SINOLTECH ENERGY LIMITED | SINOLTECH HOLDING GROUP LTD

SHANDONG SINOLTECH INTERNATIOAL CO.,LTD

Flexible* Powerful* Lightweight Solar Solution

POWER THE POSSIBILITIES

WWW.SINOLTECH.COM

Applications and Opportunities

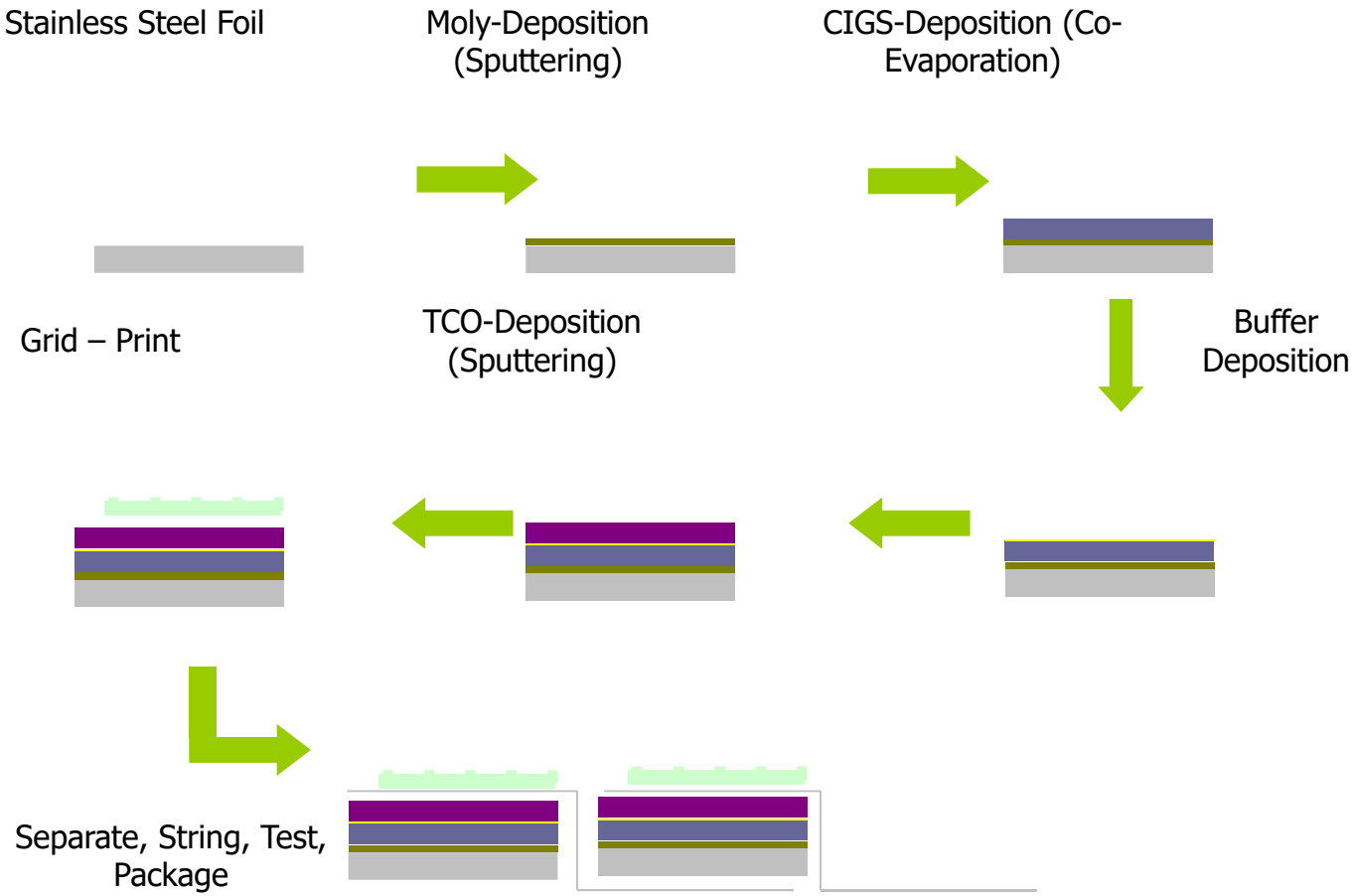
Outline

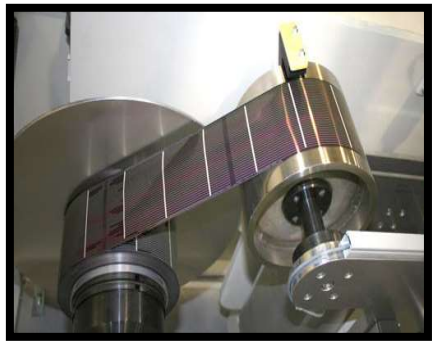
- Company overview
- Roll-to-roll manufacturing of CIGS thin film
- Flexible products and application examples / opportunities

SINOLTECH Solar Technology

- CIGS on a lightweight metal foil substrate
- Continuous Roll to Roll Processing
- Compact, high-volume deposition equipment
- Efficient material utilization

CIGS Cell Production Process Flow

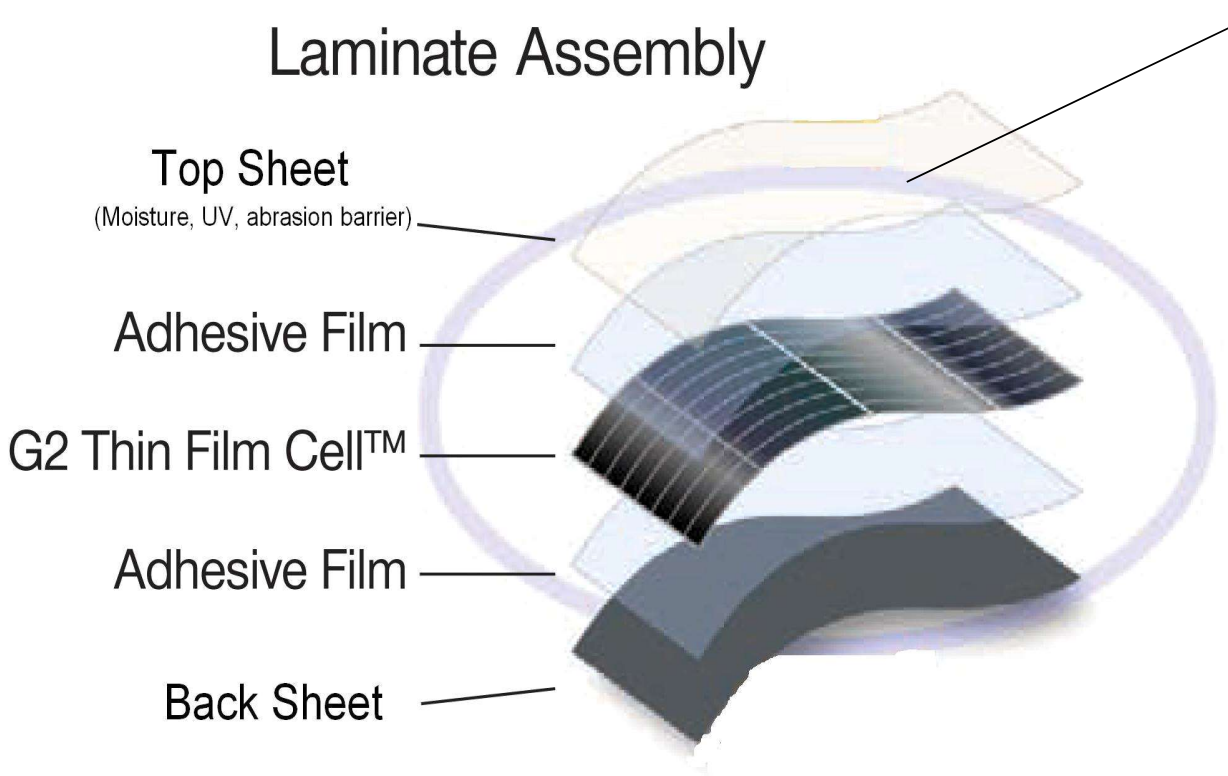




~1 m / min web speed
300 mm wide web
600-1200 m lengths

Low cost and scalable roll-to-roll process

BIPV Laminate Components



Top Sheet Details

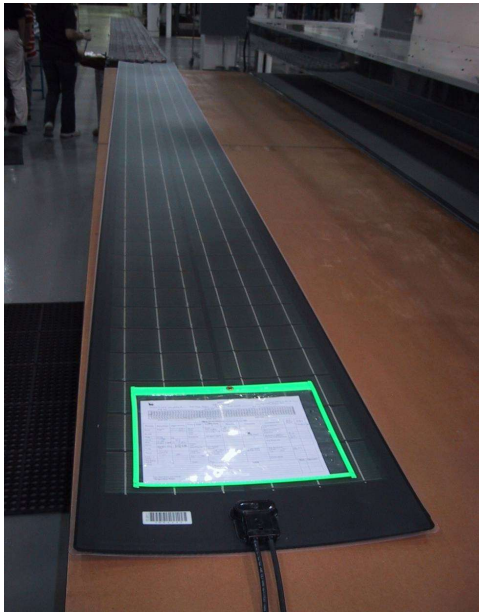
- •Glass replacement
  - •Moisture barrier
  - •UV stable
  - •Abrasion resistant
- •Flexible
- •Transparent (92%+) Low shrinkage at lamination
- •Good adhesion to encapsulant

BIPV Module Production Line

Module Assembly Station

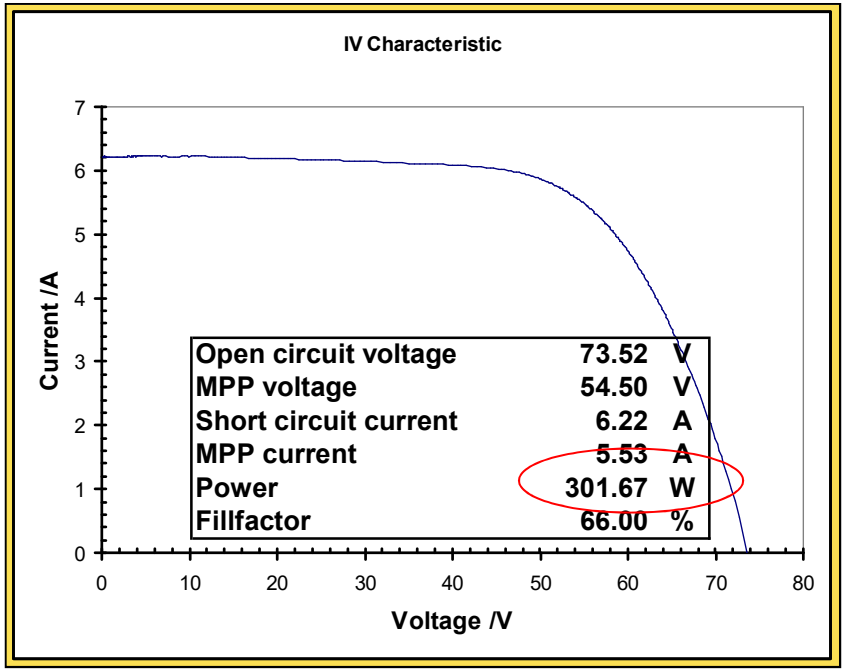
HiPot Station

6 meter Module



Laminator

PowerFLEX™ BIPV Module



- High power flexible modules up to 300 Watts
- 2, and 6 m modules available
- Both front and back j-box models

SPECIFICATION DATA SHEET

Electrical Performance at STC		FLEX-90	FLEX-100	FLEX-200	FLEX-275
Nominal Power(W)	Pmpp(W)	**90**	**100**	**200**	**275**
Module Aperture Area Efficiency(%)	(%)	11.4	12.7	12.6	11.5
Power Output Tolerance(W)	(W)	+10/-7%	+10/-7%	+10/-7%	+10/-7%
Maximum Power Voltage(V)	Vmpp(V)	16.5	17.8	36.2	51.5
Maximum Power Current(A)	Impp(A)	5.4	5.6	5.5	5.3
Open Circuit Voltage(V)	Voc(V)	22.0	23.3	46.4	67.6
Short Circuit Current(A)	Isc(A)	6.3	6.4	6.4	6.3
Maximum Series Fuse Rating	(A)	10	10	10	10
Maximum System Voltage	IEC/UL(V)	1000/600	1000/600	1000/600	1000/600
Physical and Mechanical Specifications					
Length	mm	2017	2017	3881	5745
Width	mm	494	494	494	494
Thickness(Max)	mm	3	3	3	3
Weight(without adhesive)	kg	2.6	2.6	4.9	7.2
Weight(with adhesive)	kg	3.3	3.3	6.3	9.3
Weight Area(without adhesive)	kg/m²	2.6	2.6	2.6	2.5
Weight Area(with adhesive)	kg/m²	3.3	3.3	3.3	3.3
Junction box-Top Mounted		TE Connectivity SOLARLOKTM Micro Junction Box with 4 mm2 dual rated cables and SOLARLOKTM connectors			
Top surface Material		Non-stick E TF E			
Solar Cells		108, 72 or 36 CIGS cells (210 mm x 100 mm)			
Adhesive		ADCO HelioBondTM PVA 600BT butyl mastic			
Hot Spot Protection		Bypass diodes at each cell; 1 at junction box			
Materials		Lead free and exempt from RoHS requirements			
Temperature Range		-40°C to + 85°C			
Warranty & Guarantee		Materials and workmanship - 5 years; Power output - 25 years (90% @ 10 yrs; 80% @ 25 yrs) Limited Warranty			

Note 1: Standard Test Conditions (STC): Cell Temperature at 25° C; Solar irradiance intensity of 1000 W/m2; AM1.5 solar reference spectrum (ASTM E892)
Note 2: Average efficiency is calculated using the aperture area of the module : 0.79m2 for 90/100W, 1.59m2 for 185/200W, and 2.38m2 for 275/300W
Note 3: Electrical parameters are +/-10% unless stated otherwise

Temperature Coefficients

Maximum power	P max	-0.43%/°C
Voltage at Maximum Power	V max	-0.38%/°C
Open circuit voltage	Voc	-0.33%/°C
Short circuit current	Isc	-0.03%/°C

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	Relative Efficiency
1000 W/m²	100%
500 W/m²	99%
200 W/m²	91%

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

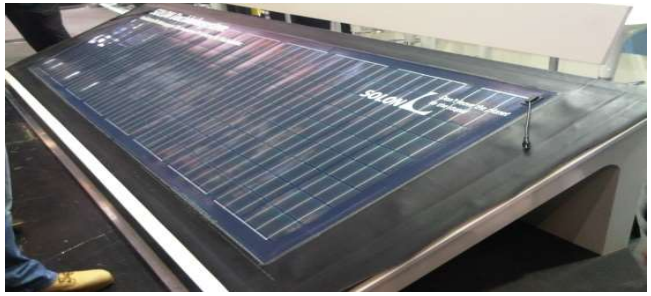
Enabling Attributes and Metrics for Flexible CIGS Products

Enabling Attribute	Key Metric
*Lightweight	*3.5kg/m^2 - Enables low load-bearing roof sector 3.5KG/m^2
*Low Profile Minimizes Wind Lift forces	*Enables low load-bearing roof sector
*Architecturally unique	*Enables High – Value Applications
*Flexible and Conforming	*Enables High - Value Applications
*Unbreakable	*Earthquake proof
*Installation Streamlined and Lower Cost	*Minimal infrastructure required
*Ideally suited for end customer solar kit (e.g. RV kit)	*Enables Mobile and Portable applications
*Higher Wattage and kWh produced per limited area *low-slope roofs than tilted arrays at most latitudes	*Enables High - Value Applications
*Better Shade tolerance than p-Si	*Site Enabling at times
*Comparable Low-light sensitivity, temperature coefficient, energy production (kWh/m2/day) to p-Si	

Applications

- **FLEX modules are compatible with**
- Directly onto metal Standing-Seam roofs
- Roof membranes
- Roofs rated at less than 5-10kg/m^2 additional load
- Curved roof / architectural structures
- Mobile applications - RVs, Trucks
- (DOW) Landfills
- Larger Mobile applications - Boats, Containers
- Tensioned-Fabric structures
- Corrugated roofs rated at 7-10kg/m2
- Elastomeric Coated Roofs
- Poles and Towers
- Architectural glass
- Larger Shingles

Shingle 屋顶板



Solar membrane 光伏薄膜

BIPV SOLUTION WITH FLEX SOLAR MODULE:
Low-profile, Lightweight, Unbreakable Roofing Solution

Roofs with weight limitations
Technical Preference FLEX

Target market segment

- **Roofs with weight-bearing limitations**
  - Require light weight solution
  - Glass modules weight (>11-20kg/m2) is prohibitive
  - Additional load rating allowances between ~5-10 kg/m^2
  - **Sinoltech** products at 3 to 7 kg/m2 are enabling

  ~30% of all commercial & industrial roofs

- 50 GW addressable / year in new roofs
- 100's GW addressable in retrofit

Plastic

Bitumen

Metal

Flexible CIGS unique attributes

Designed for roofs

- Light weight (10X less than c-si)
- No roof penetration – adhesive attachment
- Flexible – conforms to surface

High energy per roof 12.6% aperture efficiency – 300W / module

- High performance – shade tolerant Covers entire roof area – no tilt required

Superior economics

- Higher revenue per roof 30% to 40% savings in BOS & installation costs per Watt

PowerFlex – Mounting Options

- **Standard mounting options:**
  - Peel and stick onto properly prepared existing roof
    - Standing seam metal roofing (e.g. coated Galvalume)
    - TPO membrane roofing
    - EPDM and fiberglass roofs with and without EPDM perimeter frame
- **Deployed in Selected Sites**
  - Bitumen Roof: Direct module attachment with barrier and adhesive system
  - Bitumen Roof: Perimeter-only sealing of a PV-to-membrane structure
  - PVC membrane: Full-area adhesion of a PV-to-membrane structure

Standing Seam Metal roof

Bitumen, Italy

TPO, Japan

EPDM, Italy

Bitumen - Pre-Fabrication of Full roof segment plus

- Installation: December, 2011
- Modules: CIGS FLEX 275W BIPV
- Power: 4.4kWp
- Roofing Material: IcoSun Bitumen
- Installation Method: Pre-Fabrication of Full roof segment plus PV.

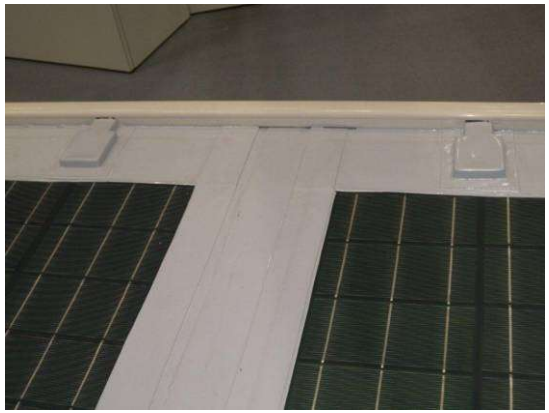
  Finished assembly delivered to site.

Netherlands Installation site

Field bonded to PVC sacrificial sheet

- Installation: October, 2011
- Modules: CIGS FLEXIBLE MODULE BIPV
- Power: 4.5 kW
- Roofing Material: Tajima PVC
- Installation: Field bonded to added sheet

Tajima, via OG Corporation – Japan



Factory bonded to Steel –Mounted raised above primary roof

- Installation: 2011
- Modules: CIGS FLEX MODULE 100W
- Power: 1.2kW
- Installation Method: Factory bonded

<u>Backside</u> J-box Module – Golf Course System

Factory bonded to Steel –Mounted raised above primary roof

Backside J-box Module – Mounting Hardware;
Underside view

Return cable can be routed in flexi-tubing beneath modules, next to roof pan ridge

Weights of Selected Mounting Alternatives

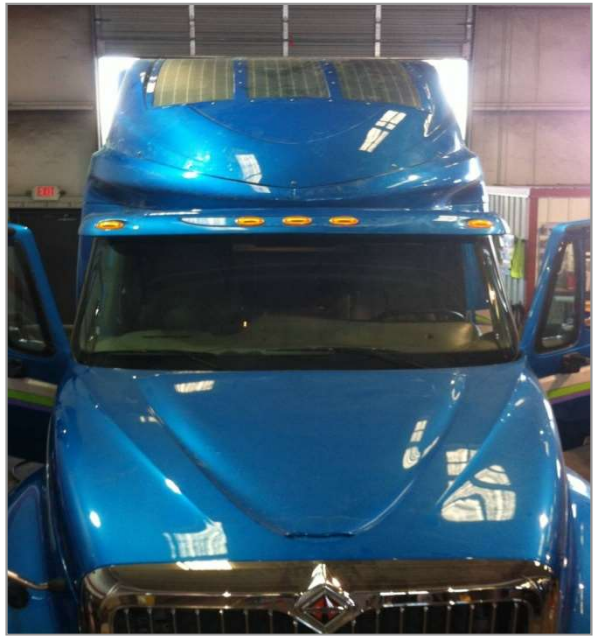
Mounting Method	Module Structure Weight(for 6m Module)
Peel and Stick with Butyl Mastic Adhesive (Standard)	~3.0 kg/m^2
Pre-mounted onto 1.2mm membrane, then Direct Edge Bonding to roof Membrane (edge welding to be confirmed)	~4.5 kg/m^2
Pre-mounted onto 0.5mm Galvalume	~6.9 kg/m^2

- Lightest glass-based solar modules have weights of approximately >11-15kg/m^2
- At ~3kg/m2, Sinoltech Stick-on modules enable most opportunities
- For more difficult roof surfaces (e.g. corrugated), Sinoltech offers structures at <7kg/m^2

Note: Estimated weight for pre-mounted on Galvalume does not include clamps, if needed

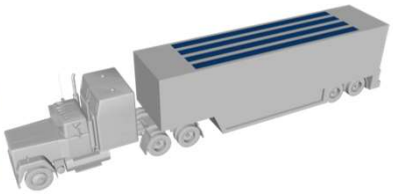
- Average Energy produced by **SINOLTECH** CIGS FLEX MODULE is comparable or greater than poly-Si but is clearly more versatile.

Flexible modules – Mobile Applications



Application of CIGS Flex modules on air fairing

Application of CIGS Flex modules on refrigeration trailer

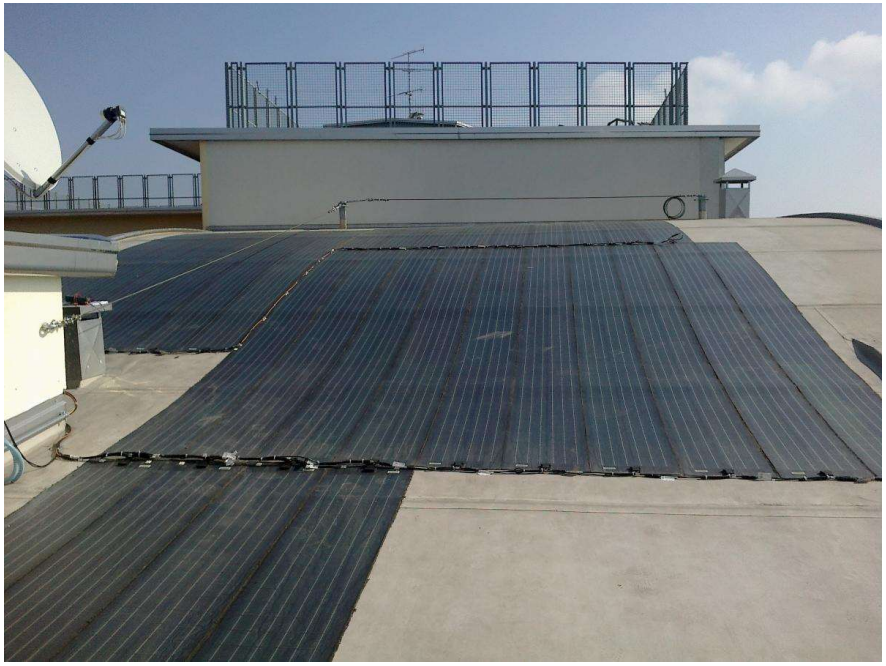


Application of *CIGS Flex* modules on RV roof

Flexible modules – Mobile Applications

Application of *CIGS Flex* modules on
BOAT AND YACHT

CIGS flex module for commercial/residential Roof and Landfill Site



CIGS flex module for LED lighting-Pole Mounted or Tower Mounted

Demo Module

17cm dia pole mounting (e.g. Lighting)

Tower Demo Exists

Mounting solution for CIGS flex module on cell phone towers

Goals:

- Provide power independent of grid in remote locations as stand-alone or in combination with other power sources
- Aesthetic looks
- Theft proof
- Indestructible by hail or vandalism

CIGS FLEX MODULE on Metal Standing seam car shading structure

- The modules used are standard **SINOLTECH** BIPV product
- Modules are mounted using standard Installation methods onto the Standing seam metal Structure

Architecturally Appealing, Solarized Tensioned-Fabric Structures

- Unique
- Functional
- Recognizable
- Modern Appeal
- Minimal Structure
- Easy Access

Thank you

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Ms Susan LIU General Manager

SINOLTECH ENERGY LIMITED
SHANDONG SINOLTECH INTERNATIONAL CO., LTD
SINOLTECH HOLDING GROUP LTD

TEL: +86-15318807707 / +86-18678875144,
FAX: 0086-531-88894033
Factory address: Bazi Industrial park, Hehua Road, Jinan, China
Sales office address: No.555 Jingde Road, Licheng district, Jinan, CHINA
Email: Susan@sinoltech.com / Sinoltech@hotmail.com
SKYPE: Sinoltech
Website: www.sinoltech.com

WWW.SINOLTECH.COM