Dali Health School Stop and West Yunnan University of Applied Sciences Stop (Installed capacity: 1.68kWp)

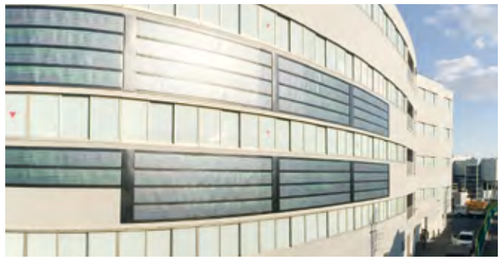
Natural History Museum BIPV in, Hohhot, Inner Mongolia Autonomous Region (Installed capacity: 13.6kWp)

The Milan Railway Station project in Italy (Installed capacity: 19.8 kWp)

Hawaii military base project in the United States (Installed capacity: 100 kWp)

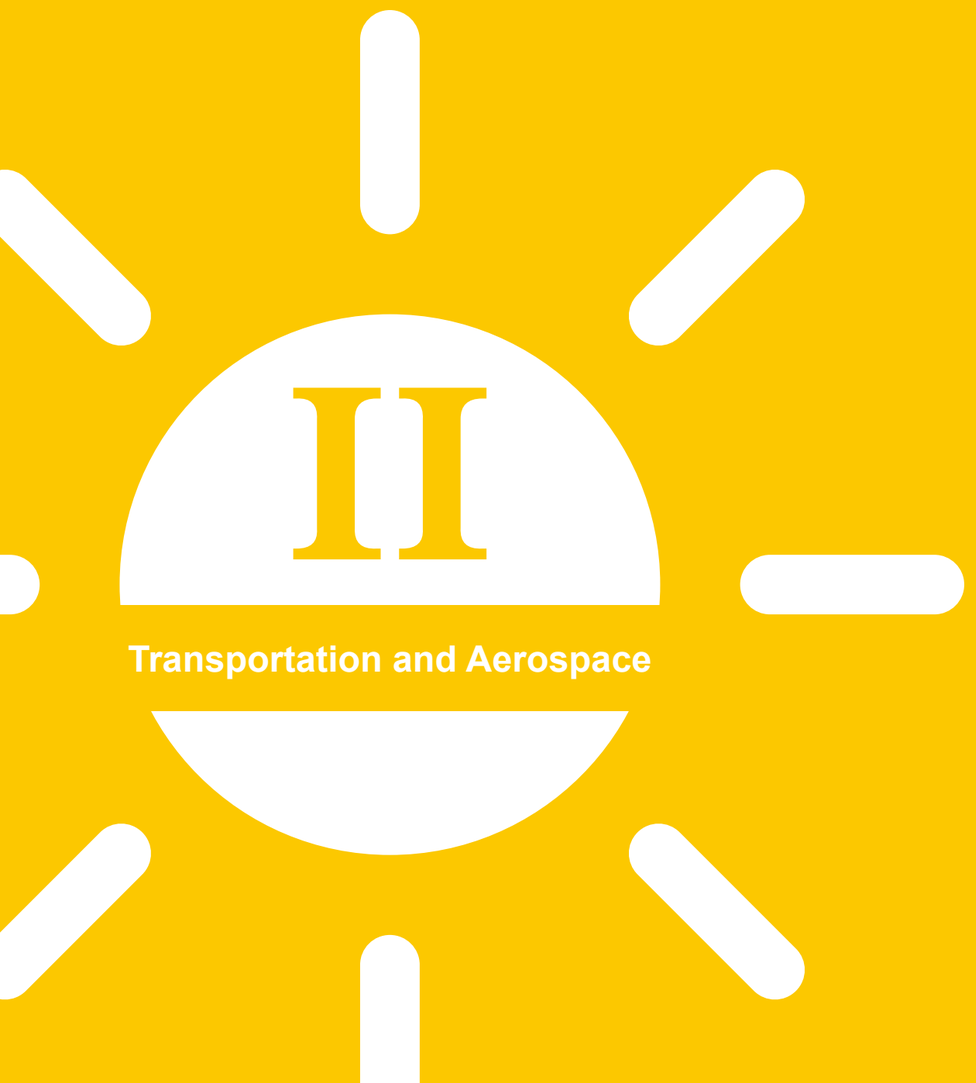


The project of National Stadium—Bird's Nest in Beijing (Installed capacity: 129.6 kWp)



The thin-film solar wall project of Kanazawa Bunko Station in Yokohama of Japan (Installed capacity: 17 kWp)

# UBIQUITOUS THIN-FILM SOLAR PRODUCTS



# VEHICLES
# •THIN-FILM SOLAR SOLUTION

Hanergy fully-solar powered electric car utilizes the solar power as the main driving source. The most advanced gallium arsenide(GaAs) thin film solar cell technology is adopted in designing the vehicle. When certain amount of light is provided to the car, the solar energy would be converted to electric power via thin film solar cell and stable power supply would be assured through the intelligent control management system on board for the improvement of the efficiency of the vehicle.

Such a product will solve the global issue of energy shortage from the source and enable the realization of green and ecological travel.

## Redefine new energy vehicles, through two disruptive innovations

1. Direct solar power generation changes the way of charging traditional electric vehicles depending on chargers

   The GaAs thin-film solar cells with the highest conversion efficiency of 31.6% in the world are used to customize flexible thin-film modules covering 3.5-7.5 square meters according to different needs of customers; on sunny days, with 5-6 hours of sunlight, the thin-film solar cells on the vehicle are able to generate eight to ten kilowatt-hours of power a day, allowing it to travel about 80 kilometers, equivalent to over 20,000 kilometers annually; on rainy days or for long-distance travel, the lithium batteries equipped in the vehicles can also get power from chargers, enabling them to travel a maximum of 350 kilometers per charge.

2. Such vehicles alter the inherent concept of “distance per charge” of traditional electric vehicles, making “zero charging” during medium and short distance travel

   With sunlight, the vehicles are able to “charge themselves while traveling”, driving a “zero charging” distance 10%-15% more than that of common electric vehicles, making “zero charging” medium and short distance travel possible in urban areas.



### Hanergy launched the “Solar” series fully solar powered vehicles

On July 2, 2016, Hanergy held “Disruptive Innovation, Drive the Future-Hanergy Mobile Energy Strategy Achievements and Fully Solar Powered Vehicle Launch Conference”, to launch the “Solar” series fully solar powered vehicles: Hanergy Solar A, Hanergy Solar L, Hanergy Solar O and Hanergy Solar R.

### Hanergy Solar A

Hanergy Solar A enhances the stability of high-speed driving, and maximizes the area covered by solar cells, while greatly reducing the drag coefficient. Seen from a distance, white lines through its whole body and the highly distinctive spoiler design make the vehicle like a fast sailing yacht in the sea, looking so dynamic; with a closer look, the modeling of front and rear bumpers resembles the texture of Energon in Transformers, leaving an impression of “Full Energy”.

### Hanergy Solar O

Hanergy Solar O adopts the customized design of side panels to obtain the maximum area of solar panels exposed to sunlight. The dynamic visual image outlined by its black butterfly door and silver body is inspired by the concept of Chinese “Tai chi” passed down from the ancient times, symbolizing life and eternity. The edge of metal plates is inlaid with a long and thin blue strip for decoration, which is a symbol of pure and sustainable renewable energy.

### Hanergy Solar R

Hanergy Solar R is a new energy sports car with flexible thin-film solar cells placed on its hood, roof and side panels, which are perfectly integrated with its streamlined body. The overall color design of using black and white separately makes the sports car more dynamic. The integrated spoiler design at the rear and on the roof of the car greatly reduces the drag coefficient, while maximizing the area covered by solar cells, thus enhancing its stability at a high speed.

### Hanergy Solar L

Hanergy Solar L has a body nearly 6 meters long, which makes the integrated solar cells on its roof reach 6 square meters amazingly. Its highly streamlined shape, hidden wheel hubs, and thin camera rearview mirrors significantly reduce the wind resistance of the whole vehicle. The whole vehicle adopts an aluminum alloy frame combined with carbon fiber bodywork, weighing only 700 kilograms. The lightweight design reduces its energy consumption to an extremely low level.

# VEHICLES
# •THIN-FILM SOLAR SOLUTION

Hanergy thin-film solar power generation modules can be widely used in the fields of sunroofs, car roofs, vehicle-mounted flexible portable power generation facilities, and vehicle charging systems. With the thin-film power generation technology, vehicles will become a clean energy generation system and gain sustainable power supply in the future.


Hanergy has signed strategic agreements with excellent brands at home and abroad such as Audi, BAIC BJEV, FAW and Ruichi automobile, etc. According to those agreements, cooperation under the mode of mobile energy plus electric automobile will be carried out, including automobile skylights and roof solution, new energy car charging station, sharing electric car, and distributed energy construction for industrial park and plant, etc.


## Aston Martin Racing

Hanergy provides power support for Aston Martin Racing with solar power generation technology, helping the latter to take the crown in FIA World Endurance Championship (WEC) held in different places.

## Hanergy Solar-powered Sightseeing Vehicle

Endurance mileage: 80-100km

Total weight: 1158kg

Maximum speed: 30km/h

Daily solar power supply: 1800WH

Purpose of solar power supply: driving 15km


## Hanergy Solar-powered RV

Battery: 12V120Ah (2)

Total weight: 4300kg

Maximum speed: 140km/h

Daily solar power supply: 2400WH

Solar power applications: mobile phone chargers/ lighting/ loudspeakers/car refrigerators/LCD TV/fans and other electrical appliances


## Hanergy electric dining cars with solar powered facilities

The flexible thin-film solar modules are used to charge the vehicle battery and thus power the electrical appliances in the cars, including supplemented power supply to vehicle lighting and power supply to cold chain logistics or temperature control systems, so as to expand daily delivery area, reduce fuel consumption, and cut down system maintenance costs; on-board electronic system applications are provided with no delay, such as on-board Wi-Fi, USB, multimedia systems, refrigerators and coffee makers.

# SHARED BICYCLES •THIN-FILM SOLAR SOLUTION



**Hanergy becomes the largest thin-film solar solution provider and supplier in the bike-sharing industry.**

## Solution provider for Mobike

Every bike of Mobike is equipped with a “smart lock”, and integrated with GPS and a communication module. Based on the new generation of IoT technology, a Mobike user can locate and use the nearest shared bike through its APP at any place and any time, and when reaching his destinations, the user can store it at the nearest proper place, and lock it to realize e-payment. To realize these, the solar panels mounted on the basket are needed.

Hanergy’s mobile energy solution for “Mobike” makes full use of the advantages of thin-film solar modules such as flexibility, light weight, high conversion efficiency, and good weak light performance, and can integrate thin-film solar modules into the body of “Mobike”, to transform the bikes into independent green power generators that can charge the batteries of Mobike with sunlight and meet various power needs of Mobike’s “smart locks”, thus making it more convenient to ride, improve the efficiency of energy production, recycling and sharing of Mobike, and bring upgraded green experience to users.

## Established partnerships with 8 bike sharing providers

Since Mobike launched the shared bicycles developed jointly with Hanergy in market, Hanergy’s thin-film flexible solar modules featured by lightness, softness, reliability and safety have been fully displayed. They can withstand riding on bumpy roads, toppling down and impacts from something heavy, and can still generate electricity without damage whether in the shade of a tree or when the modules are partly covered. Therefore, just within half a year, ofo, MTbike, 99bike etc. all concluded partnership agreements with Hanergy quickly.

By now, there have been 8 shared bicycle brands in partnerships with Hanergy, and Hanergy’s thin-film solar has become a symbol of high-tech shared bicycle brands pursuing good customer experience.

# LOGISTICS VEHICLE •THIN-FILM SOLAR SOLUTION

Address the pressure of the delivery men on work, ensure safety, and release their anxiety about electric charges at the last three kilometers.

The high efficiency flexible solar modules of Hanergy, which can be stuck or fixed on the surface of the express vehicle directly through strut, transfer the solar energy into the electric energy. The electric energy, which can be stored in the battery through the charging controller, Increases the mileage of the express vehicle, and thus solves the problem of fuel efficiency existing in the express industry.

## Advantages of Hanergy solar solution

- Bump resistance, pressure resistance and long service life
- Increase the life of single battery cell by 50%
- No influence on the piling of cargoes
- Decrease the manual charging time and operation cost
- Prevent over-discharge and increase the battery life
- Increase the delivery capacity by 40 pieces each day
- High electricity generation efficiency in low light condition
- Excellent anti-shielding capability

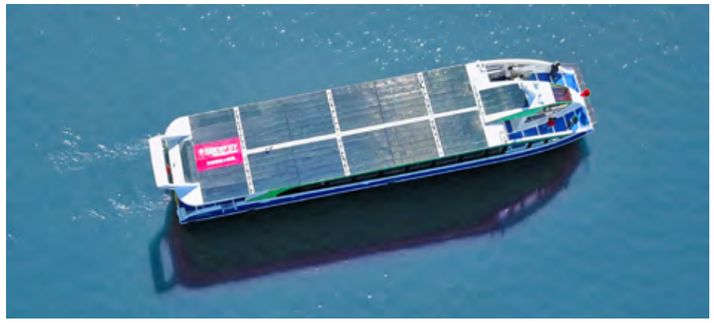


Hanergy joins hands with Jingdong Logistics to build smart delivery vehicle powered by solar energy. The issue of range of the delivery vehicle has been perfectly solved, with 30% to 50% increase of the range. The operation cost has been decreased and the service life of the battery has been extended. Hanergy thin-film power can also provide power support for Internet intelligent control system, security system, and mobile phones.

# VESSELS •THIN-FILM SOLAR SOLUTION


In 2016, Hanergy teamed up with KARA SOLAR, an Ecuadorean company, to build a fully thin-film solar-powered boat named “ Tapiatpia”, for transportation services in the Amazon River basin.

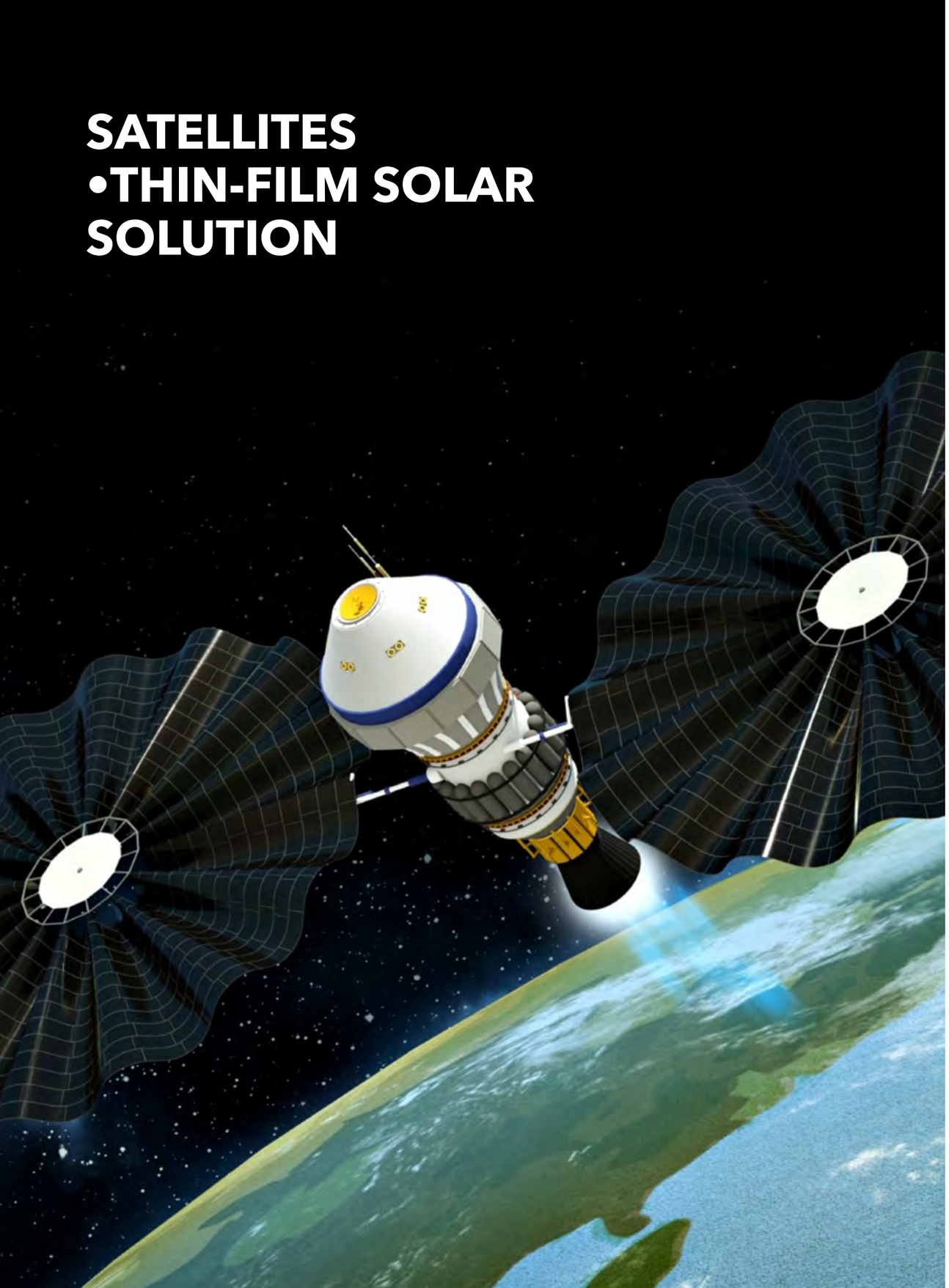
One of the purposes of establishing KARA SOLAR Project is to protect the ecological environment of the Amazon River basin, and exclusively provide photovoltaic electric boats for this region full stop. After realising Hanergy’s flexible copper indium gallium selenide (CIGS) thin-film solar modules are environment-friendly, light, flexible,windproof, resistant to high temperature and humidity and stable in power generation efficiency, the officials from KARA SOLAR contacted the American team of Hanergy to work on the project jointly. Hanergy in conjuction with KARA SOLAR still continues to develop solar-powered vehicles and vessels that are suitable for nature reserves where fuel powered vehicles are prohibited.

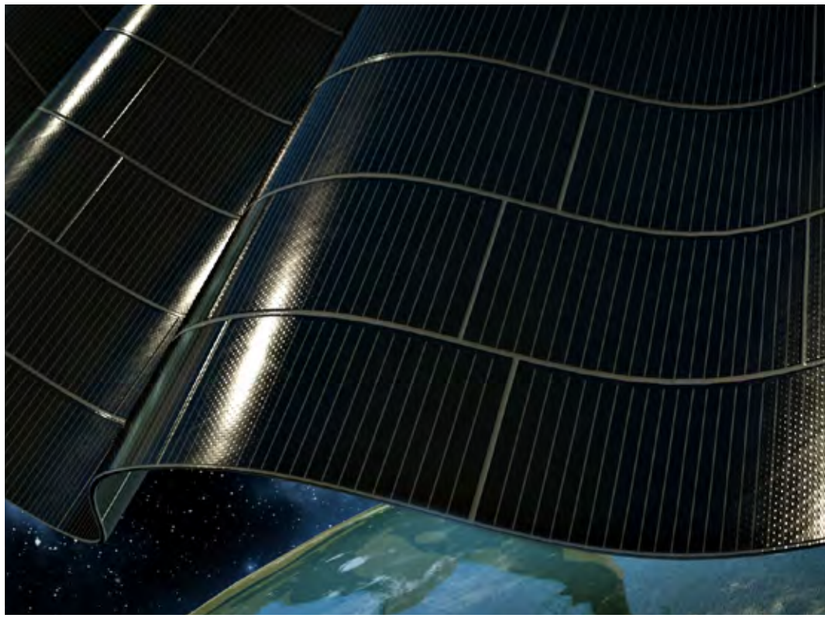


In July 2017, as a traffic tool for carrying tourists, a thin-film solar-powered luxurious yacht was put into use on Dongting Lake, which is a new green vessel developed by Hanergy jointly with Wuhan University of Science and Technology and Hunan Haiquan Yacht Co., Ltd., and built by Hunan Haiquan Yacht Co., Ltd.

As a solar ship with the largest tonnage in China, the yacht not only promotes the ecological economic construction of Dongting Lake and shows the ecological civilization of this area developing green economy, but also enhances the competitiveness of shipbuilding enterprises, conforming to the development policy of China encouraging scientific and technological innovation and the transformation and upgrading of the shipbuilding industry. It has attracted the attention from mainstream media at home and abroad, shipbuilding manufacturers and aquatic tourist attractionshas been winning praises for its par excellence capabilities.

# SATELLITES •THIN-FILM SOLAR SOLUTION





## Application of Hanergy's Thin-film Solar on Satellites

Offering "thinness and high conversion efficiency", Hanergy's thin-film solar modules for satellites can maximize surface coverage on satellites, and improve power while minimizing cost and launch mass, so as to power satellite with solar energy to the largest extent.

In the field of small satellites, many manufacturers in the world are using Hanergy's thin-film solar technology, such as Twiggs Space Laboratory, Near Space Launch and OreSat.

OreSat is the first man-made satellite launched by Oregon. As part of NASA's 2017 Cubesat Launch Initiative, it is used for learning and communication among many disciplines in space engineering of Oregon; it is a test-bed equipped with a remote wireless network, thin-film solar and satellite platform technology, the innovative results of which will be popularized across Oregon and even the United States.

# UBIQUITOUS THIN-FILM SOLAR PRODUCTS

# HANPOWER

## Enjoying power from paper: Refusing to lose contact

HanPower is a black technology product based on high-efficiency flexible copper indium gallium selenide thin-film solar cell. It generates electricity automatically under the sunshine, which is mobile and portable and can convoy your electronic products.


**Solar charging**
Recharge anytime and anywhere

**Thin-film cells**
Help you quickly replenish electricity with high technology

**Power generation in weak light**
In cloudy days, you can also use it

**Power generation at low temperatures**
In cold weather, you can also use it

**It can be folded**
After folded, it is only the size of a notebook

**1mm thin**
It's really as thin as paper

**Environmental protection certification**
Its benefit for environmental protection is equivalent to growing one more green plant on the earth

**Indispensable to travelers**
Go out with it and you'll never have to worry about your camera battery running out when taking pictures

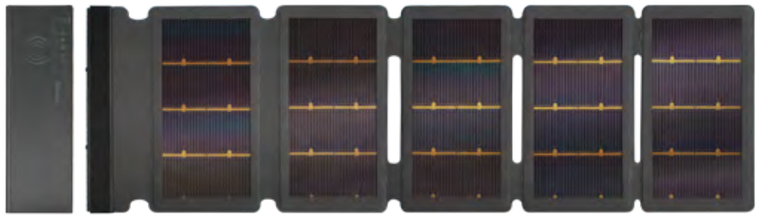
**USB output**
Compatible to various electronic products

**Waterproof and insulated from high temperature**
No fear of heavy rain or extremely high temperatures

## Thin-film solar power paper
## Plus in series


Split type design, supporting wireless charging mode (Qi standard), with two charging modes: solar energy and electric supply.

| | | | |
|---|---|---|---|
| Product name | Thin-film solar power paper , Plus in series | Output Interface | USB type-A |
| Color | Digital gray, Jade gold, Carmine | Folding size of power generation end | 198*118*26mm |
| Maximum power | 12W | Energy storage end size | 198*64*9mm |
| Maximum output | 5V/2.1A | | |



## Thin-film solar power paper
## 12W/16W/100W

You just need to open the folded power paper and put it under the sunshine to charge the device.
The USB output port can charge various electronic products such as mobile phones, Bluetooth speakers, digital cameras, and e-books.

RoHS FC CE

| Product name | Thin-film solar power paper | Product output | Output interface | Folding size |
|---|---|---|---|---|
| SP-12 | 12W | Product output 5V/2A | USB | 175*250*15mm±3mm |
| SP-16 | 16W | 5V/2.5A | USB | 175*250*20mm±3mm |
| SP-100 | 100W | 19.8V/4.94A | SAE | 326*260*40mm±3mm |

Thin-film solar power paper 12W

Thin-film solar power paper 16W

Thin-film solar power paper 100W

# HANPACK

HanPack was born in the era of mobile internet. Based on the backpack function, the solar black technology to generate electricity is added, so as to realize the convergence of energy and emergency charging needs and lead a technological, fashionable and personalized mobile lifestyle.

- Business travel
- Shock absorption design
- Solar charging
- Power generation in weak light
- Light, thin and portable
- USB ports
- Scientific storage
- 3D tailoring
- High-quality fabrics
- Thin-film cells

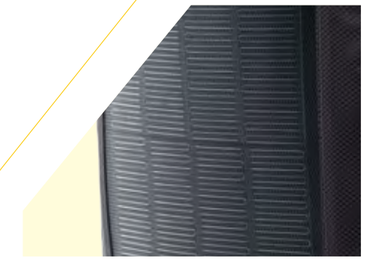
Business / Leisure / School / Travel / Charging assistant

## Your electricity is guaranteed to allow you stay online all the time


Ruizhe•Series HB-10

## Thin-film solar power Backpack 10.6W

Specially designed for charging computers, Pads, cellphones and other devices, with a large capacity, dual layers and several inner pockets, making it easy to sort out your belongings and store them in a more orderly way, and the three-layer quilted shock absorption design makes it more comfortable to carry the backpack for a long time.



RoHS FC CE

| | | | |
|---|---|---|---|
| Product name | Thin-film solar power Backpack | Output interface | 2 USB |
| Cell type | MiaSolé | Product size | 44x30x18cm |
| Maximum power | 10.6W | Color | Black |
| Maximum output | 5V/1.7A | Fabric | Waterproof Dacron |
| Weight | 1.6kg | Capacity | 25L (for a 15.6-inch laptop) |

Fold Business Travel Backpack 9W

Narci Fashion Backpack 6.14W

Solartank Fashion Backpack 7.17W

# THIN-FILM SOLAR GARMENT

- Three levels of lighting for free adjustment, namely always-on lighting, fast flashing and slow flashing
- Highly waterproof and breathable fabric
- Applicable scenarios: outdoor sports, cycling, hiking, mountaineering, skiing and city

## Thin-film Solar Lighting and Heating Garment

The garment shape is designed to better fit body curves, and the high-end waterproof breathable fabric is easy to wash.

| | | | |
|---|---|---|---|
| Product name | Thin-film Solar Lighting and Heating Garment-Outer layer | Product name | Thin-film Solar Lighting and Heating Garment-Liner |
| Product model | 16LH21001M | Core heating system | Carbon-fiber core heating system |
| Cell type | CIGS | Wash | Machine washing and drying |
| Cell conversion efficiency | 15.5% | Color | Gray |
| Maximum power | 1.5W | Heating | High temperature 58℃ /2Hs, medium temperature 45℃ /4Hs, low temperature 38℃ /6-7Hs |
| Lighting type | EL cold light | Output | USB 5V/2.1A |
| Color | Black | | Note: Tested based on 5000 mAh portable power source at room temperature |

# HUMBRELLA

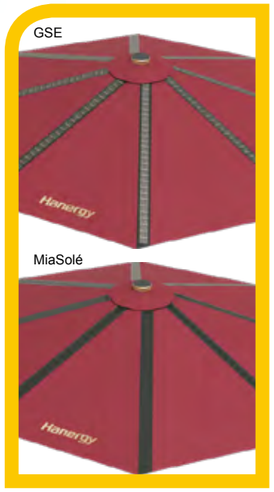
Implemented with flexible thin-film solar technology, Humbrella is a multifunctional sun umbrella developed by Hanergy. It very well integrates off-grid power supply, electricity storage, night illumination and terminal charging.


## Humbrella-Enlighten Life through Technology

In addition to its utility for shade and shelter like sun umbrella, Humbrella can also generate and store electric power. A layer of efficient and flexible thin-film solar cell laid on the surface of the umbrella makes the thin-film solar Hanging Umbrella generate power both on a sunshine day and cloudy day without relying on power grid. Unique interconnection technology in integrated cell provides a more stable electric circuit for it.

## Thin-film Solar Power Umbrella

Zero emission and pollution are achieved as Humbrella generates electricity with clean solar energy. Energy storage of Humbrella reaches 138Wh, which could support high luminance lighting for 10h or charge up to 4 cell phones at the same time. Humbrella also has the standard charging port, thus power could be supplied by utility power through DC port under emergency condition.



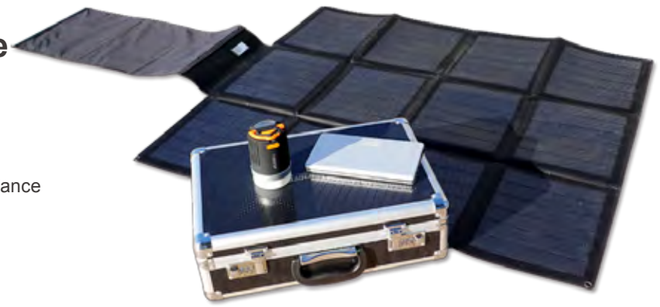

| | | | |
|---|---|---|---|
| Product name | Thin-film Solar Power Umbrella | output | DC 5V/2A, MAX 10W |
| cell type | CIGS | output interface | 4USB |
| battery capacity | 138Wh | lighting | Switching between high illuminance lighting and standard lighting |
| module power | 50.4W(GSE)<br>51.25W(MiaSolé) | size | The diameter of the umbrella pole is about 38mm, the height of the umbrella is about 2.5m, and the diameter of the umbrella canopy is about 2.8m |

# EMERGENCY THIN-FILM SOLAR POWER BANK

Your cell phone will not be powered off and you will not be disconnected with your family if you have a Emergency thin-film solar power Bank with the function of electricity generation, lighting and charging. It could provide assistance to you in your expedition or suburban leisure.

- The canopy texture of black brick wall presents the cool style
- 50W-100W thin film solar folded charging paper
- 30,000mAh mobile power supply
- 8800mAh camp lamp


## Aluminum-alloy portable code case



- High-quality craftsmanship/ endurance
- Waterproof/aviation material/crushing resistance and anti-collision
- More safe/more endured/more damp proof
- Double coded locks/ rivet reinforcement



## Camp/Energy Storage Lamp (Small Sun In Tent)

It serves both as the camp lamp and the mobile power supply with compact but fashionable design and multiple functions. It provides you with electric power and brightness, allowing you to enjoy the outdoor lifestyle, thus it is an ideal choice for outdoor activities.

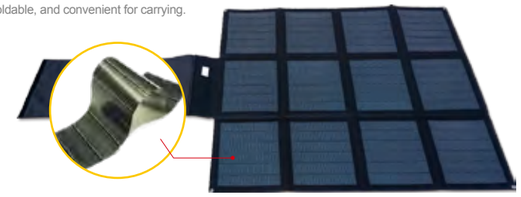
| High energy storage of | Multiple functions of | High luminance of | Long service life of | Endurance |
|---|---|---|---|---|
| 8800mAh | 4 equivalent modes | 196lm | 5,000h | waterproof and dust resistance |

## Thin-film solar folded power generation paper of 100W

Equipped with the CIGS thin film solar battery with high conversion efficiency, it could better serve as off-grid power supply supplementary to portable battery.

The more extreme the temperature is, the better waterproof performance it will show.

It is light, foldable, and convenient for carrying.



## Mobile power supply of 30,000 mAh

With the large capacity of 30,000 mAh, it has the smart voltage regulation technology that can regulate different voltages and currents and it is compatible with most laptop brands in the market.

# SOCIAL RESPONSIBILITY

Through the mission of "Change The World With Thin-Film Solar", Hanergy Thin Film Power Group, is committed to provide clean energy products and services based on its thin-film solar technology and has been consistent in making due contributions in building a low carbon society through emission reductions and promoting the green development of the society. Meanwhile, the company is working industriously on strengthening its operation and management by implementing green development philosophy, and endeavors to become an environmental friendly company by sensible utilization of energy and resources and by introducing strict control mechanism to reduce its impact on the environment. Addressing the issues pertaining to climate change-governments, entrepreneurs, and the public have together made transformations to generate awareness on environmental protection front by changing the means of production and life, and rely more on clean energy so as to reduce the impact on the environment and ecology. Embracing the rapid development of technology in the fast track, the green development model based on the eco-environmental capacity and the bearing capacity of resources will serve as new model to foster sustainable development. Hanergy, as a clean energy company, shoulders the responsibility of creating awareness of the advantages and environmental protection attribute of the solar energy and popularize it for the massive adoption to serve the public life.

**Change The World With Thin-Film Solar**

—— Hanergy is committed to providing the technology intensive clean energy, create a better world and lifestyle and strike a balance between economic & social development and environmental protection.

**Hanergy, Harbinger of the change in the World**

—— Hanergy holds the utmost loyalty to the country and world at large and aims to serve the country in the best possible way through its innovative offerings. The company is determined to make more contributions to the economic growth while maintaining the balance between mankind, environmental protection and economic development.

**Everlasting improvement and technological innovation**

—— For Hanergy, technological innovation not only represents one of the core corporate responsibilities but also the secret of remaining the vanguard of the industry. Continuous technological innovation serves as the foundation and means of achieving sustainable development.

**Caring the vulnerable and passing love**

—— Hanergy has always shown care to the vulnerable and has engaged itself in the activities of public welfare and humanitarian assistance, and showered love, hope and positive energy to the larger ecosystem.

**Respect and stay harmonious with employees**

—— Hanergy adopts the operation and development strategy in line with 10 principles required in the UN agreements on human rights, labor and environment, which is to respect the value and voice of the staff, value the physical and mental health and career development of the staff, and pursue the common growth, development and prosperity.

**Repay the society with a grateful heart**

—— At Hanergy, we believe, we would not develop without a stable society, prosperous economy and advanced culture. Therefore, at Hanergy we're always concerned about the larger ecosystem and constantly endeavor to pay back to the society and improve the well-being of the mankind.

## Photovoltaic Poverty Alleviation

In response to the Chinese government's call for "photovoltaic poverty alleviation", Hanergy has been actively fulfilling relevant tasks, and has worked jointly with many areas to build a multi-level, three-dimensional cooperation model of "Thin-film solar + photovoltaic poverty alleviation", helping relatively poor people get rid of poverty. Up to now, Hanergy has constructed nearly 30 "photovoltaic poverty alleviation" projects in cities and towns of 18 provinces such as Guangdong, Shanxi, Yunnan and Guizhou, involving household rooftops, village-level power stations, agricultural greenhouses, etc.


### CCTV's Focus

On the night of April 6, 2016, the spotlight of CCTV's *Focus Interview* was turned on the high-profile photovoltaic field. In the news program *Photovoltaic Technology Changes Life*, Hanergy's thin-film solar agriculture, photovoltaic poverty alleviation, thin-film solar cell production line, etc. were all covered.

### The project of Gangdise Tibetan Medicine College

Installed capacity: 21.1 kWp

Module type: standard module

Signing time: May 2012

Project highlights: end the electricity shortage of the 20-year-old Gangdise Tibetan Medicine College. The supply of green energy provides a strong guarantee for teaching and medical work.

### The photovoltaic poverty alleviation project in Sixian of Anhui

Installed capacity: household 3 kWp/household and village-level power station 200 kWp

Installed quantity: 6.36 MW

Module type: standard module

Signing time: October 2015

Project highlights: a photovoltaic poverty alleviation project combining the application forms of household and ground-mounted power stations, with villages as units.

### The jujube greenhouse photovoltaic poverty alleviation demonstration project in Yonghe of Shanxi

Installed capacity: 37.4kWp for an area of 4000 square meters

Module type: light module for agricultural purposes

Signing time: July 2015

Project highlights: photovoltaic poverty alleviation demonstration project, based on the combination of photovoltaic and agricultural facilities

### The thin-film solar culture corridor project of Xibaipo High School in Shijiazhuang of Hebei

Installed capacity: 7.7 kWp

Module type: CIGS

Signing time: April 2015

Project highlights: the culture corridor project, a public welfare photovoltaic project based on flexible thin-film solar modules in a school of the poverty-stricken old revolutionary base area.

# CORPORATE CULTURE

## Hanergy Core Values The Five Creeds

Dedication to Corporate Mission

Integrity

Customers First

Continuous Improvement and Innovation

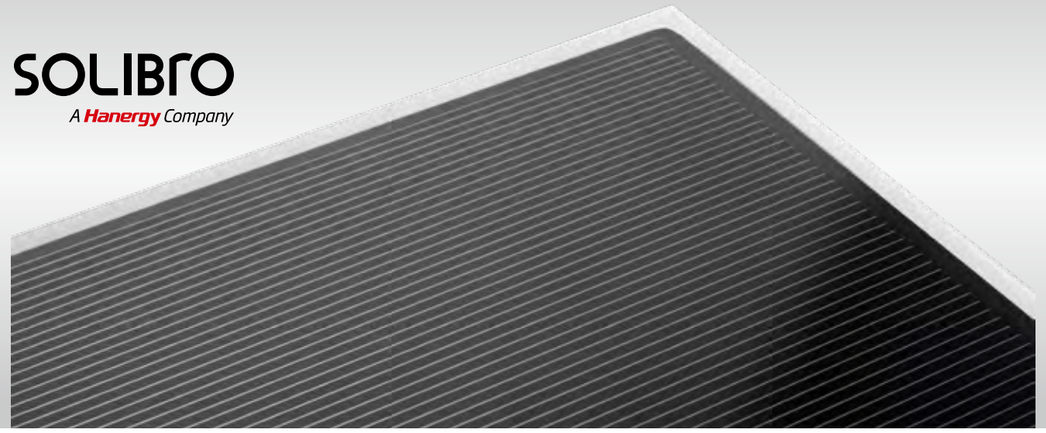
Introspection

## 18 Hanergy Mottos

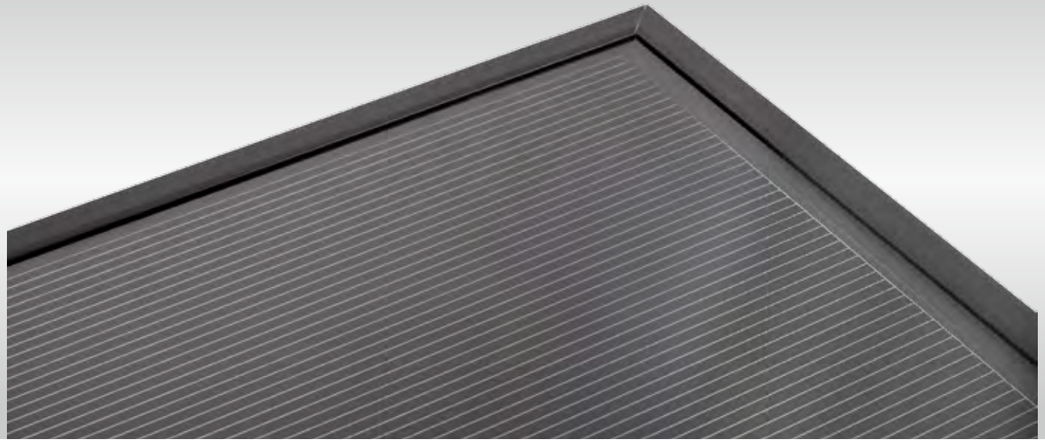
1. It is our mission and faith to change the world with thin-film solar.
2. Integrity, generosity, wisdom and inclusiveness comprise our character.
3. Foresight and pragmatism are our qualities.
4. Loyalty, responsibility and ambition are our basic requirements.
5. The secret of long-term success is to focus on our customers, and always provide them with the best product, best service and best experience.
6. The secret of company development is to grow with employees as they grow.
7. Success is determined by these three factors: people, people and people.
8. The secret of an evergreen enterprise is everlasting improvement and innovation.
9. The absence of ethics negates everything.
10. Integrity is of the essence.
11. Diligence and passion determine half of success.
12. Results talk; dignity comes from achievements.
13. Execution without excuses.
14. Learn every day.
15. Introspect every day.
16. Be grateful every day.
17. At Hanergy, nothing is impossible.
18. Hanergy, be great for the world.

# APPENDIX: MODULE SPECIFICATIONS

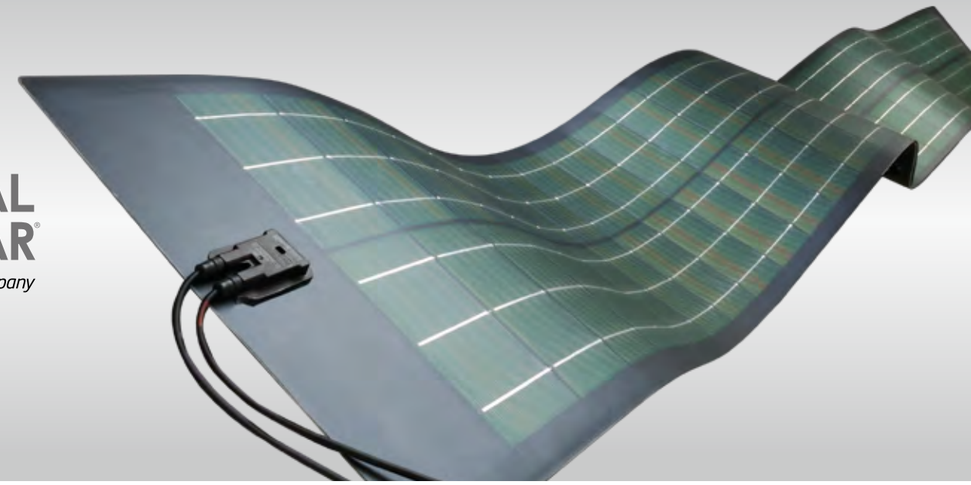
SOLIBRO
A Hanergy Company



| SOLIBRO SL2 CIGS Thin−film Module 2.3 \| 130−150 Wp | | | | | | | |
|---|---|---|---|---|---|---|---|
| Electrical Characteristics | | | | | | | |
| Performance At Standard Test Conditions (1000W/M², 25℃ , Am 1.5G Spectrum) [1] | | | | | | | |
| Power Class (+5/-0 W) | | [W] | 130 | 135 | 140 | 145 | 150 |
| Minimum Power | $P_{MPP}$ | [W] | 130.0 | 135.0 | 140.0 | 145.0 | 150.0 |
| Short Circuit Current | $I_{SC}$ | [A] | 1.75 | 1.77 | 1.79 | 1.81 | 1.83 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 104.5 | 105.6 | 106.7 | 107.8 | 108.9 |
| Current At $P_{mpp}$ | $I_{MPP}$ | [A] | 1.54 | 1.58 | 1.62 | 1.66 | 1.70 |
| Voltage At $P_{mpp}$ | $V_{MPP}$ | [V] | 84.5 | 85.5 | 86.5 | 87.4 | 88.3 |
| Module Efficiency | | [%] | ≥ 13.8 | ≥ 14.4 | ≥ 14.9 | ≥ 15.4 | ≥ 16.0 |
| Performance At Nominal Module Operating Temperature (800W/M², Nmot, Am 1.5G Spectrum) [1] | | | | | | | |
| Power Class (+5/-0 W) | | [W] | 130 | 135 | 140 | 145 | 150 |
| Minimum Power | $P_{MPP}$ | [W] | 97.9 | 101.6 | 105.4 | 109.3 | 113.1 |
| Short-Circuit Current | $I_{SC}$ | [A] | 1.40 | 1.42 | 1.44 | 1.45 | 1.47 |
| Open-Circuit Voltage | $V_{OC}$ | [V] | 98.9 | 100.1 | 101.2 | 102.3 | 103.5 |
| Current At $P_{mpp}$ | $I_{MPP}$ | [A] | 1.23 | 1.26 | 1.29 | 1.32 | 1.35 |
| Voltage At $P_{mpp}$ | $V_{MPP}$ | [V] | 79.6 | 80.6 | 81.7 | 82.8 | 83.8 |
| [1] Measurement accuracy $P_{MPP}$±5%; tolerance $I_{SC}$, Voc, $I_{MPP}$, $V_{MPP}$±10%. All STC measurements are based on a pre-treatment of modules with 20 kWh/m² of light soaking (20 hours at 1000 W/m² and MPP) followed by a cool down to 25℃ . | | | | | | | |
| Temperature Coefficients At 1000W/M² | | | | | | | |
| $P_{MPP}$ γ | [%/K] | -0.32 | | | | | |
| Isc α | [%/K] | +0.01 | | | | | |
| Voc β | [%/K] | -0.27 | | | | | |
| NMOT | | | | | | | |
| Nominal Module Operating Temperature | [℃ ] | 42 | | | | | |
| Properties For System Design | | | | | | | |
| Maximum System Voltage $V_{sys}$ | [V] | 1000(IEC)/600(UL 1703) | | Protection Class | | II | |
| Maximum Reverse Current $I_r$ | [A] | 3 | | Fire Rating | | C | |
| Positive Design Load (Iec 61215-2) | [Pa] | Up to 1600* | | Permitted operating module temperature | | -40℃ to+85℃ (-40˚F to+185˚F) | |
| Negative Design Load (Iec 61215-2) | [Pa] | Up to 1600* | | | | | |
| * tested with a safety factor $\gamma_m$ of 1.5 | | | | | | | |
| Mechanical Specifications | | | | | | | |
| Length | 1190(+3/-1)mm | | | | | | |
| Width | 789.5(+3/-1)mm | | | | | | |
| Height | 7.3 mm (+ junction box, 15.5 mm) | | | | | | |
| Weight | 16.5kg | | | | | | |
| Front Cover | 4 mm tempered low iron glass with AR coating | | | | | | |
| Back Cover | 3 mm float glass | | | | | | |
| Frame | None | | | | | | |
| Cell Type | CIGS [Cu (In, Ga) $Se_2$] | | | | | | |
| Junction Box | Ingress protection: IP67, with 1 bypass diode (8 A); 76 mm x 58 mm x 15.5 mm | | | | | | |
| Cable Type | PV1-F Solar cable 2.5mm²; Material: copper, weatherresistant from-40℃ up to +90℃ (+) 855 (+20/-0) mm; (-) 735 (+20/-0)mm | | | | | | |
| Connector | Renhe 05-6 certified according UL6703 | | | | | | |
| Qualifications And Certificates | | | | | | | |
| Module Certificates And Tests | IEC 61215 (Ed. 1:2016), IEC 61730 (Ed. 2:2016), IEC 61701:2011: Salt Mist Corrosion IEC 62716:2013: Ammonia Corrosion, IEC 60068-2-68:1994: Dust and Sand Resistance UL 1703 (CSA) CQC | | | | | | |
| Quality And Ehs Certificates | ISO 9001:2008, ISO 14001:2009, ISO 50001:2011, BS OHSAS 18001:2007 | | | | | | |



GLOBAL SOLAR
A Hanergy Company



## SOLIBRO SL2-F CIGS Thin-film Module 2.3 | 130-150 Wp

| Electrical Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Performance At Standard Test Conditions (1000W/M², 25℃ , Am 1.5G Spectrum) [1]** | | | | | | | |
| Power Class (+5/-0 W) | | [W] | 130 | 135 | 140 | 145 | 150 |
| Minimum Power | $P_{MPP}$ | [W] | 130.0 | 135.0 | 140.0 | 145.0 | 150.0 |
| Short Circuit Current | $I_{SC}$ | [A] | 1.75 | 1.77 | 1.79 | 1.81 | 1.83 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 104.5 | 105.6 | 106.7 | 107.8 | 108.9 |
| Current At $P_{mpp}$ | $I_{MPP}$ | [A] | 1.54 | 1.58 | 1.62 | 1.66 | 1.70 |
| Voltage At $P_{mpp}$ | $V_{MPP}$ | [V] | 84.5 | 85.5 | 86.5 | 87.4 | 88.3 |
| Module Efficiency | | [%] | ≥ 13.6 | ≥ 14.2 | ≥ 14.7 | ≥ 15.2 | ≥ 15.7 |
| **Performance At Nominal Module Operating Temperature (800W/M², Nmot, Am 1.5G Spectrum) [1]** | | | | | | | |
| Power Class (+5/-0 W) | | [W] | 130 | 135 | 140 | 145 | 150 |
| Minimum Power | $P_{MPP}$ | [W] | 97.9 | 101.6 | 105.4 | 109.3 | 113.1 |
| Short-Circuit Current | $I_{SC}$ | [A] | 1.40 | 1.42 | 1.44 | 1.45 | 1.47 |
| Open-Circuit Voltage | $V_{OC}$ | [V] | 98.9 | 100.1 | 101.2 | 102.3 | 103.5 |
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| Voltage At $P_{mpp}$ | $V_{MPP}$ | [V] | 79.6 | 80.6 | 81.7 | 82.8 | 83.8 |

[1] Measurement accuracy $P_{MPP}$±5%; tolerance $I_{SC}$, Voc, $I_{MPP}$, $V_{MPP}$±10%. All STC measurements are based on a pre-treatment of modules with 20 kWh/m² of light soaking (20 hours at 1000 W/m² and MPP) followed by a cool down to 25℃ .

| Temperature Coefficients At 1000W/M² | | |
|---|---|---|
| $P_{MPP}$ γ | [%/K] | -0.32 |
| Isc α | [%/K] | +0.01 |
| Voc β | [%/K] | -0.27 |

| NMOT | | |
|---|---|---|
| Nominal Module Operating Temperature | [℃ ] | 42 |

| Properties For System Design | | | | |
|---|---|---|---|---|
| Maximum System Voltage $V_{sys}$ | [V] | 1000(IEC)/600(UL 1703) | Protection Class | II |
| Maximum Reverse Current $I_r$ | [A] | 3 | Fire Rating | C |
| Positive Design Load (Iec 61215-2) | [Pa] | Up to 3600* | Permitted operating module temperature | -40℃to+85℃ (-40°F to+185°F) |
| Negative Design Load (Iec 61215-2) | [Pa] | Up to 1600* | | |

*A 1.5 safety factor ym has been taken into consideration during the test

| Mechanical Specifications | |
|---|---|
| Length | 1196.6(+3/-1)mm |
| Width | 796.1(+3/-1)mm |
| Height | 30mm |
| Weight | 18.0kg |
| Front Cover | 4 mm tempered low iron glass with AR coating |
| Back Cover | 3 mm float glass |
| Frame | Aluminum frame, black |
| Cell Type | CIGS [Cu (In, Ga) $Se_2$] |
| Junction Box | Ingress protection: IP67, with 1 bypass diode (8 A); 76 mm x 58 mm x 15.5 mm |
| Cable Type | PV1-F Solar cable 2.5mm²; Material: copper, weatherresistant from-40℃ up to +90℃ (+) 855 (+20/-0) mm; (-) 735 (+20/-0)mm |
| Connector | Renhe 05-6 certified according UL6703 |

| Qualification And Certification | |
|---|---|
| Module Certificates And Tests | IEC 61215 (Ed. 1:2016), IEC 61730 (Ed. 2:2016), IEC 61701:2011: Salt Mist Corrosion IEC 62716:2013: Ammonia Corrosion, IEC 60068-2-68:1994: Dust and Sand Resistance UL 1703 (CSA) CQC |
| Quality And Ehs Certificates | ISO 9001:2008 , ISO 14001:2009 , ISO 50001:2011 , BS OHSAS 18001:2007 |

## GSE PowerFLEX®+BAPV100/105/110/200/210/220/270/285/300W

| Electrical Specications | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacity Rating | Pmax | [W] | 100 | 105 | 110 | 200 | 210 | 220 | 270 | 285 | 300 |
| Tolerance Of Pmax | | [W] | +5/-0 | +5/-0 | +5/-0 | +10/-0 | +10/-0 | +10/-0 | +15/-0 | +15/-0 | +15/-0 |
| Module Aperture Area Eciency | | [%] | 13.0 | 13.7 | 14.3 | 13.0 | 13.6 | 14.3 | 12.8 | 13.5 | 14.2 |
| Rated Voltage | $V_{MPP}$ | [V] | 32.0 | 33.1 | 34.1 | 64.1 | 66.2 | 68.2 | 86.7 | 90.0 | 93.2 |
| Rated Current | $I_{MPP}$ | [A] | 3.2 | 3.2 | 3.3 | 3.2 | 3.2 | 3.3 | 3.2 | 3.2 | 3.3 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 41.4 | 42.3 | 43.1 | 82.8 | 84.6 | 86.2 | 113.9 | 116.3 | 118.5 |
| Short Circuit Current | $I_{SC}$ | [A] | 3.7 | 3.7 | 3.8 | 3.7 | 3.7 | 3.8 | 3.7 | 3.7 | 3.8 |

Note 1: Standard Test Conditions (STC): Cell Temperature at 25℃ ; Solar irradiance intensity of 1000 W/m²; AM1.5 solar reference spectrum (ASTM E892)
Note 2: Average apeture eciency is calculated using the average of rating and apeture area: 0.81m² for 100/110W, 1.62m² for 200/220W, and 2.22m² for 270/300W
Note 3: Electrical parameters are +/-10% unless stated otherwise

| Temperature Coecients | | |
|---|---|---|
| Maximum power | Pmax | -0.36%/℃ |
| Voltage at Maximum Power | Vmax | -0.31%/℃ |
| Open circuit voltage | Voc | -0.28%/℃ |
| Short circuit current | Isc | +0.01%/℃ |

Note: Relative to Standard Test Conditions (STC): Solar irradiance intensity of 1000 W/m²; AM1.5 solar reference spectrum (ASTM E892)

| Low-Light Performance | | | | | |
|---|---|---|---|---|---|
| Intensity | 1000W/m² | 800W/m² | 600W/m² | 400W/m² | 200W/m² |
| Relative Eciency | 100% | 100.9% | 101.5% | 100.7% | 97.1% |

Note: Relative to Standard Test Conditions (STC): Cell Temperature at 25℃ ; AM1.5 solar reference spectrum (ASTM E892)

| Mechanical Specications | | | |
|---|---|---|---|
| Model Numbers | FG-M6BP(M or N)-(270, 285, or 300) | FG-M4BP(M or N)-(200, 210, or 220) | FG-M2BP(M or N)-(100, 105, or 110) |
| | Note: where M is for mastic or N is for no mastic, and 100, 105, 110, 200, 210, 220, 270, 285, or 300 indicates wattage | | |
| Dimensions | 5411 x 494 x<3mm (213 x 19.4 x <0.12in) | 3978 x 494 x<3mm (156.6 x 19.4 x<0.12in) | 2068 x 494 x<3mm (81.4 x 19.4 x<0.12in) |
| Weight - Without Adhesive | 6.3kg (2.4kg/m²)±5% | 4.6kg (2.3kg/m²)±5% | 2.4kg (2.3kg/m²)±5% |
| Weight - With Adhesive | 8.1kg (3.0kg/m²)±5% | 6.0kg (3.0kg/m²)±5% | 3.1kg (3.0kg/m²)±5% |
| Junction Box - Top Mounted | TE Connectivity Micro Junction Box, 4.0mm², 2 Double Insulated PV Cable, 1000VDC, MC4 compatable connector (IP 67 Rated) | | |
| Top Surface Material | Low reectivity, and soil and dust resistant E TF E | | |
| Solar Cells | 176, 128 or 64 CIGS cells (211.5mm x 58mm) | | |
| Adhesive | ADCO HelioBond™ PVA 600BT butyl mastic | | |
| Hot Spot Protection | Bypass diodes at every other cell; 1 at junction bo | | |
| Maximum Series Fuse Rating | 6 Amp | | |
| Temperature Range | -40℃ to+85℃ | | |
| Maximum System Voltage | 1000VDC IEC, 1000VDC UL | | |

| Qualification And Certification |
|---|
| EN 61646, EN 61730, UL 1703; Fire Rating UL790, Class C, CE Mark |

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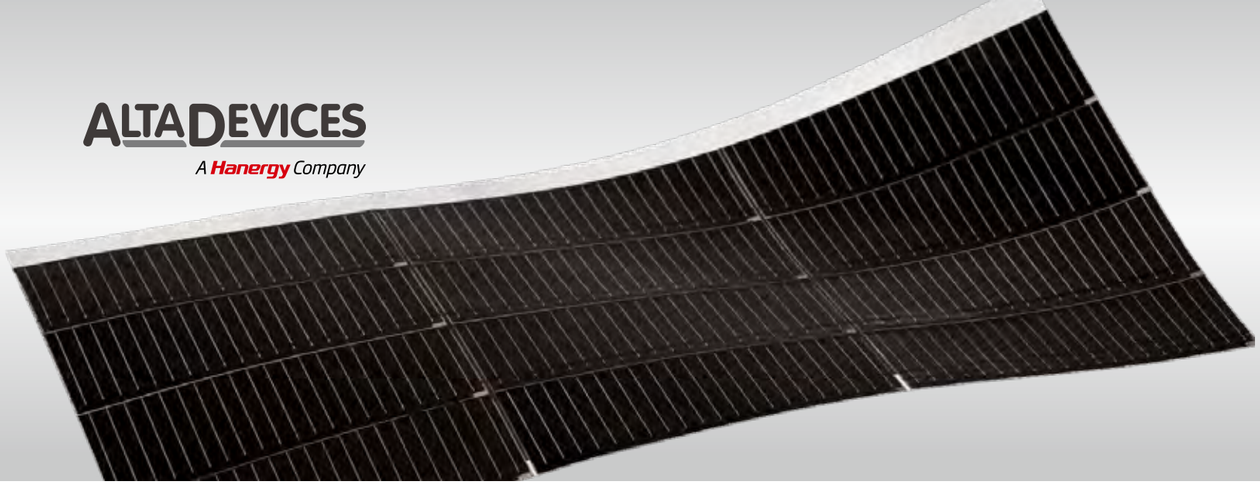
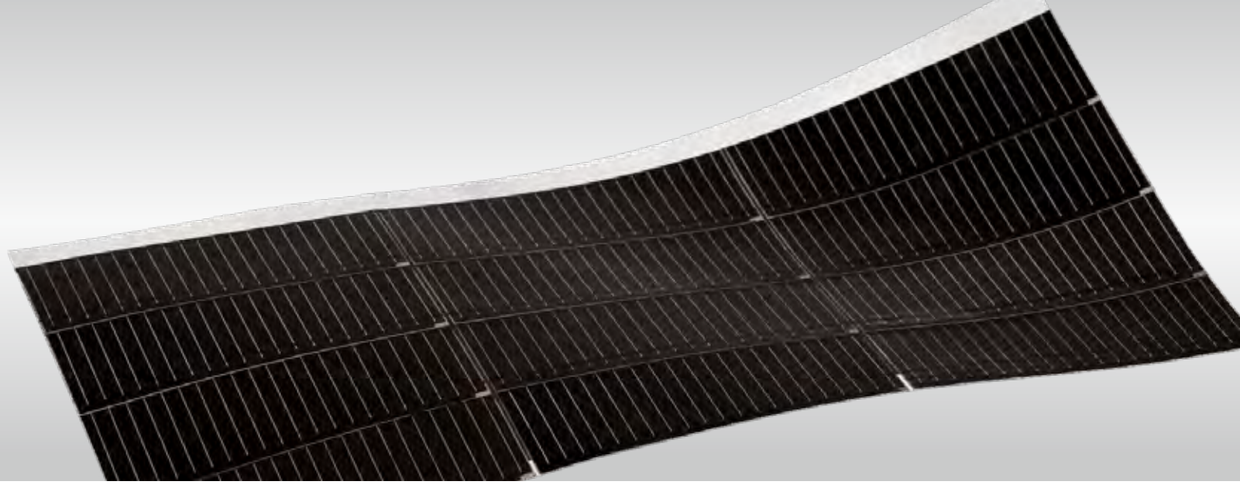


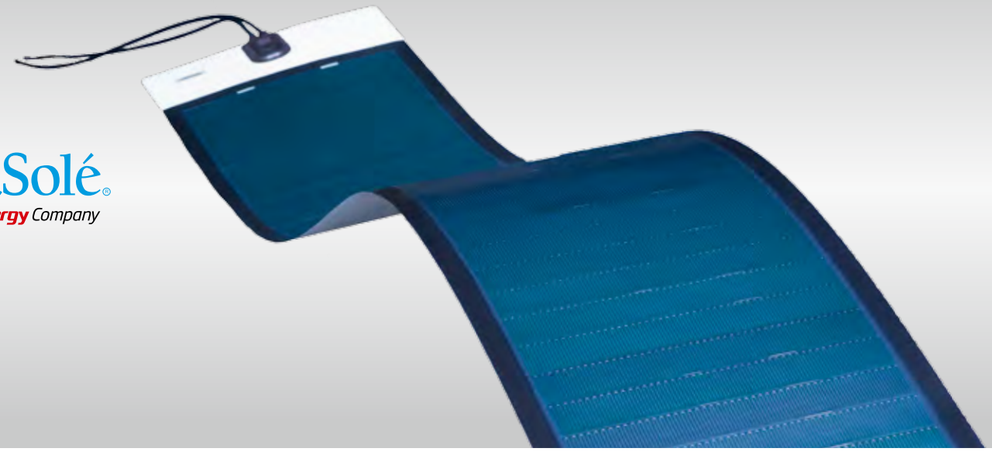


## Alta Devices Dual Junction

| Electrical Characteristics | | | |
|---|---|---|---|
| | | Typical at AM1.5, 1000W/m² 25℃ | Estimated at AM0, 1366W/m², 25℃ |
| Power Per Cell (Unshingled) | [W] | 0.28 | 0.34 |
| Efficiency | [%] | 29 | 25 |
| Power Per Cell (Shingled) | [W] | 0.25 | 0.30 |
| Power Density | [W/m²] | 290 | 345 |
| Open Circuit Voltage (Voc) | [V] | 2.54 | 2.59 |
| Max Power Voltage (Vmp) | [V] | 2.14 | 2.14 |
| Short Circuit Current (Isc) | [mA] | 119 | 142 |
| Max Power Current (Imp) | [mA] | 116 | 138 |
| **Temperature Coefficients** | | | |
| Open Circuit Voltage | Voc | [%/℃] | -0.19 |
| Short Circuit Current | Isc | [%/℃] | +0.08 |
| Max Power Voltage | Vmp | [%/℃] | -0.17 |
| Max Power Current | Imp | [%/℃] | +0.08 |
| Power | Pmp | [%/℃] | -0.09 |
| Percentage change per kWh(25℃) | | | |
| **Mechanical Characteristics** | | | |
| Unshingled Area | mm | 50 x 19.6 | |
| Shingled Area | mm | 50 x 17.1 | |
| Density (Unshingled) | g/m² | 114 | |
| Weight Per Cell (Unshingled) | g | 0.112 | |
| Radius Of Curvature | cm | > 5 | |
| Material | | Gallium arsenide GaAs | |

## Alta Devices Single Junction

| Electrical Characteristics | | | | | |
|---|---|---|---|---|---|
| | | AM1.5 1000W/m² 25℃ | Estimated at AM0, 1366W/m², 25℃ | Indoor Light, 3000K LED, 200 lux, 25℃ | |
| Power Per Cell (Unshingled) | [W] | 0.25 | 0.30 | μw | 152 |
| Efficiency | [%] | 26 | 23 | - | - |
| Power Per Cell (Shingled) | [W] | 0.22 | 0.26 | μw | 132 |
| Power Density | [W/m²] | 260 | 310 | μW/cm² | 15 |
| Open Circuit Voltage (Voc) | [V] | 1.10 | 1.12 | V | 0.90 |
| Max Power Voltage (Vmp) | [V] | 0.97 | 0.97 | V | 0.88 |
| Short Circuit Current (Isc) | [mA] | 240 | 286 | μA | 193 |
| Max Power Current (Imp) | [mA] | 229 | 273 | μA | 150 |
| **Temperature Coefficients** | | | | | |
| Open Circuit Voltage | Voc | [%/℃] | -0.19 | | |
| Short Circuit Current | Isc | [%/℃] | +0.08 | | |
| Max Power Voltage | Vmp | [%/℃] | -0.17 | | |
| Max Power Current | Imp | [%/℃] | +0.08 | | |
| Power | Pmp | [%/℃] | -0.09 | | |
| Percent change per℃ from 25℃ | | | | | |
| **Mechanical Characteristics** | | | | | |
| Unshingled Area | mm | 50 x 19.6 | | | |
| Shingled Area | mm | 50 x 17.1 | | | |
| Density (Unshingled) | g/m² | 114 | | | |
| Weight Per Cell (Unshingled) | g | 0.112 | | | |
| Radius Of Curvature | cm | >5 | | | |
| Material | | Gallium arsenide GaAs | | | |



## MiaSolé FLEX SERIES-03N

| Electrical Performance At Stc[1] | | | | | | |
|---|---|---|---|---|---|---|
| | | | FLEX–03 115N | FLEX–03 120N | FLEX–03 125N | FLEX–03 130N |
| Nominal Power | $P_{MPP}$ | [W] | 115 | 120 | 125 | 130 |
| Aperture Efficiency | η | [%] | 15.0 | 15.7 | 16.4 | 17.0 |
| Power Output Tolerance | | [W] | +5/-0 | +5/-0 | +5/-0 | +5/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 29.7 | 30.5 | 31.3 | 32.0 |
| Maximum Power Current | $I_{MPP}$ | [A] | 3.87 | 3.93 | 4.00 | 4.06 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 37.6 | 38.1 | 38.6 | 39.1 |
| Short Circuit Current | $I_{SC}$ | [A] | 4.52 | 4.53 | 4.55 | 4.57 |
| Maximum Series Fuse Rating | | [A] | 10 | | | |
| Maximum System Voltage | IEC/UL | [V] | 1000/600 | | | |
| [1]Standard Test Conditions (STC): 1000 W/m$^2$ , 25° C cell temperature, AM 1.5 spectrum | | | | | | |

| Thermal Characteristics | | |
|---|---|---|
| NOCT | [℃] | 48 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃] | -0.40 |
| Temperature Coefficient of $V_{OC}$ | [%/℃] | -0.36 |
| Temperature Coefficient of $I_{SC}$ | [%/℃] | 0.003 |

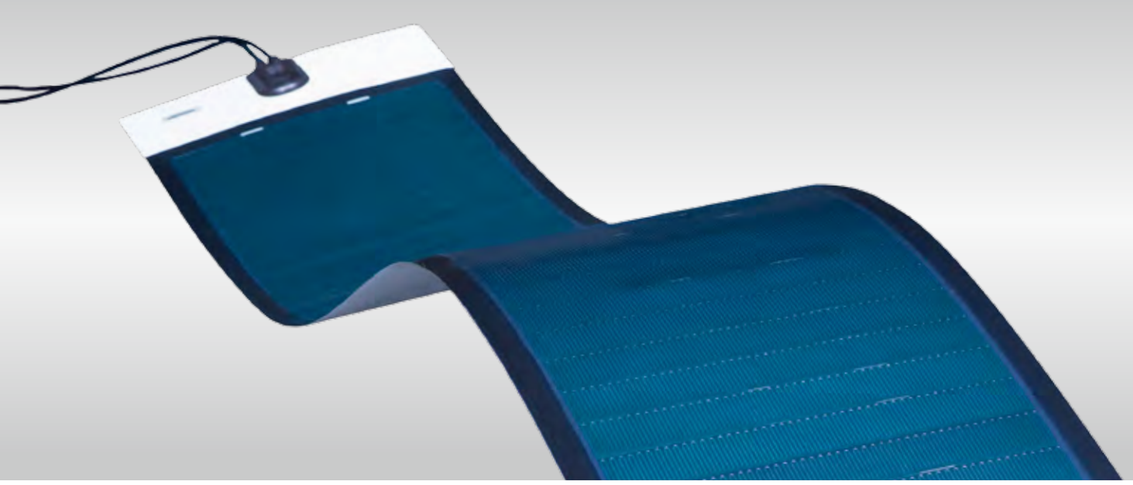
| Physical And Mechanical Specifications | |
|---|---|
| Length | 2585mm (101.8 in) |
| Width | 348mm (13.7 in) |
| Thickness, Maximum At J–Box*, Module | 17mm (0.7 in), 2.5 mm (0.1 in) |
| Weight (Module Without Adhesive) | 1.6kg (3.6 lb) |
| Weight (Module With Adhesive) | 1.9kg (4.3 lb) |
| Weight/Area (Module Without Adhesive) | 1.8kg/m$^2$ (0.4 lb/ft$^2$) |
| Weight/Area (Module With Adhesive) | 2.2kg/m$^2$ (0.5 lb/ft$^2$) |
| Junction Box Type | IP68 |
| Cell Type | CIGS |
| Certifications | UL 1703, IEC 61646, IEC 61730 |

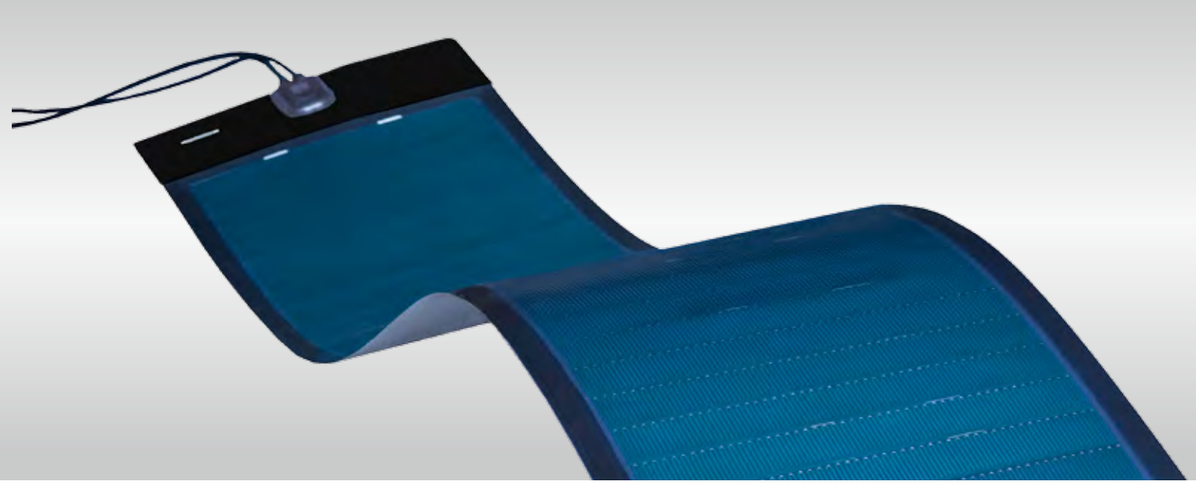
## MiaSolé FLEX SERIES-03W

| Electrical Performance At | | | | | | |
|---|---|---|---|---|---|---|
| | | | FLEX–03 470N | FLEX–03 480N | FLEX–03 490N | FLEX–03 500N |
| Nominal Power | $P_{MPP}$ | [W] | 470 | 480 | 490 | 500 |
| Aperture Efficiency | η | [%] | 15.4 | 15.7 | 16 | 16.4 |
| Power Output Tolerance | | [W] | +10/-0 | +10/-0 | +10/-0 | +10/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 60.7 | 61 | 61.4 | 61.9 |
| Maximum Power Current | $I_{MPP}$ | [A] | 7.74 | 7.86 | 7.99 | 8.08 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 75.2 | 76.2 | 77.2 | 78.2 |
| Short Circuit Current | $I_{SC}$ | [A] | 9.04 | 9.06 | 9.1 | 9.14 |
| Maximum Series Fuse Rating | | [A] | 25 | | | |
| Maximum System Voltage | IEC/UL | [V] | 1000/600 | | | |
| [1]Standard Test Conditions (STC): 1000 W/m$^2$, 25° C cell temperature, AM 1.5 spectrum | | | | | | |

| Thermal Characteristics | | |
|---|---|---|
| NOCT | [℃] | 48 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃] | -0.40 |
| Temperature Coefficient of $V_{OC}$ | [%/℃] | -0.36 |
| Temperature Coefficient of $I_{SC}$ | [%/℃] | 0.003 |

| Physical And Mechanical Specifications | |
|---|---|
| Length | 2585mm (101.8 in) |
| Width | 1293mm (50.9 in) |
| Thickness, Maximum At J–Box*, Module | 17mm (0.7 in), 2.5mm (0.1 in) |
| Weight (Module Without Adhesive) | 5.5kg (12.2 lb) |
| Weight (Module With Adhesive) | 6.6kg (14.6 lb) |
| Weight/Area (Module Without Adhesive) | 1.7kg/m$^2$ (0.3 lb/ft$^2$) |
| Weight/Area (Module With Adhesive) | 2.0kg/m$^2$ (0.4 lb/ft$^2$) |
| Junction Box Type | IP68 |
| Cell Type | CIGS |
| Certifications | UL 1703, IEC 61646, IEC 61730 |





## MiaSolé FLEX SERIES-03NL

| Electrical Performance At Stc[1] | | | | | | |
|---|---|---|---|---|---|---|
| | | | FLEX–03 275NL | FLEX–03 285NL | FLEX–03 295NL | FLEX–03 305NL |
| Nominal Power | $P_{MPP}$ | [W] | 275 | 285 | 295 | 305 |
| Nominal Efficiency | η | [%] | 15.3 | 15.8 | 16.4 | 16.9 |
| Power Output Tolerance | | [W] | +10/-0 | +10/-0 | +10/-0 | +10/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 70.7 | 72.3 | 73.8 | 75.3 |
| Maximum Power Current | $I_{MPP}$ | [A] | 3.89 | 3.94 | 4.00 | 4.05 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 89.0 | 90.0 | 91.0 | 92.1 |
| Short Circuit Current | $I_{SC}$ | [A] | 4.52 | 4.54 | 4.55 | 4.57 |
| Maximum Series Fuse Rating | | [A] | 10 | | | |
| Maximum System Voltage | IEC/UL | [V] | 1000/600 | | | |
| [1]Results based on preliminary testing | | | | | | |

| Thermal Characteristics | | |
|---|---|---|
| NOCT | [℃] | 48 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃] | -0.40 |
| Temperature Coefficient of $V_{OC}$ | [%/℃] | -0.36 |
| Temperature Coefficient of $I_{SC}$ | [%/℃] | 0.003 |

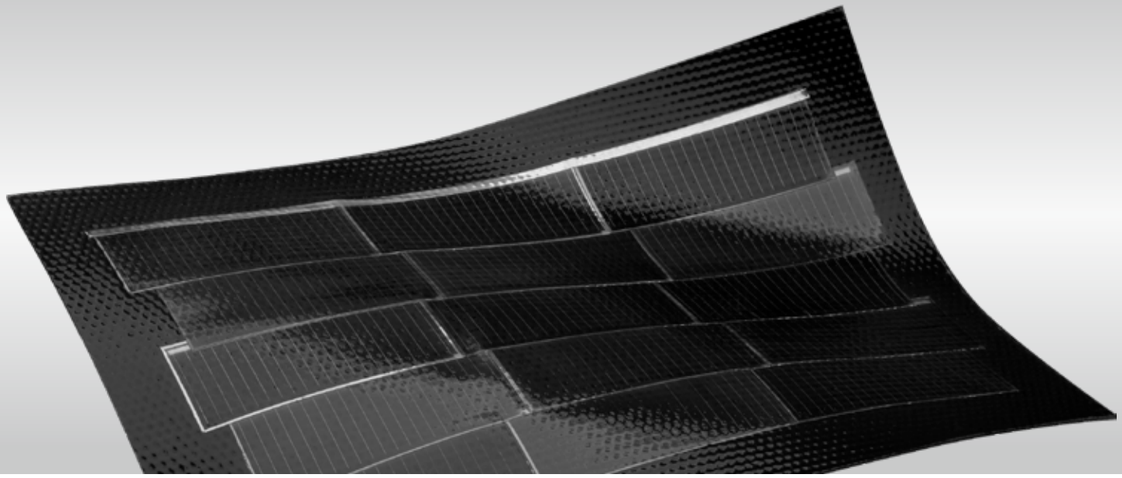
| Physical And Mechanical Specifications[1] | |
|---|---|
| Length | 5910mm (232.7 in) |
| Width | 348mm (13.7 in) |
| Thickness, Maximum at J–Box*, Module | 17mm (0.7 in) |
| Weight (Module without adhesive) | 3.5kg (7.9 lb) |
| Weight (Module with adhesive) | 4.3kg (9.5 lb) |
| Weight/Area (Module without adhesive) | 1.7kg/m$^2$ (<0.4 lb/ft$^2$) |
| Weight/Area (Module with adhesive) | 2.5kg/m$^2$ (0.4 lb/ft$^2$) |
| Junction Box Type | IP68 |
| Cell Type | CIGS |
| Certifications | UL 1703, IEC 61646, IEC 61730 |

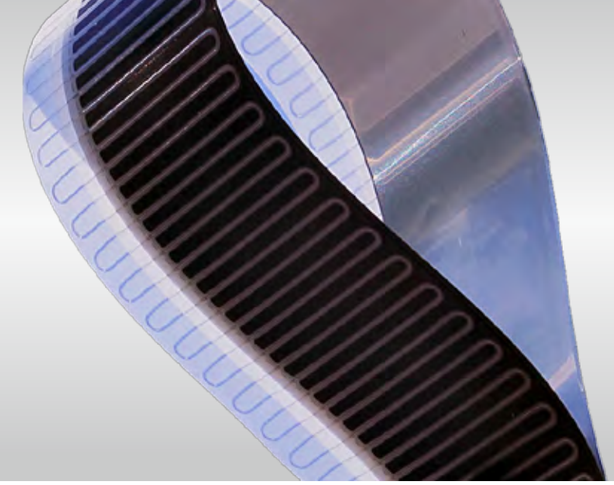
## MiaSolé FLEX SERIES-03NL

| Electrical Performance At Stc[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | FLEX–03 260NL | FLEX–03 270NL | FLEX–03 280NL | FLEX–03 290NL | FLEX–03 300NL | FLEX–03 310NL |
| Nominal Power | $P_{MPP}$ | [W] | 260 | 270 | 280 | 290 | 300 | 310 |
| Nominal Efficiency | η | [%] | 14.4 | 15.0 | 15.5 | 16.1 | 16.7 | 17.2 |
| Power Output Tolerance | | [W] | +10/-0 | +10/-0 | +10/-0 | +10/-0 | +10/-0 | +10/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 67.3 | 68.3 | 69.3 | 70.3 | 71.3 | 72.3 |
| Maximum Power Current | $I_{MPP}$ | [A] | 3.88 | 3.96 | 4.04 | 4.13 | 4.21 | 4.29 |
| Open Circuit Voltage | $V_{OC}$ | [V] | 86.2 | 86.8 | 87.3 | 87.9 | 88.4 | 89.0 |
| Short Circuit Current | $I_{SC}$ | [A] | 4.70 | 4.70 | 4.70 | 4.70 | 4.70 | 4.70 |
| Maximum Series Fuse Rating | | [A] | 10 | | | | | |
| Maximum System Voltage | IEC/UL | [V] | 1000/1000 | | | | | |
| [1]Standard Test Conditions (STC): 1000 W/m$^2$ , 25° C cell temperature, AM 1.5 spectrum | | | | | | | | |

| Thermal Characteristics | | |
|---|---|---|
| NOCT | [℃] | 48 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃] | -0.38 |
| Temperature Coefficient of $V_{OC}$ | [%/℃] | -0.28 |
| Temperature Coefficient of $I_{SC}$ | [%/℃] | 0.008 |

| Physical And Mechanical Specifications | |
|---|---|
| Length | 5910mm (232.7 in) |
| Width | 348mm (13.7 in) |
| Thickness, Maximum at J–Box*, Module | 17mm (0.7 in) |
| Weight (Module without adhesive) | 3.6kg (7.9 lb) |
| Weight (Module with adhesive) | 4.3kg (9.5 lb) |
| Weight/Area (Module without adhesive) | 1.7kg/m$^2$ (<0.4 lb/ft$^2$) |
| Weight/Area (Module with adhesive) | 2.1kg/m$^2$ (0.4 lb/ft$^2$) |
| Junction Box Type | IP68 |
| Cell Type | CIGS |
| Certifications | UL 1703, IEC 61646, IEC 61730 |





## MiaSolé MS Series-04

| Electrical Performance At Stc[1] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Power | $P_{MPP}$ | [W] | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 |
| Module Efficiency | η | [%] | 13.1 | 13.5 | 14.0 | 14.5 | 14.9 | 15.4 | 15.9 | 16.3 |
| Power Output Tolerance | | [W] | +5/-0 | +5/-0 | +5/-0 | +5/-0 | +5/-0 | +5/-0 | +5/-0 | +5/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 18.4 | 18.8 | 19.2 | 19.6 | 19.95 | 20.3 | 20.7 | 21 |
| Maximum Power Current | $I_{MPP}$ | [A] | 7.61 | 7.72 | 7.82 | 7.91 | 8.02 | 8.13 | 8.21 | 8.33 |
| Open Circuit Voltage | Voc | [V] | 23.8 | 24.1 | 24.4 | 24.7 | 24.9 | 25.2 | 25.5 | 25.7 |
| Short Circuit Current | Isc | [A] | 9.06 | 9.07 | 9.08 | 9.09 | 9.10 | 9.12 | 9.13 | 9.15 |
| Maximum Series Fuse Rating | | [A] | 25 | | | | | | | |
| Maximum System Voltage | (IEC/UL) | [V] | 1000/1000 | | | | | | | |
| [1]Standard Test Conditions (STC): 1000 W/m$^2$, 25° C cell temperature, AM 1.5 spectrum | | | | | | | | | | |
| Ratings at Nominal Operating Cell Temperature | | | | | | | | | | |
| Nominal Power | $P_{MPP}$ | [W] | 103.0 | 106.7 | 110.4 | 114.1 | 117.8 | 121.4 | 125.1 | 128.8 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 16.0 | 16.3 | 16.6 | 16.9 | 17.2 | 17.6 | 17.9 | 18.2 |
| Maximum Power Current | $I_{MPP}$ | [A] | 6.44 | 6.55 | 6.65 | 6.75 | 6.85 | 6.9 | 6.99 | 7.08 |
| Open Circuit Voltage | Voc | [V] | 20.7 | 20.9 | 21.1 | 21.3 | 21.6 | 21.8 | 22.0 | 22.2 |
| Short Circuit Current | Isc | [A] | 7.7 | 7.71 | 7.72 | 7.73 | 7.73 | 7.75 | 7.76 | 7.78 |
| Nominal operating cell temperature conditions: 800W/m$^2$, ambient temperature 20℃ , wind speed 1m/s. The power measurement uncertainty is within ±3%, and an AAA solar simulator is used for testing. | | | | | | | | | | |

| Temperature Coefficients | | |
|---|---|---|
| NOCT | [℃ ] | 45 |
| The Temperature Coefficient of Peak Power | [%/℃ ] | -0.40 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃ ] | -0.35 |
| Temperature Coefficient of $I_{SC}$ | [%/℃ ] | -0.03 |

| Mechanical Parameters | |
|---|---|
| Length | 1611mm |
| Width | 665mm |
| Thickness | 7.5mm; 28mm (including the junction box) |
| Weight | 18kg |
| Cell Type | CIGS |
| Maximum load | Snow load: 5400N/m$^2$ |
| Certification | IEC61646, IEC61730 (Application Level A), UL1703 (Fire Rating A) |

## MiaSolé CIGS SOLAR CELL

| Electrical Characteristics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nominal Power | $P_{MPP}$ | [W] | 1.91 | 1.98 | 2.05 | 2.12 | 2.18 | 2.25 |
| Cell Efficiency | | [%] | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 | 16.5 |
| Power Output Tolerance | | [W] | +0.1/-0 | +0.1/-0 | +0.1/-0 | +0.1/-0 | +0.1/-0 | +0.1/-0 |
| Maximum Power Voltage | $V_{MPP}$ | [V] | 0.536 | 0.544 | 0.552 | 0.559 | 0.567 | 0.575 |
| Maximum Power Current | $I_{MPP}$ | [A] | 3.57 | 3.64 | 3.71 | 3.78 | 3.85 | 3.92 |
| Open Circuit Voltage | Voc | [V] | 0.668 | 0.675 | 0.681 | 0.688 | 0.695 | 0.701 |
| Short Circuit Current | Isc | [A] | 4.10 | 4.14 | 4.19 | 4.23 | 4.28 | 4.32 |
| Electrical Properties Of 0.5% Efficiency Box | | | | | | | | |

| Thermal Characteristics* | | |
|---|---|---|
| NOCT | [℃ ] | 48 |
| Temperature Coefficient of $P_{MPP}$ | [%/℃ ] | -0.38 |
| Temperature Coefficient of $V_{OC}$ | [%/℃ ] | -0.28 |
| Temperature Coefficient of $I_{SC}$ | [%/℃ ] | 0.008 |
| *based on MiaSole FLEX-02 module measurements | | |

| Physical And Mechanical Specifications | |
|---|---|
| Length | 312mm+2/-4mm |
| Width | 43.75mm±0.005mm |
| Thickness | 0.33mm±0.1mm |
| Weight | 7.5gm±0.1gm |
| Cell Type | CIGS |