

# JKM320P-72

## 305-320 Watt

### POLY CRYSTALLINE MODULE

Positive power tolerance of 0/+3%

ISO9001:2008、ISO14001:2004、OHSAS18001  
certified factory.  
IEC61215、IEC61730 certified products.

(4BB)



## KEY FEATURES



### 4 Busbar Solar Cell:

4 busbar solar cell adopts new technology to improve the efficiency of modules, offers a better aesthetic appearance, making it perfect for rooftop installation.



### High Efficiency:

High module conversion efficiency (up to 16.49%), through innovative manufacturing technology.



### Low-light Performance:

Advanced glass and solar cell surface texturing allow for excellent performance in low-light environments.



### Severe Weather Resilience:

Certified to withstand: wind load (2400 Pascal) and snow load (5400 Pascal).

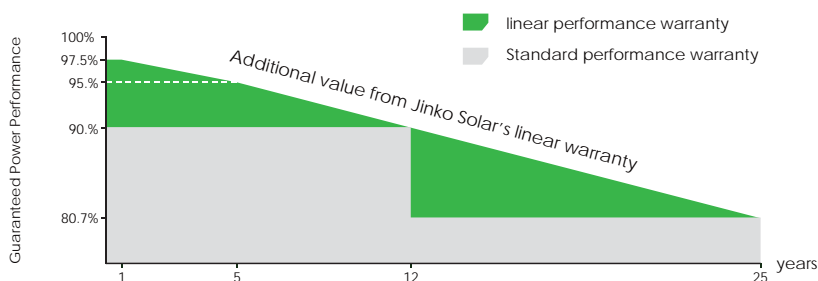


### Durability against extreme environmental conditions:

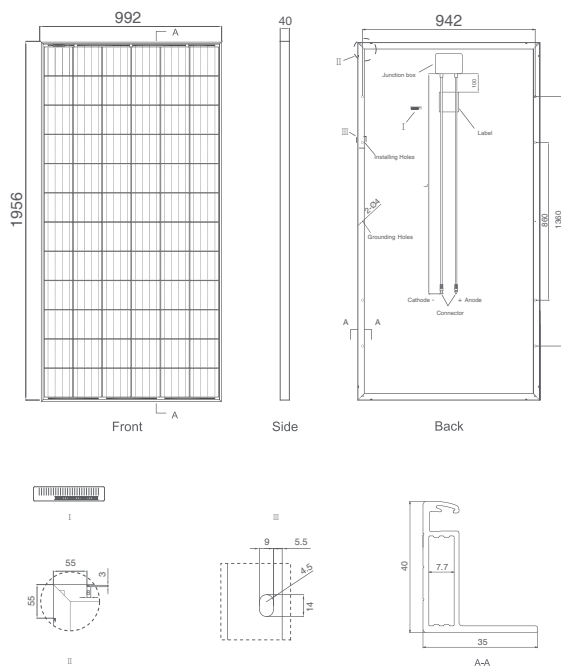
High salt mist and ammonia resistance certified by TUV NORD.

## LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty • 25 Year Linear Power Warranty



## Engineering Drawings

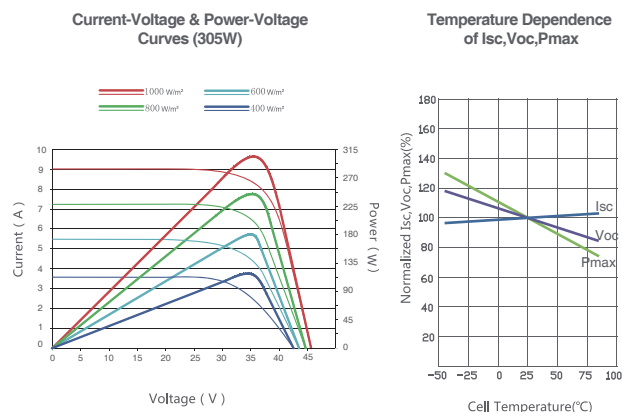


## Packaging Configuration

( Two boxes =One pallet )

25pcs/ box, 50pcs/pallet, 600 pcs/40'HQ Container

## Electrical Performance & Temperature Dependence



## Mechanical Characteristics

Cell Type	Poly-crystalline	156×156mm (6 inch)
No. of cells	72 (6×12)	
Dimensions	1956×992×40mm (77.01×39.05×1.57 inch)	
Weight	26.5 kg (58.4 lbs.)	
Front Glass	4.0mm, High Transmission, Low Iron, Tempered Glass	
Frame	Anodized Aluminium Alloy	
Junction Box	IP67 Rated	
Output Cables	TÜV 1×4.0mm², Length: 900mm or Customized Length	

## SPECIFICATIONS

Module Type	JKM305P		JKM310P		JKM315P		JKM320P	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	305Wp	225Wp	310Wp	230Wp	315Wp	233Wp	320Wp	237Wp
Maximum Power Voltage (Vmp)	36.8V	34.0V	37.0V	34.4V	37.2V	34.7V	37.4V	34.7V
Maximum Power Current (Imp)	8.30A	6.62A	8.38A	6.68A	8.48A	6.71A	8.56A	6.83A
Open-circuit Voltage (Voc)	45.6V	42.4V	45.9V	42.7V	46.2V	42.8V	46.4V	43.0V
Short-circuit Current (Isc)	8.91A	7.21A	8.96A	7.26A	9.01A	7.28A	9.05A	7.35A
Module Efficiency STC (%)	15.72%		15.98%		16.23%		16.49%	
Operating Temperature(°C)	-40°C~+85°C							
Maximum system voltage	1000VDC (IEC)							
Maximum series fuse rating	15A							
Power tolerance	0~+3%							
Temperature coefficients of Pmax	-0.41%/°C							
Temperature coefficients of Voc	-0.31%/°C							
Temperature coefficients of Isc	0.06%/°C							
Nominal operating cell temperature (NOCT)	45±2°C							

STC: Irradiance 1000W/m² Cell Temperature 25°C AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM=1.5 Wind Speed 1m/s

\* Power measurement tolerance: ± 3%

## TRANSFORMERLESS CENTRAL INVERTERS WITH A SINGLE POWER BLOCK

**830TL B300 / 1000TL B360 / 1070TL B385 /  
1110TL B400 / 1140TL B410 / 1165TL B420**

### Maximum power density

These PV central inverters feature more power per cubic foot. Thanks to the use of high-quality components, this inverter series performs at the highest possible level.

### Latest generation electronics

The B Series inverters integrate an innovative control unit that runs faster and performs a more efficient and sophisticated inverter control, as it uses a last-generation digital signal processor. Furthermore, the hardware of the control unit allows some more accurate measurements and very reliable protections.

These inverters feature a low voltage ride-through capability and also a lower power consumption thanks to a more efficient power supply electronic board.

### Integrated DC and AC connections

The input and output connections are integrated into the same cabinet, facilitating connection, maintenance and repair work.

### Maximum protection

These three phase inverters are equipped with a motorized DC switch to decouple the PV generator from the inverter. Optionally, these inverters can be supplied with an AC circuit breaker with door control, in addition to fuses, grounding kit and input current monitoring.

### Maximum efficiency values

Through the use of innovative electro-nic conversion topologies, efficiency values of up to 98.9% can be achieved. Thanks to a sophisticated control algorithm, this equipment can guarantee maximum efficiency depending on the PV power available.

### A complete range of equipment for all types of projects

Versions available:

- Indoor inverters with integrated DCAC cabinet.
- Outdoor inverters with integrated DCAC cabinet.
- Symmetrical indoor inverters, with the connection cabinet on the opposite side, to make it possible to install two inverters facing each other, with a common power supply point.

### Enhanced functionality

This new INGECON® SUN PowerMax range features a revamped, improved enclosure which, together with its innovative air cooling system, makes it possible to increase the ambient operating temperature to deliver its rated power up to 50 °C.



830TL B300 / 1000TL B360 / 1070TL B385 / 1110TL B400 / 1140TL B410 / 1165TL B420

### Long-lasting design

The inverters have been designed to guarantee a long life expectancy, as demonstrated by the stress tests they are subjected to. Standard 5 year warranty, extendable for up to 25 years.

### Grid support

The INGECON® SUN PowerMax B Series has been designed to comply with the grid connection requirements in different countries, contributing to the quality and stability of the electric system. These inverters therefore feature a low voltage ride-through capability, and can deliver reactive power and control the active power delivered to the grid.

### Ease of maintenance

All the elements can be removed or replaced directly from the inverter's front side, thanks to its new design.

### Easy to operate

The INGECON® SUN PowerMax inverters feature an LCD screen for the simple and convenient monitoring of the inverter status and a range of internal variables.

The display also includes a number of LEDs to show the inverter operating status with warning lights to indicate any incidents. All this helps to simplify and facilitate maintenance tasks.

### Monitoring and communication

Ethernet communications supplied as standard. The following applications are included at no extra cost: INGECON® SUN Manager, INGECON® SUN Monitor and its Smartphone version Web Monitor, available on the App Store. These applications are used for monitoring and recording the inverter's internal operating variables through the Internet (alarms, real time production, etc.), in addition to the historical production data.

Two communication ports available (one for monitoring and one for plant controlling), allowing fast and simultaneous plant control.

#### PROTECTIONS

- DC Reverse polarity.
- Short-circuits and overloads at the output.
- Anti-islanding with automatic disconnection.
- Insulation failure DC.
- Up to 15 pairs of fuse-holders.
- Lightning induced DC and AC surge arrestors, type 2 (type 1 also available).
- Motorized DC switch to automatically disconnect the inverter from the PV array.
- Low-voltage ride-through capability.
- Hardware protection via firmware.
- IP66 protection class for the electronics.

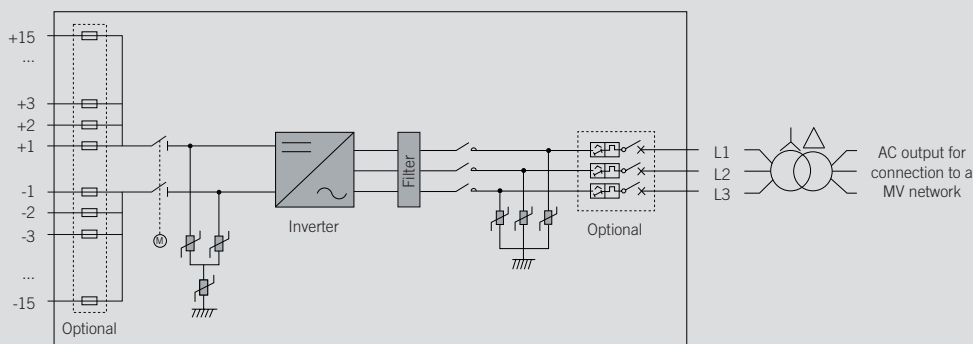
#### OPTIONAL ACCESSORIES

- AC circuit breaker with remote tripping.
- Motorization kit for the AC circuit breaker.
- Insulation failure AC.
- Grounding kit.
- Heating kit, for operating at an ambient temperature of down to -30 °C.
- DC fuses.
- Monitoring of the DC currents.
- Wattmeter on the AC side.
- PID prevention kit (PID: Potential Induced Degradation).
- Nighttime reactive power injection.

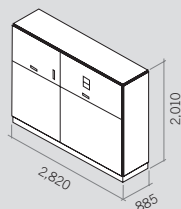
#### ADVANTAGES OF THE MONOBLOCK VERSION

- Higher power density.
- Latest generation electronics.
- More efficient electronic protection.
- Night time supply to communicate with the inverter at night.
- Enhanced performance.
- Easier maintenance thanks to its new design and enclosure.
- Lightweight spares.
- It allows to ground the PV array.
- Components easily replaceable.
- IP66 protection class for the electronics.

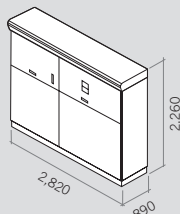
### PowerMax B Series



### Size and weight (mm)



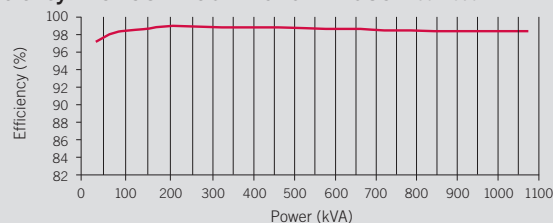
**Indoor inverter**  
1,500 kg.



**Outdoor inverter**  
1,560 kg.

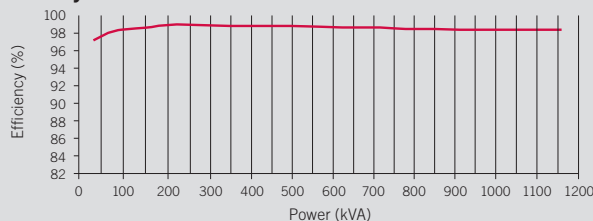
	830TL B300	1000TL B360	1070TL B385
Input (DC)			
Recommended PV array power range <sup>(1)</sup>	845 - 1,081 kWp	1,013 - 1,297 kWp	1,084.3 - 1,387 kWp
Voltage Range MPP <sup>(2)</sup>	440 - 820 V	524 - 820 V	560 - 820 V
Maximum voltage <sup>(3)</sup>	1,050 V		
Maximum current	2,000 A		
N° inputs with fuse holders	5 up to 15		
Fuse dimensions	63 A / 1,000 V to 630 A / 1,000 V fuses (optional)		
Type of connection	Connection to copper bars		
Number of power blocks	1		
MPPT	1		
Max. current at each input	From 40 A to 410 A for positive and negative poles		
Inputs protection			
Overvoltage protections	Type 2 surge arresters (type 1 optional)		
DC switch	Motorized DC load break disconnect		
Other protections	Up to 15 pairs of DC fuses (optional) / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton		
Output (AC)			
Power @35 °C / @50 °C <sup>(4)</sup>	831.4 kVA / 765 kVA	997.7 kVA / 918 kVA	1,066.9 kVA / 981.8 kVA
Current @35 °C / @50 °C	1,600 A / 1,472 A		
Rated voltage	300 V IT System	360 V IT System	385 V IT System
Frequency	50 / 60 Hz		
Power Factor <sup>(5)</sup>	1		
Power Factor adjustable	Yes. Smax=831.4 kVA	Yes. Smax=997.7 kVA	Yes. Smax=1,066.9 kVA
THD (Total Harmonic Distortion) <sup>(6)</sup>	<3%		
Output protections			
Overvoltage protections	Type 2 surge arresters (type 1 optional)		
AC breaker	Optional AC circuit breaker with door control, remote trip or motorized		
Anti-islanding protection	Yes, with automatic disconnection		
Other protections	AC short circuits and overloads		
Features			
Maximum efficiency	98.7%	98.9%	
Euroefficiency	98.3%	98.5%	
Max. consumption aux. services	2,500 VA		
Stand-by or night consumption <sup>(7)</sup>	60 W		
Average energy consumption per day	18 kWh		
General Information			
Operating temperature	-20 °C to +55 °C		
Relative humidity (non-condensing)	0 - 100%		
Protection class	IP50 (Indoor) / IP56 (Outdoor)		
Maximum altitude <sup>(8)</sup>	3,000 m		
Cooling system	Air forced with temperature control (230 V phase + neutral power supply)		
Air flow	6,200 m³/h		
Acoustic emission	<77 dB (A) at 1 m		
Marking	CE		
EMC and security standards	EN 61000-6-1, EN 61000-6-2, EN 61000-6-4, EN 61000-3-11, EN 61000-3-12, EN 62109-1, EN 62109-2, IEC62103, EN 50178, FCC Part 15, AS3100		
Grid connection standards	IEC 62116, Arrêté 23-04-2008, CEI 0-16 Ed. III, Terna A68, G59/2, BDEW-Mittelspannungsrichtlinie:2011, P.O.12.3, South African Grid code (ver 2.6), Chilean Grid Code, Ecuadorian Grid Code, Peruvian Grid code, Thailand PEA requirements, IEC61727, UNE 206007-1, ABNT NBR 16149, ABNT NBR 16150, IEEE 1547, IEEE1547.1, GGC&CGC China, DEWA (Dubai) Grid code, Jordan Grid Code		

**Notes:** <sup>(1)</sup> Depending on the type of installation and geographical location. Data for STC conditions <sup>(2)</sup> V<sub>mpp,min</sub> is for rated conditions (V<sub>ac</sub>=1 p.u. and Power Factor=1) <sup>(3)</sup> Consider the voltage increase of the 'Voc' at low temperatures <sup>(4)</sup> For each °C of increase between 35 °C and 50 °C, the output power will be reduced at the rate of 0.53%. Over 50 °C, the output power will be reduced at the rate of 1.8% / °C <sup>(5)</sup> For P<sub>out</sub>>25% of the rated power <sup>(6)</sup> For P<sub>out</sub>>25% of the rated power and voltage in accordance with IEC 61000-3-4 <sup>(7)</sup> Consumption from PV field when there is PV power available <sup>(8)</sup> Over 1,000 m temperature for rated power is reduced at the rate of 4.5 °C for each 1,000 m. For installations beyond the maximum altitude, please contact Ingeteam's solar sales department.

**Efficiency INGECON® SUN 1070TL B385 V<sub>dc</sub> = 650 V**


	1110TL B400	1140TL B410	1165TL B420
<b>Input (DC)</b>			
Recommended PV array power range <sup>(1)</sup>	1,124.2 - 1,441.1 kWp	1,151 - 1,476.8 kWp	1,179.3 - 1,513.2 kWp
Voltage Range MPP <sup>(2)</sup>	580 - 820 V	595 - 820 V	610 - 820 V
Maximum voltage <sup>(3)</sup>	1,050 V		
Maximum current	2,000 A		
N° inputs with fuse holders	5 up to 15		
Fuse dimensions	63 A / 1,000 V to 630 A / 1,000 V fuses (optional)		
Type of connection	Connection to copper bars		
Number of power blocks	1		
MPPT	1		
Max. current at each input	From 40 A to 410 A for positive and negative poles		
<b>Inputs protection</b>			
Overvoltage protections	Type 2 surge arresters (type 1 optional)		
DC switch	Motorized DC load break disconnect		
Other protections	Up to 15 pairs of DC fuses (optional) / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton		
<b>Output (AC)</b>			
Power @35 °C / @50 °C <sup>(4)</sup>	1,108.5 kVA / 1,020 kVA	1,136.2 kVA / 1,045.5 kVA	1,163.9 kVA / 1,071 kVA
Current @35 °C / @50 °C	1,600 A / 1,472 A		
Rated voltage	400 V IT System	410 V IT System	420 V IT System
Frequency	50 / 60 Hz		
Power Factor <sup>(5)</sup>	1		
Power Factor adjustable	Yes. Smax=1,108.5 kVA	Yes. Smax=1,136.2 kVA	Yes. Smax=1,163.9 kVA
THD (Total Harmonic Distortion) <sup>(6)</sup>	<3%		
<b>Output protections</b>			
Overvoltage protections	Type 2 surge arresters (type 1 optional)		
AC breaker	Optional AC circuit breaker with door control, remote trip or motorized		
Anti-islanding protection	Yes, with automatic disconnection		
Other protections	AC short circuits and overloads		
<b>Features</b>			
Maximum efficiency	98.9%		
Euroefficiency	98.6%	98.5%	
Max. consumption aux. services	2,500 VA		
Stand-by or night consumption <sup>(7)</sup>	60 W		
Average energy consumption per day	18 kWh		
<b>General Information</b>			
Operating temperature	-20 °C to +55 °C		
Relative humidity (non-condensing)	0 - 100%		
Protection class	IP50 (Indoor) / IP56 (Outdoor)		
Maximum altitude <sup>(8)</sup>	3,000 m		
Cooling system	Air forced with temperature control (230 V phase + neutral power supply)		
Air flow	6,200 m³/h		
Acoustic emission	<77 dB (A) at 1 m		
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EMC and security standards	EN 61000-6-1, EN 61000-6-2, EN 61000-6-4, EN 61000-3-11, EN 61000-3-12, EN 62109-1, EN 62109-2, IEC62103, EN 50178, FCC Part 15, AS3100		
Grid connection standards	IEC 62116, Arrêté 23-04-2008, CEI 0-16 Ed. III, Terna A68, G59/2, BDEW-Mittelspannungsrichtlinie:2011, P.O.12.3, South African Grid code (ver 2.6), Chilean Grid Code, Ecuadorian Grid Code, Peruvian Grid code, Thailand PEA requirements, IEC61727, UNE 206007-1, ABNT NBR 16149, ABNT NBR 16150, IEEE 1547, IEEE1547.1, GGC&CGC China, DEWA (Dubai) Grid code, Jordan Grid Code		

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**Efficiency INGECON® SUN 1165TL B420** V<sub>dc</sub> = 650 V




# SUN POWER SYSTEM for solar power plants

Remote diagnostic monitoring and efficiency analysis  
In real-time via internet

- **SOLAR RESOURCE ASSESSMENT**  
Continuous solar radiation measurements
- **YIELD ANALYSIS**  
Off-line or on-line
- **REAL-TIME MONITORING**  
Web Posting
- **REMOTE ALARM**  
Automatic SMS and email alert message

Brochure n° 9742.0004



SOLAR AND  
METEO SENSORS



REMOTE TERMINAL UNIT  
DATA LOGGER & TRANSMITTER



WEB-POSTING  
Real-time graphic presentation  
and data download via internet



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ENVIRONMENTAL MONITORING INSTRUMENTATION

# SUN POWER SYSTEM

## for solar power plants

Remote diagnostic monitoring and efficiency analysis  
In real-time via internet

### SOLAR POWER PLANT (THERMAL OR PHOTOVOLTAIC)

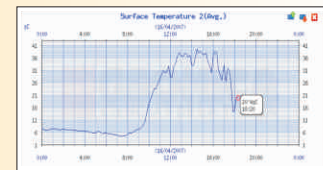


PLANT SENSORS  
and  
WEBCAMS

INPUT SIGNALS

DATA, ALARM AND STILL IMAGES  
TRANSMISSION VIA INTERNET  
(GPRS/CDMA) – WEB POSTING  
SMS and email Alarm messages

WEBPOSTING BY THE  
WEBTRANS Platform



#### SOLAR RADIATION

- Global
- Direct
- Diffuse
- Daily/Monthly Insolation

#### ARRAY PARAMETERS

- DC Voltages and Currents
- Battery Voltage
- DC Power
- Modules Temperature
- Thermal fluid temperature and flow

#### GRID PARAMETERS

- AC Voltage and injected currents
- AC Power

#### METEOROLOGY

- Turbulent Wind Effects
- Wind Speed and Direction
- Precipitation (rain, snow, hail)
- Temperature and Relative Humidity

#### STILL IMAGES

- Optional color Webcams for still images transmission

ANY OTHER Plant Parameter

GPRS



REMOTE TERMINAL UNIT 2000/3000  
DATA LOGGER TRANSMITTER



OTHER LOCAL  
CONNECTIONS  
ETHERNET, etc...

#### SYSTEM PROVIDES:

- Quick look and off-line Analysis
- Identification of failed components or abnormal operation conditions
- Minimization of trouble-shooting efforts and maintenance work
- Prevention of key components damage
- Improvement of overall plant performance



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# SUN POWER SYSTEM for solar power plants

Remote diagnostic monitoring and efficiency analysis  
In real-time via internet

## SYSTEM DESCRIPTION

GEONICA introduces the Sun Power System, a turnkey integral solution specifically designed for the remote monitoring and efficient analysis of solar power plants, thermal or photovoltaic, in real-time, via Internet.

Solar resource assessment is the first objective to be covered, in order to determine, during a certain time, the site conditions regarding the available solar energy. So the Power System has been designed for allowing the measurement of all solar radiation parameters, such as global, direct and diffuse radiation, by means of highly sensitive pyranometers and pyrhemometers supported by very precise solar trackers.

Once the solar plant is in operation, other three fundamental issues have to be considered:

- Real-time monitoring of all the main or critical plant parameters. This will provide the possibility of a quick identification of failed components or abnormal operation conditions of the plant.
- An efficient remote alarm management procedure by means of the urgent transmission of SMS alert messages to cellular phones and emails to central computers, in order to minimize the troubleshooting efforts and to prevent damages in key plant components.
- Off-line analysis of the plant efficiency, in order to know the overall performance of the thermal or photovoltaic installation.

These three issues will allow to enlarge the operative life of the plant and, at the same time, to assure the maximum investment profitability.

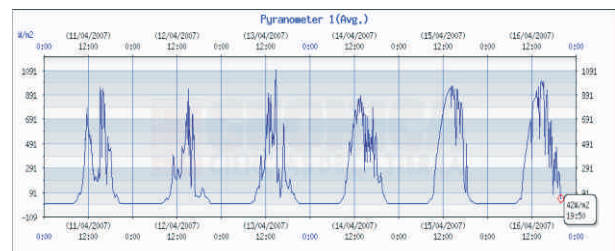
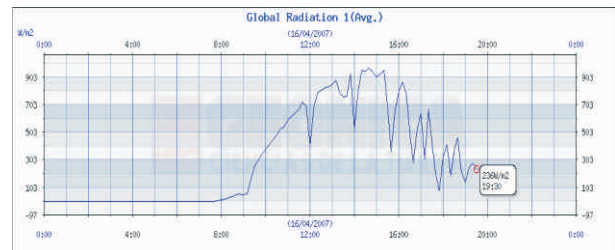
## WEB POSTING

A very valuable option offered by GEONICA with the Sun Power System, is the possibility of web posting, in such a way to provide worldwide access via INTERNET, to the historical and instant values of all the parameters measured at the solar plant.

This optional service is offered by WEBTRANS Platform, which is supported by a powerful Server located at GEONICA's facilities.

All the parameters measured at the solar plant, are displayed in the WEBTRANS pages as clear graphical presentation.

## WEBPOSTING BY THE WEBTRANS Platform



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# SUN POWER SYSTEM for solar power plants

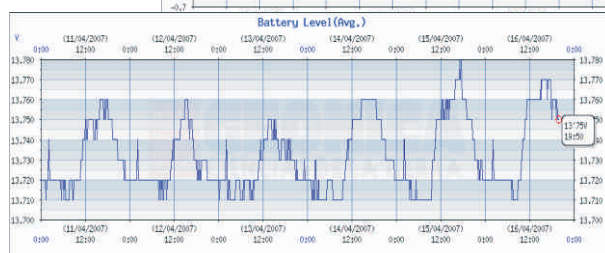
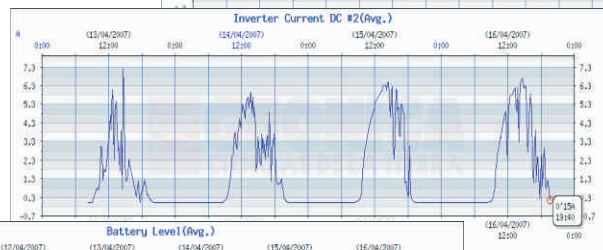
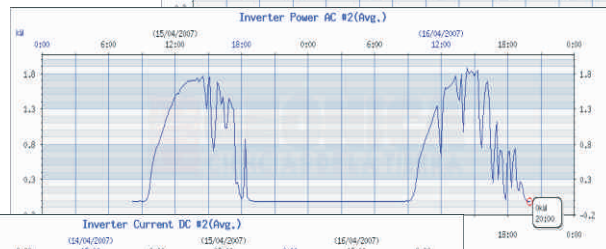
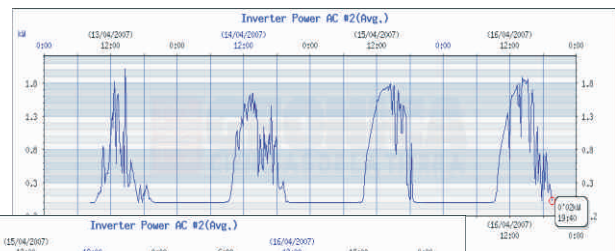
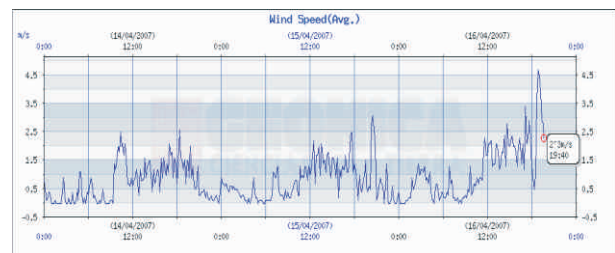
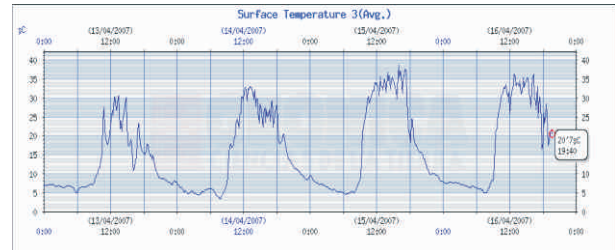
Remote diagnostic monitoring and efficiency analysis  
In real-time via internet

## WEBPOSTING BY THE WEBTRANS Platform

At the same time, the historical data can be also downloaded to your own computer. In all cases, only a user's name and password are required for accessibility, assuring a total confidentiality to your own information.

The remote Acquisition and Transmission Unit Model 2000C/3000C Series (the heart of the Sun Power System) includes a GPRS cellular modem that allows the trasmission of data, and also still images when connecting optional color webcams to the remote unit. Data and image transmission to the WEBTRANS Platform, is carried out in near-real-time, or at programmable intervals of 5, 10, 20 or 30 minutes.

An advanced and useful graphical presenttaion of historical data is showed in the standard layout of the WEBTRANS Platform, but the portal can be also designed according to customer's preferences.



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## Grid-Connected System: Simulation parameters

**Project :** **PEF2827 Armenia Masrik TMY Client**

**Geographical Site** **Masrik** Country **Armenia**

**Situation** Latitude 40.2°N Longitude 45.8°E

Time defined as Legal Time Time zone UT Altitude 1942 m

Albedo 0.20

**Meteo data:** **Masrik** Project client - TMY

**Simulation variant :** **Masrik 1 Feasibility initial TMY shd**

Simulation date 21/09/16 09h07

### Simulation parameters

**Collector Plane Orientation** Tilt 28° Azimuth 0°

**Models used** Transposition Perez Diffuse Imported

**Horizon** Average Height 3.3°

**Near Shadings** Linear shadings

### PV Array Characteristics

**PV module** Si-poly Model **JKM 320PP-72**

Custom parameters definition

Manufacturer Jinkosolar

Number of PV modules In series 19 modules In parallel 9120 strings

Total number of PV modules Nb. modules 173280 Unit Nom. Power 320 Wp

Array global power Nominal (STC) **55450 kWp** at operating cond. 49787 kWp (50°C)

Array operating characteristics (50°C) U mpp 636 V I mpp 78281 A

Total area Module area **336224 m²** Cell area 303670 m²

**Inverter** Model **INGECON SUN 1165TL B420 Outdoor**

Custom parameters definition

Manufacturer Ingeteam

Characteristics Operating Voltage 610-820 V Unit Nom. Power 1164 kWac

Max. power (=>25°C) 1164 kWac

Inverter pack Nb. of inverters 40 units Total Power 46560 kWac

### PV Array loss factors

Array Soiling Losses Loss Fraction 2.0 %

Thermal Loss factor U<sub>c</sub> (const) 29.0 W/m²K U<sub>v</sub> (wind) 0.0 W/m²K / m/s

Wiring Ohmic Loss Global array res. 0.14 mOhm Loss Fraction 1.5 % at STC

LID - Light Induced Degradation Loss Fraction 1.0 %

Module Quality Loss Loss Fraction -0.8 %

Module Mismatch Losses Loss Fraction 1.0 % at MPP

Incidence effect, ASHRAE parametrization IAM = 1 - b<sub>0</sub> (1/cos i - 1) b<sub>0</sub> Param. 0.04

### System loss factors

AC wire loss inverter to transfo Inverter voltage 420 Vac tri

Wires: 3x30000.0 mm² 69 m Loss Fraction 1.3 % at STC

External transformer Iron loss (24H connexion) 109196 W Loss Fraction 0.2 % at STC

Resistive/Inductive losses 0.0 mOhm Loss Fraction 1.5 % at STC

## Grid-Connected System: Simulation parameters (continued)

**User's needs :** Unlimited load (grid)

**Auxiliaries loss**

Constant (fans)	70000 W from Poper thresh.	0.0 kW
Proportionnal to Poper	2.0 W/kW from Poper thresh.	0.0 kW

## Grid-Connected System: Horizon definition

**Project :** PEF2827 Armenia Masrik TMY Client

**Simulation variant :** Masrik 1 Feasibility initial TMY shd

### Main system parameters

#### Horizon

System type **Grid-Connected**

Average Height 3.3°

#### Near Shadings

Linear shadings

PV Field Orientation

tilt 28°

azimuth 0°

PV modules

Model JKM 320PP-72

Pnom 320 Wp

PV Array

Nb. of modules 173280

Pnom total **55450 kWp**

Inverter

INGECON SUN 1165TL B420 Optimum

Pnom 1164 kW ac

Inverter pack

Nb. of units 40.0

Pnom total **46560 kW ac**

User's needs

Unlimited load (grid)

### Horizon

Average Height 3.3°

Diffuse Factor 0.98

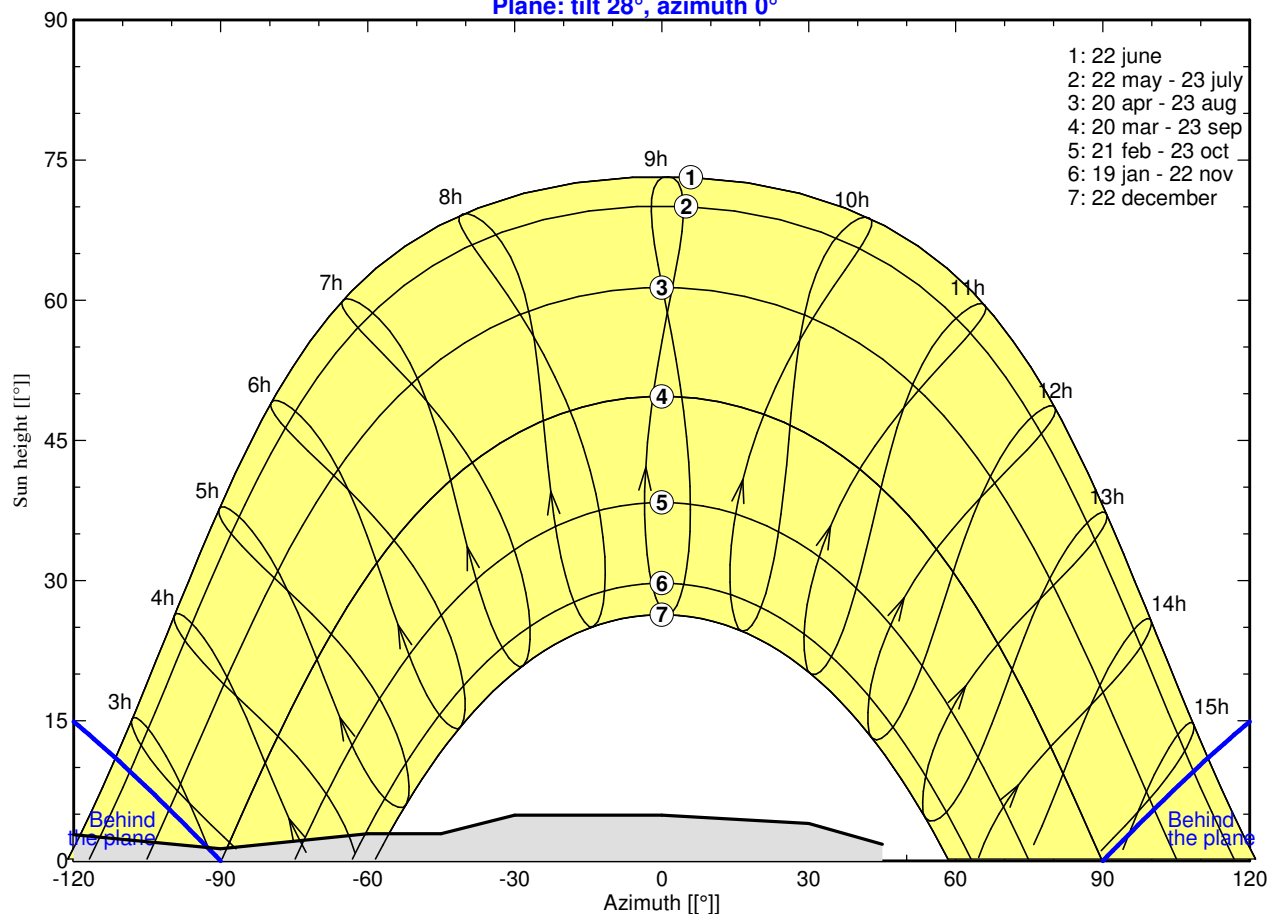
Albedo Factor 100 %

Albedo Fraction 0.81

Height [°]	2.8	1.3	2.9	2.9	4.9	4.9	4.0	1.8
Azimuth [°]	-120	-90	-60	-45	-30	0	30	45

### Horizon lineLegal Time

Plane: tilt 28°, azimuth 0°





## Grid-Connected System: Near shading definition

**Project :** PEF2827 Armenia Masrik TMY Client

**Simulation variant :** Masrik 1 Feasibility initial TMY shd

### Main system parameters

#### Horizon

System type **Grid-Connected**

Average Height 3.3°

### Near Shadings

PV Field Orientation

PV modules

PV Array

Inverter

Inverter pack

User's needs

Linear shadings

tilt 28°

azimuth 0°

Model JKM 320PP-72

Pnom 320 Wp

Nb. of modules 173280

Pnom total **55450 kWp**

INGECON SUN 1165TL B420 OP1000

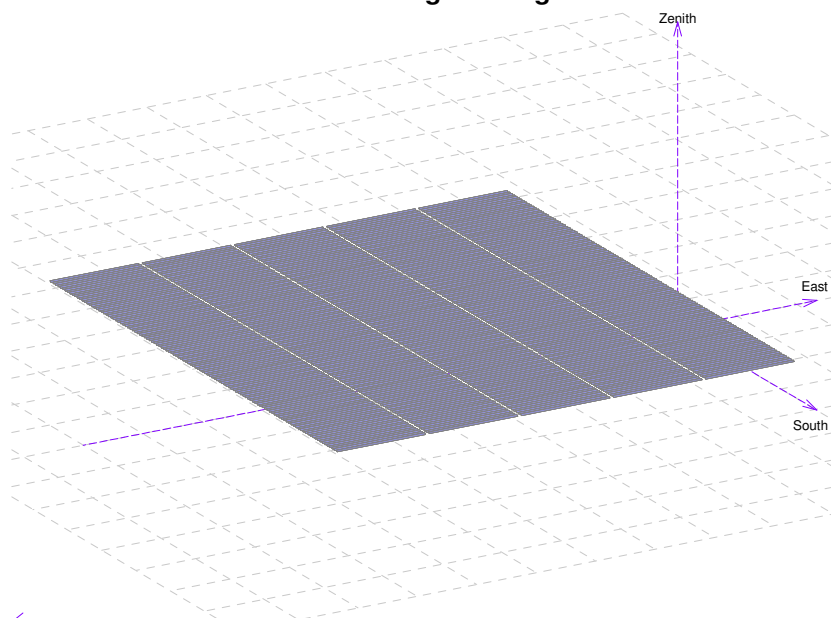
Pnom total 1164 kW ac

Nb. of units 40.0

Pnom total **46560 kW ac**

Unlimited load (grid)

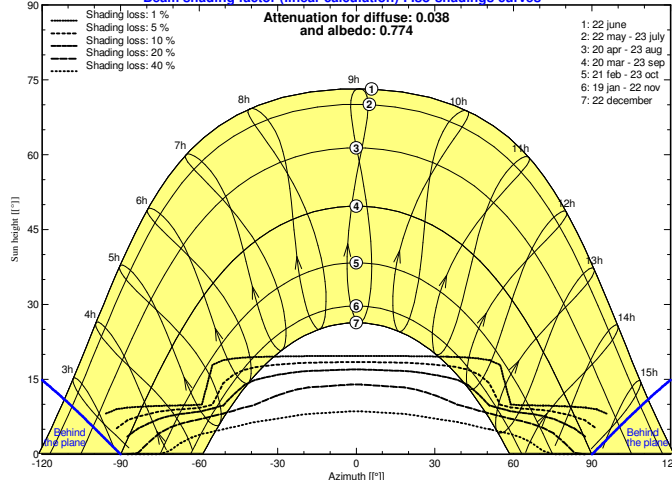
### Perspective of the PV-field and surrounding shading scene



### Iso-shadings diagram

PEF2827 Armenia Masrik Legal Time

Beam shading factor (linear calculation) : Iso-shadings curves



## Grid-Connected System: Main results

**Project :** PEF2827 Armenia Masrik TMY Client

**Simulation variant :** Masrik 1 Feasibility initial TMY shd

**Main system parameters** System type **Grid-Connected**

**Horizon** Average Height 3.3°

**Near Shadings**

Linear shadings

PV Field Orientation tilt 28° azimuth 0°

PV modules Model JKM 320PP-72 Pnom 320 Wp

PV Array Nb. of modules 173280 Pnom total **55450 kWp**

Inverter INGECON SUN 1165TL B420 Output 1164 kW ac

Inverter pack Nb. of units 40.0 Pnom total **46560 kW ac**

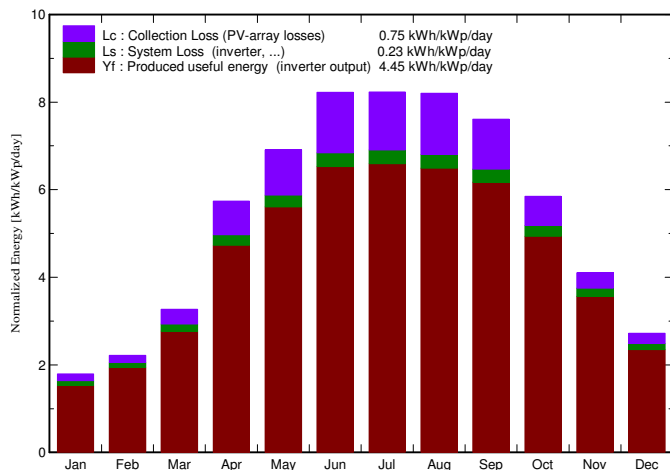
User's needs Unlimited load (grid)

### Main simulation results

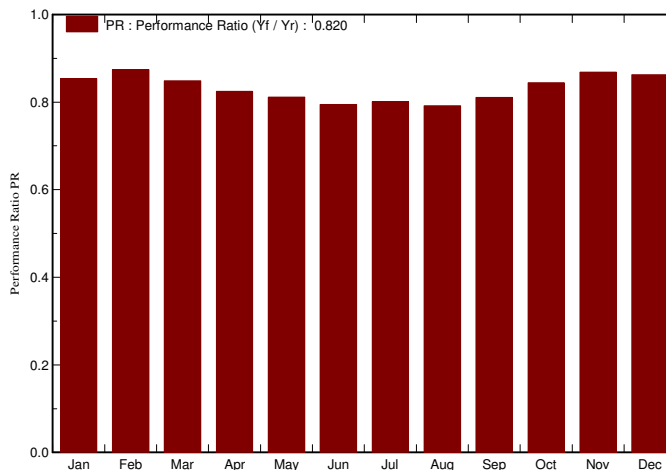
System Production **Produced Energy 90009 MWh/year** Specific prod. 1623 kWh/kWp/year

Performance Ratio PR 82.0 %

**Normalized productions (per installed kWp): Nominal power 55450 kWp**



**Performance Ratio PR**



**Masrik 1 Feasibility initial TMY shd**  
**Balances and main results**

	GlobHor	T Amb	GlobInc	GlobEff	EArray	E_Grid	EffArrR	EffSysR
	kWh/m²	°C	kWh/m²	kWh/m²	MWh	MWh	%	%
January	40.5	-7.04	55.7	49.8	2822	2634	15.08	14.08
February	52.0	-6.55	62.0	56.1	3196	3008	15.32	14.42
March	91.9	-2.64	101.3	92.5	5041	4769	14.79	14.00
April	161.1	2.06	172.2	159.0	8267	7873	14.28	13.60
May	216.3	6.46	214.2	199.0	10107	9640	14.03	13.39
June	256.5	10.50	246.7	230.0	11383	10865	13.73	13.10
July	260.0	11.81	255.3	238.7	11881	11339	13.84	13.21
August	238.5	11.85	254.2	237.9	11704	11162	13.69	13.06
September	189.7	9.29	228.4	214.7	10763	10266	14.02	13.37
October	132.9	3.86	181.2	170.1	8906	8485	14.62	13.93
November	79.2	-1.10	123.2	114.2	6242	5929	15.07	14.32
December	51.6	-5.98	84.4	76.3	4282	4039	15.08	14.23
Year	1770.1	2.76	1978.8	1838.3	94592	90009	14.22	13.53

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
- EffArrR: Effic. Eout array / rough area
- EffSysR: Effic. Eout system / rough area

## Grid-Connected System: Loss diagram

**Project :** PEF2827 Armenia Masrik TMY Client

**Simulation variant :** Masrik 1 Feasibility initial TMY shd

### Main system parameters

#### Horizon

System type **Grid-Connected**

Average Height 3.3°

#### Near Shadings

Linear shadings

PV Field Orientation

tilt 28°

azimuth 0°

PV modules

Model JKM 320PP-72

Pnom 320 Wp

PV Array

Nb. of modules 173280

Pnom total **55450 kWp**

Inverter

INGECON SUN 1165TL B420 Output 1164 kW ac

Inverter pack

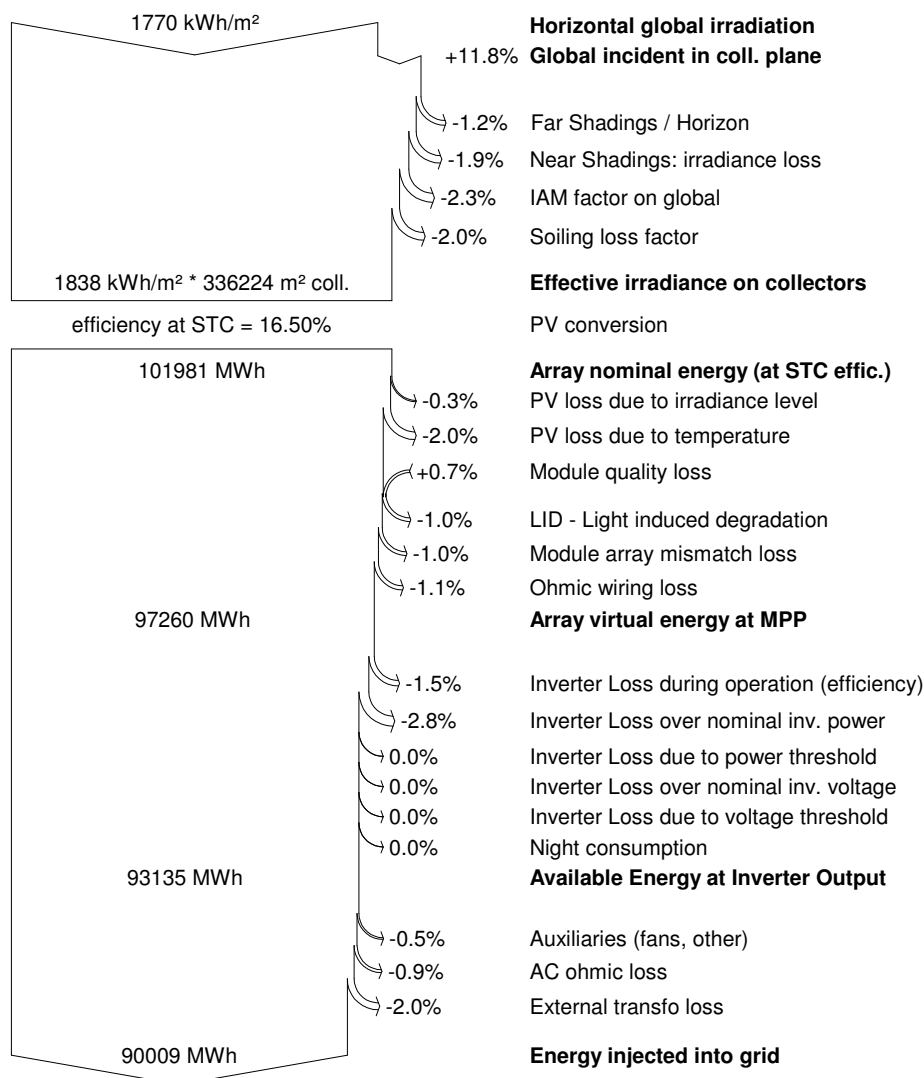
Nb. of units 40.0

Pnom total **46560 kW ac**

User's needs

Unlimited load (grid)

## Loss diagram over the whole year



## PEF2827-050-Masrik 1-BOM

Bill of Quantities.17/10/2016

### BOQ

SL.NO	UOM	DESCRIPTION	QTY
1		ELECTRICAL MAIN EQUIPMENT	
1.1		PV MODULES	
1.1.1		JKM320P-72(4BB)	
	Nos	PV Modules Model: JINKO SOLAR JKM320P-72(4BB). Rated Power: 320kWp. Polycrystalline. 72 cells.	173,280.00
1.2		INVERTERS	
1.2.1		INGECON SUN 1165TL B420 Outdoor	
	Nos	PV Inverter. Model: INGECON SUN 1165TL B420 Outdoor. Rated Power: 1634kVA. 3-phase. Frequency: 50Hz. DC/AC voltage: 1000/420 V. cos fi:± 1 adjustable	40.00
1.3		TRANSFORMERS	
1.3.1		2330kVA Transformer	
	Nos	Oil-inmersed distribution Transformer 2330 kVA, ONAN, 35/0.42/0.42kV, Dynyn11, Double Secondary winding.	20.00
1.3.2		10kVA Transformer	
	Nos	Oil-inmersed distribution Transformer 10 kVA, ONAN, 420/400V, Dyn11. ITCs Auxiliary Services.	20.00
1.3.3		50kVA Transformer	
	Nos	Oil-inmersed distribution Transformer 50 kVA, ONAN, 35/0.4kV, Dyn11. Control Center and Warehouse Auxiliary Services.	1.00
1.4		MV SWITCHGEAR	
1.4.1		MV Line connection Switchgear. 40.5kV, 400A	
	Nos	MV Line connection Switchgear . 40.5kV, 630A. Frequency 50Hz, Gas insulated SF6.Circuit breaker. Earth-Switch disconnecter.	36.00
1.4.2		MV Transformer Protection Switchgear . 40.5kV, 630A	
	Nos	MV Transformer Protection Switchgear . 40.5kV, 630A. Frequency 50Hz, Gas insulated SF6.Circuit breaker or fuse. Earth-Switch disconnecter.	20.00

SL.NO	UOM	DESCRIPTION	QTY
<b>1.4.3 MV Line connection Switchgear. 40.5kV, 1250A</b>			
	Nos	MV Line connection Switchgear . 40.5kV, 1250A. Frequency 50Hz, Gas insulated SF6.Circuit breaker. Earth-Switch disconnector.	6.00
<b>1.4.4 MV Transformer Protection Switchgear . 40.5kV, 1250A</b>			
	Nos	MV Transformer Protection Switchgear . 40.5kV, 1250A Frequency 50Hz, Gas insulated SF6.Circuit breaker or fuse. Earth-Switch disconnector.	1.00
<b>1.4.5 MV Measurement Switchgear . 40.5kV, 1250A</b>			
	Nos	MV Measurement Switchgear . 40.5kV, 1250A. Frequency 50Hz, Gas insulated SF6.Voltage and current transformers.	1.00
<b>1.5 COMBINER BOXES</b>			
<b>1.5.1 LV metal-enclosed switchboar DC strings combiner.</b>			
	Nos	Low voltage metal-enclosed switchboar DC strings combiner. 0.6/1kV. Max. 30 inputs.Fuse & switch disconnector included.	320.00
<b>1.6 CABLES</b>			
<b>1.6.1 M.V. Cable</b>			
1.6.1.1	m	MV cable 26/45 kV 1 x 240 mm <sup>2</sup> Al. Single core conductor. Isolation: XLPE. Conductor: Aluminium. Oversheath: PVC. Metallic screen.	16,700.00
<b>1.6.2 L.V. DC Cable</b>			
1.6.2.1	m	LV DC cable XLPO 0.6/1 kV 1 x 6 mm <sup>2</sup> Cu. Single core conductor. Conductor: Electrolytic copper. Insulation: XLPE. Sheath: EVA 120°C (Ethylene-Vinylacetat-Copolyme)	834,624.00
1.6.2.2	m	LV DC cable XLPE 0.6/1 kV 1 x 240 mm <sup>2</sup> Al. Single core conductor. Isolation: XLPE. Conductor: Aluminium. Sheath: Special mix of low smoke emissions.	154,043.00
<b>1.6.3 L.V. AC Cable</b>			
1.6.3.1	m	LV AC cable XLPE 1.8/3 kV 1 x 240 mm <sup>2</sup> Cu. Single core conductor. Isolation: XLPE. Conductor: Electrolytic copper. Sheath: Special mix of low smoke emissions.	3,528.00
<b>1.7 GROUNDING</b>			
<b>1.7.1 Cu conductor</b>			
	m	Bare copper conductor Cu 35mm <sup>2</sup> . Supply and installation.	18,474.00
	Nos	Electrical copper steel rod Cu . L=2 m, diameter 16 mm <sup>2</sup> . Supply and installation.	129.00
	Nos	Exothermic welding .Cadwel type for bare copper conductor and electrical rods. (Connection type wire-wire and wire-rod) Supply and execution.	569.00



SL.NO	UOM	DESCRIPTION	QTY
<b>1.8</b>		<b>EVACUATION POWER LINE</b>	
<b>1.8.1</b>		<b>OHL 110kV</b>	
	m	Overhead 110kV double circuit line. Supply and installation of supports, cable, isolators and all necessary equipment including foundations and civil works.	<b>5,000.00</b>
<b>1.9</b>		<b>SUBSTATION</b>	
<b>1.9.1</b>		<b>AIS Substation</b>	
	Nos	Outdoor Air Insulated Substation, including two (2) main oil insulated step-up transformers ONAN/ONAF 50/63 MVA, 110/35 kV. The substation will have a double busbar configuration and five (5) bays: - Bay 1: Interconnection Line 1 (Kaputak) - Bay 2: Interconnection Line 2 (Akunk) - Bay 3: Power transformer 1 (50/63MVA 110+10x1%/35kV) - Bay 4: Power transformer 2 (50/63MVA 110+10x1%/35kV) - Bay 5: Coupling busbars  Supply and installation of supports, cables, isolators, PT, CT, circuit breakers, switches, grounding and protection lightning, protection relays and communications, auxiliary services and all necessary equipment including foundations and civil works.	<b>1.00</b>
<b>2</b>		<b>CIVIL WORKS</b>	
<b>2.1</b>		<b>Earthmovements</b>	
2.1.1	m <sup>2</sup>	Clearing and grubbing of the site area.	<b>974,009.00</b>
2.1.2	m	Low Voltage Underground Networks.Electrical trenching. Excavation, laying and filling. Type dimension 1.2 depth * 0.6 m wide. Corrugated duct and warning tape included.	<b>13,132.00</b>
2.1.3	m	Medium Voltage Underground Networks.Electrical trenching. Excavation, laying and filling. Type dimension 1.2 depth * 0.6 m wide. Corrugated duct and warning tape included.	<b>3,643.00</b>
2.1.4	m	Manholes. Type dimension 1.2 depth * 1 m wide * 1 m large. Reinforced concrete with cast iron cover. Supply and installation.	<b>440.00</b>
<b>2.2</b>		<b>Urbanization</b>	
2.2.1	m	Perimeter fence. It will be erected a perimeter fence 2 m height with strands of barbed wire for security, with steel posts separated adequately and steel post reinforcement each 15 m and in each direction change. A galvanized steel wire mesh of simple twist at least, will be placed between the steel posts. It will be taken into account the location of the accesses for the vehicles and pedestrians. Foundation included.	<b>4,595.00</b>

SL.NO	UOM	DESCRIPTION	QTY
<b>2.3 Access, perimeter and internal road</b>			
2.3.1	m	Access road to the plant (5 m wide).	200.00
2.3.2	m	Internal road (5 m wide).Parking area included (15 vehicles).	2,300.00
2.3.3	m	Perimeter road.(5 m wide).	4,595.00
<b>2.4 Foundations</b>			
2.4.1	m	Foundation of the photovoltaic structure. Drive steel profiles. According to photovoltaic structures provides the suporting structure of photovoltaic modules normally is hot-dip galvanized steel (according to EN ISO 1461).Supply and installation.	115,520.00
2.4.2	Nos	Connection Center. Excavation, preparing the contact area with a sand bed and fill.	1.00
2.4.3	Nos	Control Center foundation. Excavation, preparing the contact area and reinforced concrete pouring.	1.00
2.4.4	Nos	Warehouse foundation. Excavation, preparing the contact area and reinforced concrete pouring.	1.00
<b>2.5 Photovoltaic structure</b>			
2.5.1	Nos	Metallic structure. Structure of photovoltaic modules normally is hot-dip galvanized steel (according to EN ISO 1461). All the elements and bolt. There are 8 piles,4 main beams and 4 longitudinal beams.	14,440.00
<b>2.6 Building</b>			
2.6.1	Nos	Inverter transformer Center (ITC). Prefabricated galvanized steel building (container-type) with approximately dimensions 6 x 2.5 x 2.9 m (or similar) with one or two inverters, one medium power transformer, one auxiliary power transformer, and all auxiliary elements to lighting, auxiliary power supply, ventilation, security and fire protection. Supply and installation.	20.00
2.6.3	Nos	Connection center (CC). Prefabricated concrete building with approximately dimensions 12 x 2.6 x 3.6 m (or similar) with auxiliary medium voltage power transformer, medium voltage switchgears and all auxiliary elements to lighting, auxiliary power supply, ventilation, security and fire protection. Supply and installation.	1.00
2.6.4	Nos	Control building. Prefabricated galvanized steel building (container blocks-type). It will contain an occupation of 12.5m*6m (75m²). approximately, sharing inside a control room, toilet and dressing room and electrical room. Supply and installation.	1.00
2.6.5	Nos	Warehouse. Prefabricated galvanized steel building (container blocks-type). It will contain an occupation of 12.5m*6m (75m²). Supply and installation.	1.00

SL.NO	UOM	DESCRIPTION	QTY
<b>2.7</b>			
2.7.1	m	Drainage system. Triangular or rectangular channel.	5,676.00
<b>3</b>			
3.1.	Nos	Fixed thermal camera to be installed in the perimeter near the fence	29.00
3.2.	Nos	Mobile cameras, to installed in a inner layer, which perform intruders movements tracking	1.00
3.3.	Nos	4m post, to install cameras	29.00
3.4.	m	Communication cable from Control Building to cameras	4,422.00
3.5.	m	Power cable from ATCs to cameras	4,422.00
3.6.	Nos	Image analizers (6 ch.), including hardware and software	5.00
3.7.	Nos	Network Video Recorder NVR (64 ch., 5Mpx H.264, 400Mbps, 2TB HDD)	1.00
3.8.	Nos	UPS to feed security hardware	1.00
3.9.	Nos	Alarm set to be mounted outside	1.00
3.10.	Nos	HMI installed in Control building (color screens 32")	2.00
3.11.	Nos	Volumetric intrusion sensor for Control building, including 15 meter of cable	3.00
3.12.	Nos	Rack (2200x1200x800 mm, frontal door, with ventilation and internal illumination), including terminals, cabel glands, and accesories	1.00
<b>4</b>			
4.1.	m	Fiber optic, multimode for ITC communication ring	10,524.52
4.2.	m	Multicore cable, 6x2x1.5 mm2	10,137.12
4.3.	Nos	SCADA equipment: 1 SCADA server (Intel Xeon E5-2620v2 6C/12T 2.10GHz 15MB, 4 GB DDR3, 6G 500GB) rack mount, keyboard 1 Client PC 1 SCADA software including DDBB	1.00
4.4.	Nos	HMI SCADA (19" color screen)	1.00

<b>SL.NO</b>	<b>UOM</b>	<b>DESCRIPTION</b>	<b>QTY</b>
4.5.	Nos	Rack to be installed in Control Building for SCADA hardware, (19", 24U, frontal door, with ventilation and internal illumination), including terminals, cabel glands, and accesories	1.00
4.6.	Nos	Rack (800x600x300 mm, frontal door, with ventilation) installed in ITC, including switch FO-FO, datalogger, UPS, gateways	20.00
4.7.	Nos	Meteorological station (temperature, atmospheric pressure, wind, humidity, rain, and solar irradiation sensors (pyranometers). Meteorological station will be mounted on tower of 6 m. height)	4.00
4.8.	Nos	Radio datalink (in case of ADSL connection is not available)	1.00
4.9.	Nos	UPS for 3 hours of autonomous operation for Control Building devices	1.00