AMERESCO
Green • Clean • Sustainable

Appendix for ECM 13: Solar PV, FunPlex

I. Energy Savings Calculations

Grid-Connected System: Simulation parameters

Project : City of Greeley

Geographical Site Greeley/weld (awos) **Country** USA

Situation Latitude 40.4°N Longitude 104.8°W
Time defined as Legal Time Time zone UT-7 Altitude 1420 m
Albedo 0.20

Meteo data : Greeley/weld (awos), NREL TMY3

Simulation variant : version 2 JH

Simulation date 09/09/12 22h52

Simulation parameters

Collector Plane Orientation Tilt 10° Azimuth 0°

Horizon Free Horizon

Near Shadings No Shadings

PV Array Characteristics

PV module Si-poly Model **TSM-290 PC14 for SA**
Manufacturer Trina Solar

Number of PV modules In series 11 modules In parallel 41 strings
Total number of PV modules Nb. modules 451 Unit Nom. Power 290 Wp
Array global power Nominal (STC) **131 kWp** At operating cond. 116 kWp (50°C)
Array operating characteristics (50°C) U mpp 355 V I mpp 327 A
Total area Module area **875 m²**

Inverter Model **PVP 100KW-480**
Manufacturer PV Powered

Characteristics Operating Voltage 295-500 V Unit Nom. Power 100 kW AC

PV Array loss factors

Thermal Loss factor Uc (const) 20.0 W/m²K Uv (wind) 0.0 W/m²K / m/s
=> Nominal Oper. Coll. Temp. (G=800 W/m², Tamb=20°C, Wind=1 m/s.) NOCT 56 °C

Wiring Ohmic Loss Global array res. 12 mOhm Loss Fraction 1.0 % at STC

Array Soiling Losses

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%

Module Quality Loss Loss Fraction 0.0 %
Module Mismatch Losses Loss Fraction 1.3 % at MPP
Incidence effect, ASHRAE parametrization IAM = 1 - bo (1/cos i - 1) bo Parameter 0.05

User's needs : Unlimited load (grid)

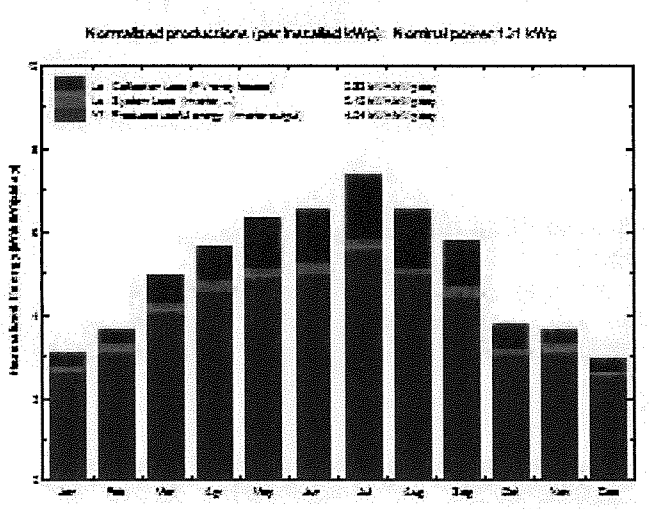
Grid-Connected System: Main results

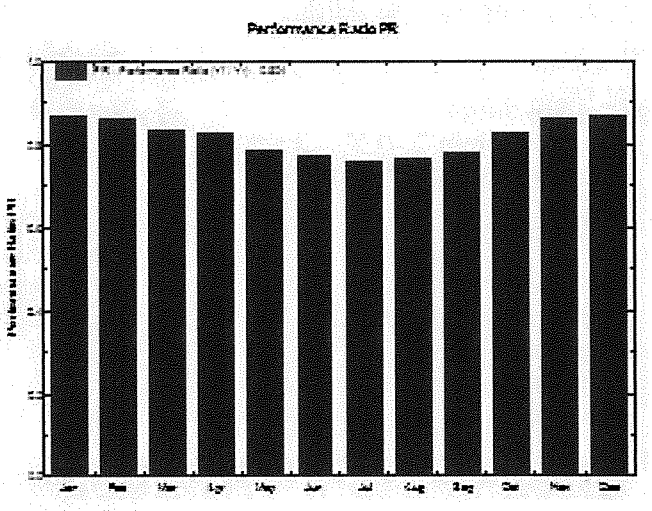
Project : **City of Greeley**

Simulation variant : **version 2 JH**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	10°	azimuth	0°
PV modules	Model	TSM-290 PC14 for SA	Pnom	290 Wp
PV Array	Nb. of modules	451	Pnom total	**131 kWp**
Inverter	Model	PVP 100KW-480	Pnom	100 kW ac
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**192.6 MWh/year**	Specific prod.	1473 kWh/kWp/year
	Performance Ratio PR	80.4 %		





version 2 JH

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR Arr %	PR Sys %
January	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
September	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
November	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
December	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Legends: GlobHor Horizontal global irradiation; T Amb Ambient Temperature; GlobInc Global incident in coll. plane; GlobEff Effective Global, corr. for IAM and shadings; EArray Effective energy at the output of the array; E_Grid Energy injected into grid; PR Arr Perf. Ratio array / rough area; PR Sys Perf. Ratio system / rough area

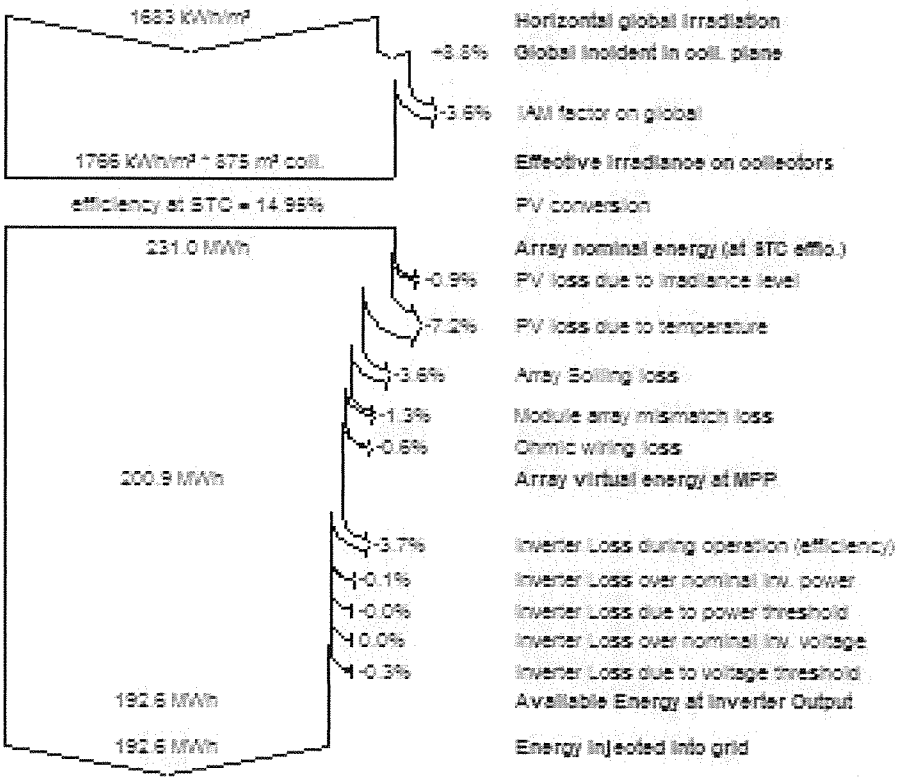
Grid-Connected System: Loss diagram

Project : City of Greeley

Simulation variant : version 2 JH

Main system parameters	System type	Grid-Connected		
PV Field Orientation	tilt	10°	azimuth	0°
PV modules	Model	TSM-290 PC14 for SA	Pnom	290 Wp
PV Array	Nb. of modules	451	Pnom total	**131 kWp**
Inverter	Model	PVP 100KW-480	Pnom	100 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



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Appendix for ECM 13: Solar PV, FunPlex

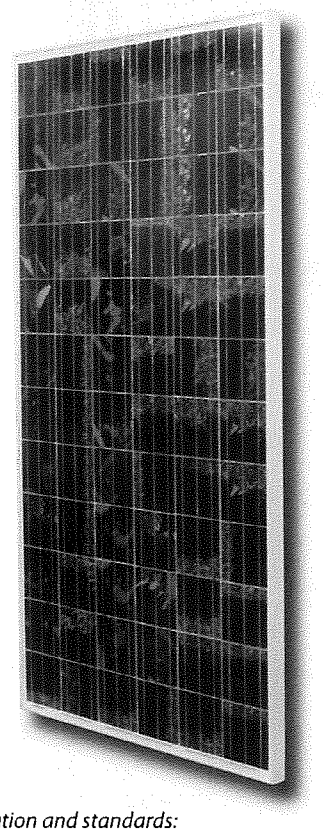
II. Manufacturer Specification Sheets

STP290 - 24/Vd
STP285 - 24/Vd

SUNTECH

Solar powering a green future™

290 Watt
POLYCRYSTALLINE SOLAR MODULE



Features

14.9%

High module conversion efficiency
Up to 14.9%, through superior cell technology and leading manufacturing capability

0/+5%

Positive tolerance
Guaranteed positive tolerance 0/+5% ensures power output reliability

3800Pa 5400Pa

Extended wind and snow load tests
Entire module certified to withstand extreme wind (3800 Pascal) and snow loads (5400 Pascal) *

Self-clean

Self-cleaning & anti-reflective
Anti-reflective, hydrophobic layer improves light absorption and reduces surface dust

Weak light

Excellent weak light performance
Excellent performance under low light environments (mornings, evenings, and cloudy days)

2%

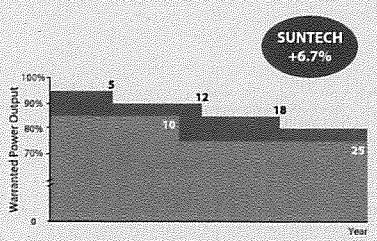
Suntech current sorting process
All Suntech modules sorted and packaged by amperage, maximizing system output by reducing mismatch losses by up to 2%

Certification and standards:
UL1703, IEC 61215, IEC 61730, conformity to CE

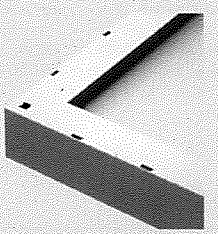
Trust Suntech to Deliver Reliable Performance Over Time

- World's No.1 manufacturer of crystalline silicon photovoltaic modules
- Unrivaled manufacturing capacity and world-class technology
- Rigorous quality control meeting the highest international standards : ISO 9001: 2008, ISO 14001: 2004 and ISO 17025: 2005

Industry-leading Warranty based on Pnom



- Based on nominal power (Pnom)
- 25-year transferrable power output warranty: 5 years/95%, 12 years/90%, 18 years/85%, 25 years/80% **
- Warrants 6.7% more power than the market standard over 25 years
- 10-year material and workmanship warranty



Superior Frame Design
Specially designed drainage holes and rigid construction prevent frames from deforming. Screwless frame design for long term durability.

Most Modern IP67 Rated Junction Box
Supports any orientation installation. High performance low resistance connectors ensure maximum module power output for highest energy production.

* Please refer to Suntech Standard Module Installation Manual for details.
** Please refer to Suntech Product Warranty for details.

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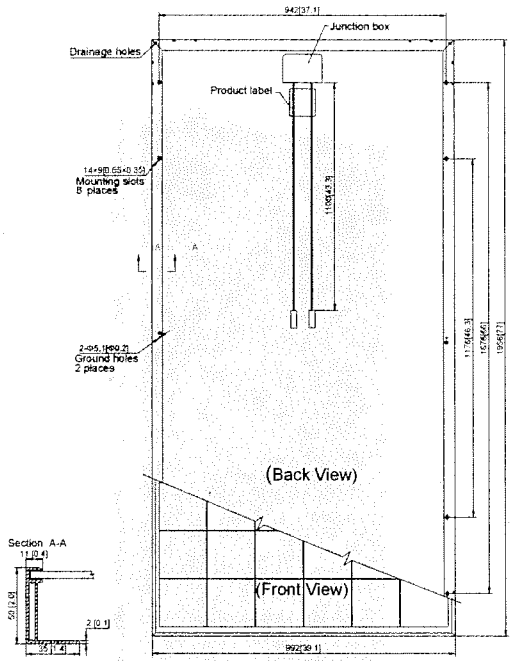
STP290 - 24/Vd
STP285 - 24/Vd



Note: mm [inch]

Electrical Characteristics

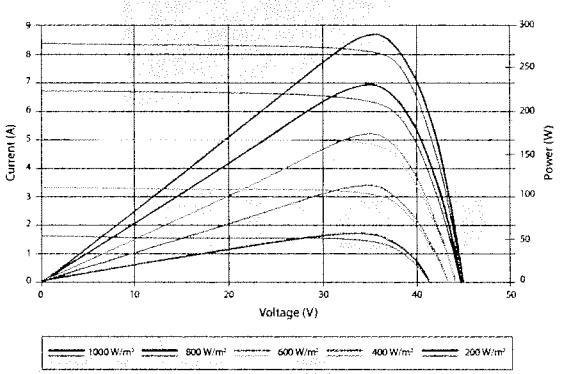
STC	STP290-24/Vd	STP285-24/Vd
Optimum Operating Voltage (Vmp)	35.6 V	35.4 V
Optimum Operating Current (Imp)	8.15 A	8.06 A
Open Circuit Voltage (Voc)	45.0 V	44.9 V
Short Circuit Current (Isc)	8.42 A	8.37 A
Maximum Power at STC (Pmax)	290 W	285 W
Module Efficiency	14.9%	14.7%
Operating Module Temperature	-40 °C to +85 °C	
Maximum System Voltage	600 V DC (UL)/ 1000 V DC (IEC)	
Maximum Series Fuse Rating	20 A	
Power Tolerance	0/+5 %	

STC: Irradiance 1000 W/m², module temperature 25 °C, AM=1.5;
Best in Class AAA solar simulator (IEC 60904-9) used, power measurement uncertainty is within +/- 3%

NOCT	STP290-24/Vd	STP285-24/Vd
Maximum Power at NOCT (Pmax)	211 W	208 W
Optimum Operating Voltage (Vmp)	32.2 V	32.1 V
Optimum Operating Current (Imp)	6.56 A	6.48 A
Open Circuit Voltage (Voc)	41.2 V	41.0 V
Short Circuit Current (Isc)	6.80 A	6.77 A

NOCT: Irradiance 800 W/m², ambient temperature 20 °C, AM=1.5, wind speed 1 m/s;
Best in Class AAA solar simulator (IEC 60904-9) used, power measurement uncertainty is within +/- 3%

Current-Voltage & Power-Voltage Curve (290-24)



Excellent performance under weak light conditions: at an irradiation intensity of 200 W/m² (AM 1.5, 25 °C), 95.5% or higher of the STC efficiency (1000 W/m²) is achieved

Mechanical Characteristics

Solar Cell	Polycrystalline 156 × 156 mm (6 inches)
No. of Cells	72 (6 × 12)
Dimensions	1956 × 992 × 50 mm (77.0 × 39.1 × 2.0 inches)
Weight	27.0 kgs (59.5 lbs.)
Front Glass	4.0 mm (0.16 inches) tempered glass
Frame	Anodized aluminium alloy
Junction Box	IP67 rated
	UL 4703, TUV (2Pfg1169: 2007)
Output Cables	4.0 mm² (0.006 inches²), symmetrical lengths (-) 1100 mm (43.3 inches) and (+) 1100 mm (43.3 inches)
Connectors	H4 connectors (MC4 compatible)

Temperature Characteristics

Nominal Operating Cell Temperature (**NOCT**)	45±2°C
Temperature Coefficient of Pmax	-0.44 %/°C
Temperature Coefficient of Voc	-0.33 %/°C
Temperature Coefficient of Isc	0.055 %/°C

Packing Configuration

Container	20' GP	40' GP	40' HC
Pieces per pallet	21	21	21
Pallets per container	5	12	24
Pieces per container	105	252	504

Dealer information

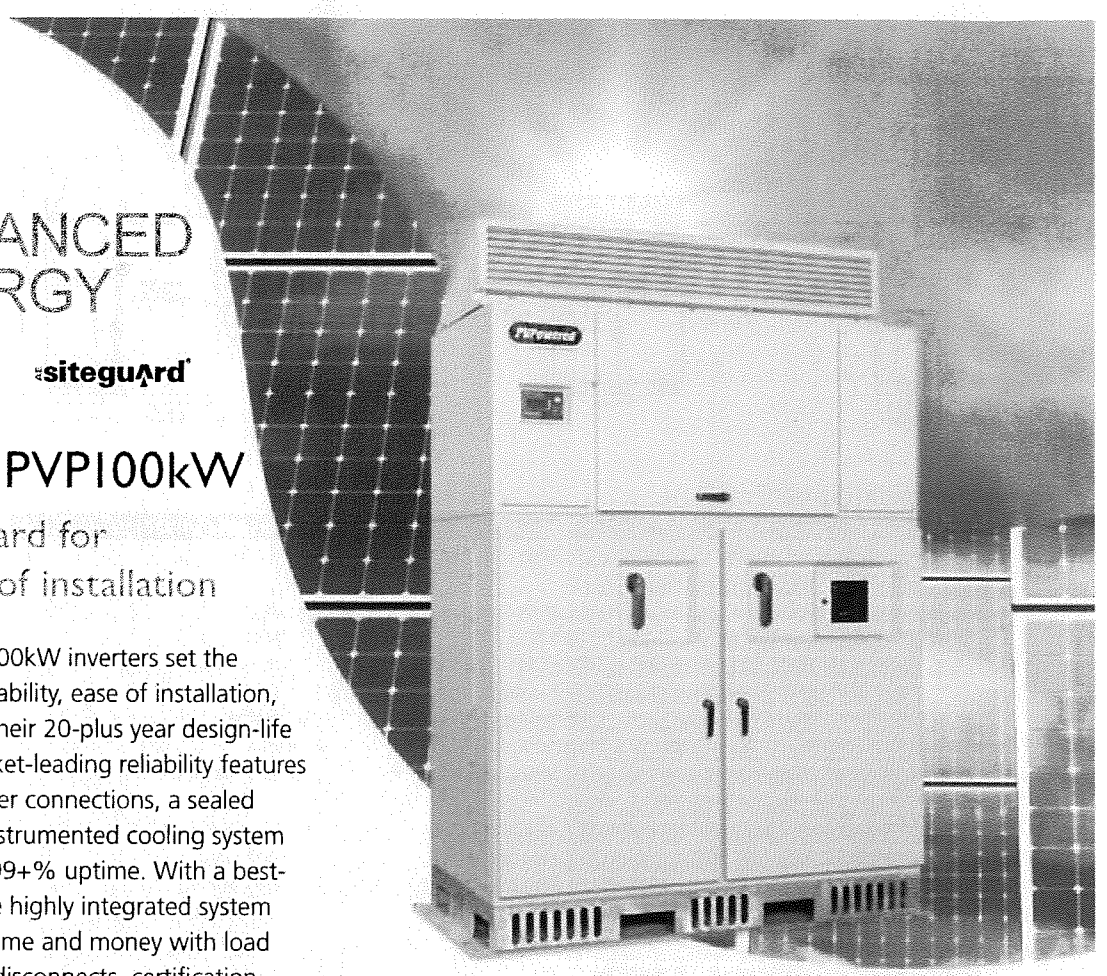
Specifications are subject to change without further notification

ADVANCED ENERGY

PVPowered™ solaron™ siteguard™

PVP75kW and PVP100kW

The industry standard for reliability and ease of installation



The PV Powered 75kW and 100kW inverters set the industry standard for high reliability, ease of installation, and lifetime maintainability. Their 20-plus year design-life is enabled by an array of market-leading reliability features including bus bars for all power connections, a sealed electronics module, and an instrumented cooling system resulting in a track record of 99+% uptime. With a best-in-class efficiency of 96%, the highly integrated system is designed to save installers time and money with load break rated AC & DC service disconnects, certification for installation without a neutral conductor, and exterior mounting flanges for fast and easy anchoring with no pre-drilling. The wide 295-595V voltage window provides exceptional flexibility and stringing capability with all PV modules including thin film.

New features include remote disable inputs and an expanded array of monitored subcombiner fusing options. A 24V auxiliary power supply, revenue grade meter, and performance monitoring gateway can also be added for a completely integrated inverter solution. Advanced power controls provide essential utility support functions including power factor, curtailment, and controlled ramp rate.

Advanced Energy backs all of its commercial inverters with an industry-leading 10-year nationwide warranty and a comprehensive optional 20-year warranty; plus the best service and support team in the business.

Superior Reliability

- Engineered power connections eliminate failure points
- Advanced, high-reliability circuit board system
- Redundant cooling system with Smart Air Management™
- Redundant industrial grade power supply for long-life and high quality control power

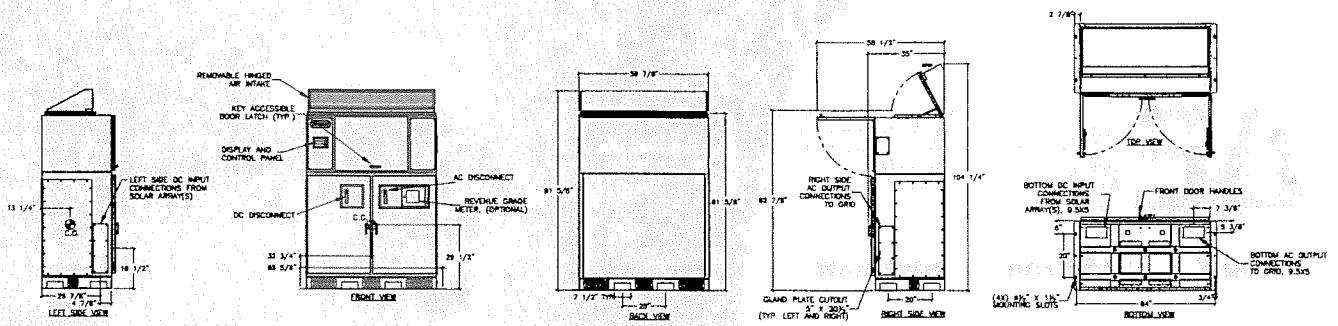
Exceptional Installability & Maintainability

- Bottom, and side cable entry
- Generous cable bending area
- Complete range of fused DC sub-combiner options
- Exterior mounting flange for fast and easy anchoring
- Error-free AC auto-phasing

Easy to Maintain

- All maintenance and service via front and side access
- Load break rated AC and DC service disconnects
- Positive-locking, tool-free circuit board cage
- Optional preventative maintenance program and extended warranty

PV Powered and Solaron products built in the U.S. are fully compliant with the Buy America Act and qualify for projects funded by the federal stimulus package.



Electrical Specifications

	Model PVP75kW	Model PVP100kW
Continuous Output Power	75kW	100kW
Weighted CEC Efficiency		
208	95.5%	95.5%
480	95.5%	96.0%
600	96.0%	96.0%
Maximum DC Input Voltage	600 Voc	600 Voc
DC Peak Power Tracking Range	295-595 V	295-595V
Maximum Operating Input Current	267 A	356A
AC Nominal Voltage	208V Y, 480V Y, 600V Y	208V Y, 480V Y, 600V Y
AC Operating Range		
208	183-228 V	183-228 V
480	423-528 V	423-528 V
600	528-660 V	528-660 V
AC Frequency Range	59.3-60.5 Hz	59.3 - 60.5 Hz
AC Maximum Continuous Current		
208	208 A	278 A
480	91 A	120 A
600	72 A	96 A
Standby Losses	42 W	42 W
Harmonic Distortion	<3% THD	<3% THD
Power Factor	>.99	>.99

Mechanical Specifications

	Model PVP75kW	Model PVP100kW
Enclosure	NEMA 4	NEMA 4
Construction	Powder Coated Steel	Powder Coated Steel
	Optional Stainless Steel	Optional Stainless Steel
Mounting	Pad Mount	Pad Mount
Weight (lbs)	2750	3000
Cooling	Forced Convection	Forced Convection
Operating Ambient Temperature Range	-30 to 50 °C	-30 to 50 °C
Standby/Storage Ambient Temperature Range	-40 to 60 °C	-40 to 60 °C
Isolation Transformer	Yes	Yes
Noise Emission (typical at full load)	<61dBA at 8ft	<61dBA at 8ft

Advanced power Controls:

- Power factor
- Curtailment
- Controlled ramp rate
- Remote enable/disable

Options

- Integrated fused subcombiner: up to 9 inputs of 70A-600A (max total of 675A)
- Integrated fused subcombiner with monitoring: Up to 6 inputs of 70A-100A or up to 5 inputs of 70A - 200A (max total of 675A)
- Integrated revenue grade meter
- Integrated data monitoring
- 24V auxiliary power supply
- Stainless steel
- 20-year extended warranty

Agency Approvals

UL 1741, IEEE519, IEEE929, IEEE1547, CSA 107.1-1
FCC Class A for conducted and radiated

Performance Monitoring

Increase uptime and reduce maintenance costs with integrated performance monitoring hardware that enables connectivity to a variety of software solutions from industry leading monitoring partners. The tight integration between Advanced Energy and our monitoring partners creates a superior service and support experience while seamlessly delivering meaningful data. Factory integration and testing of our UL listed monitoring solution ensures high reliability and significantly reduces field installation costs.

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Specifications are subject to change without notice.

ADVANCED ENERGY
Advanced Energy Industries, Inc. · 20720 Brinson Blvd. · Bend, OR 97701 U.S.A.
T: 877.312.3832 · sales.support@aei.com · www.advanced-energy.com/solarenergy
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Intertek

panelclaw®

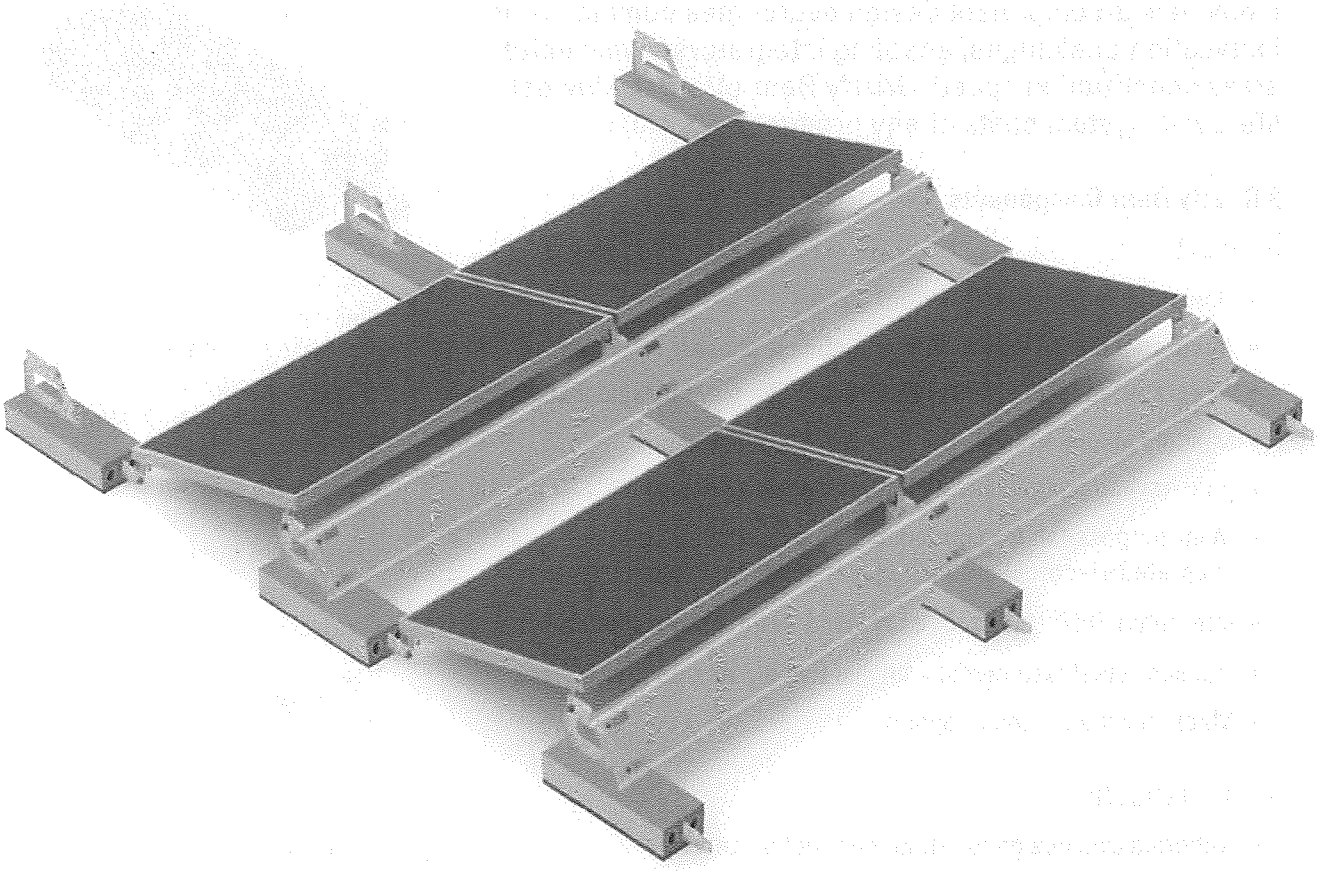
Securing a Brighter Future

LOWEST LIFE-CYCLE COST

CUTTING-EDGE ENGINEERING

WORLD-CLASS SERVICE

ENVIRONMENTAL RESPONSIBILITY



GRIZZLY BEAR® FR *Gen II*

10 Degree

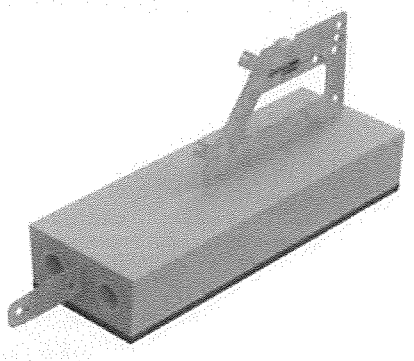
PanelClaw delivers mounting and balance-of-system solutions to accelerate the adoption of photovoltaics worldwide.

panelclaw®

Securing a Brighter Future

Grizzly Bear *Gen II*
10 Degree
Flat Roof Mounting System

Grizzly Bear FR *Gen II* is an eco-friendly, integrated ballast mounting solution for commercial flat roofs. Its innovative 3-component design overcomes common roof installation challenges, enabling integrators to maximize array construction speed. Grizzly Bear offers the lowest life-cycle system costs of any product in its class.



3 Grizzly Bear Components

Support

- Universal, module-independent design
- Integrated ballast and wire-management chases
- Integrated recycled rubber roof protection pad for rapid installation
- Multiple mounting holes for wavy roof friendliness
- Inter-row spacing flexibility for optimal array design
- Multi-purpose tab for enhanced wire management or integrated electrical ground lug (when necessary)
- Integrated PEM® studs for easy Wind Deflector installation
- Stainless steel fastener kit with just two nut and bolt sizes
- Mechanical attachment option

Wind Deflector

- A-thermalized design for enhanced roof protection
- Chamfered edges and lightweight construction facilitate easy handling and safe installation
- Common Deflector for Polar Bear and Grizzly Bear 10 Degree products
- Available in aluminum or G90 steel

Claw

- Universal to all PanelClaw mounting systems
- UL 2703 certified for electric bonding and grounding
- Factory-installed module-mounting stainless steel screw
- Serrated design to increase clamping power

UL 2703 Recognized E33973 Electric Bonding and Grounding

Application
Flat Roof
(max slope 5 degrees)

Installation Speed
190-210 modules per day
(3-person crew)

Module Tilt Angle
10-12 degrees
(dependent on module width)

Module Orientation
Landscape

Basic Wind Speed
Up to 100 mph *(161 km/h)*

Wind Exposure Category
B and C (D upon request)

Array Platform Load
~4 psf *(~19 kg/m²)*
(racking, ballast, and modules)

Building Height
Up to 60 feet *(18.3 meters)*
(custom upon request)

Standard Warranty
10 years

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978.688.4900
sales@panelclaw.com
www.panelclaw.com

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