

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).

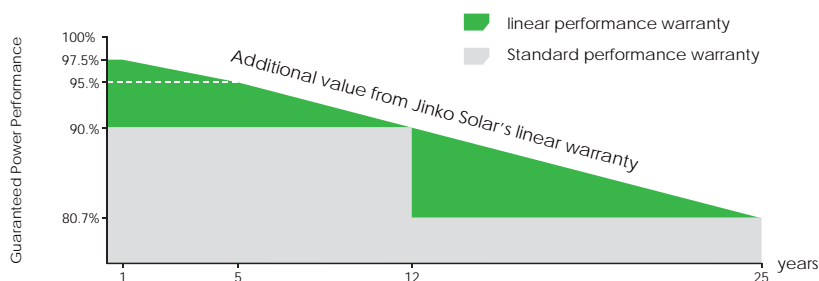


Durability against extreme environmental conditions:

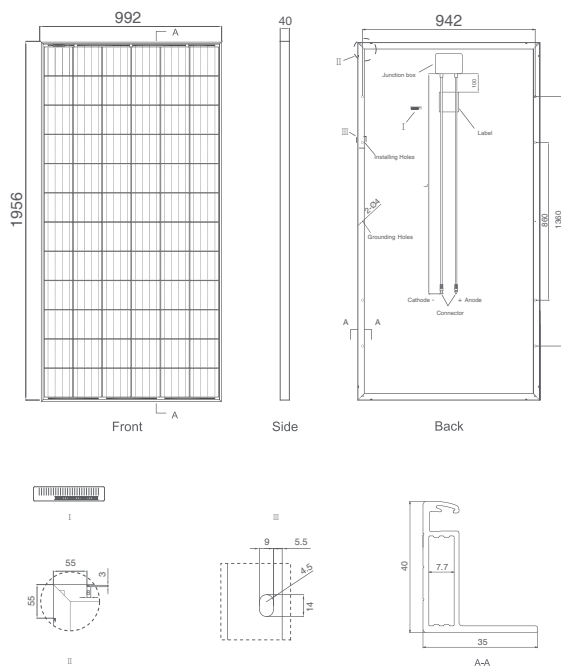
High salt mist and ammonia resistance certified by TUV NORD.

LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty • 25 Year Linear Power Warranty



Engineering Drawings

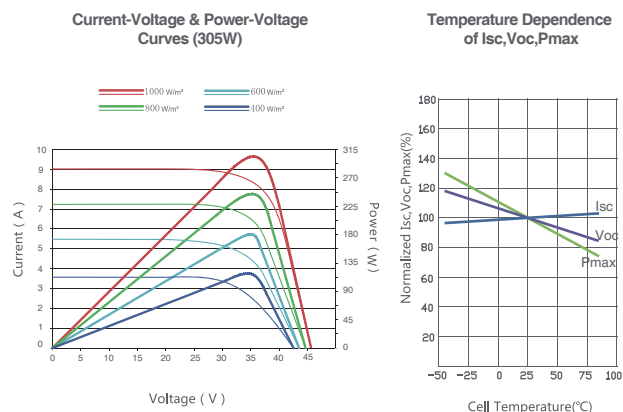


Packaging Configuration

(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.

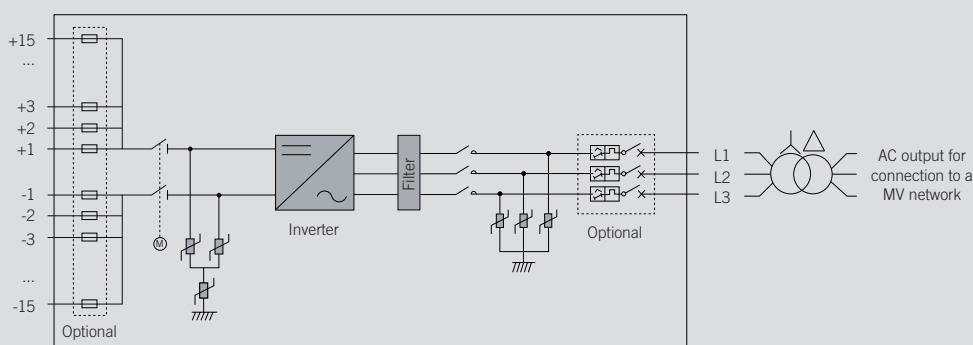
OPTIONAL ACCESSORIES

- 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.

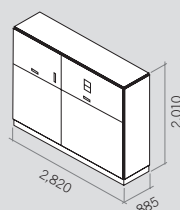
ADVANTAGES OF THE MONOBLOCK VERSION

- 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.

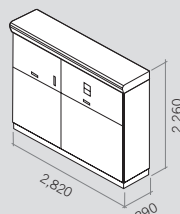
PowerMax B Series



Size and weight (mm)



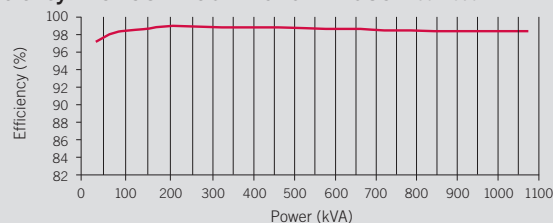
Indoor inverter
1,500 kg.



Outdoor inverter
1,560 kg.

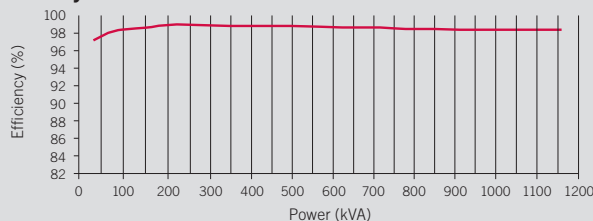
| | 830TL B300 | 1000TL B360 | 1070TL B385 |
|---|--|---------------------|-------------------------|
| Input (DC) | | | |
| Recommended PV array power range ⁽¹⁾ | 845 - 1,081 kWp | 1,013 - 1,297 kWp | 1,084.3 - 1,387 kWp |
| Voltage Range MPP ⁽²⁾ | 440 - 820 V | 524 - 820 V | 560 - 820 V |
| Maximum voltage ⁽³⁾ | 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 ⁽⁴⁾ | 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 ⁽⁵⁾ | 1 | | |
| Power Factor adjustable | Yes. Smax=831.4 kVA | Yes. Smax=997.7 kVA | Yes. Smax=1,066.9 kVA |
| THD (Total Harmonic Distortion) ⁽⁶⁾ | <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 ⁽⁷⁾ | 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 ⁽⁸⁾ | 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: ⁽¹⁾ Depending on the type of installation and geographical location. Data for STC conditions ⁽²⁾ V_{mpp,min} is for rated conditions (V_{ac}=1 p.u. and Power Factor=1) ⁽³⁾ Consider the voltage increase of the 'Voc' at low temperatures ⁽⁴⁾ 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 ⁽⁵⁾ For P_{out}>25% of the rated power ⁽⁶⁾ For P_{out}>25% of the rated power and voltage in accordance with IEC 61000-3-4 ⁽⁷⁾ Consumption from PV field when there is PV power available ⁽⁸⁾ 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_{dc} = 650 V


| | 1110TL B400 | 1140TL B410 | 1165TL B420 |
|---|--|---------------------------|-------------------------|
| Input (DC) | | | |
| Recommended PV array power range ⁽¹⁾ | 1,124.2 - 1,441.1 kWp | 1,151 - 1,476.8 kWp | 1,179.3 - 1,513.2 kWp |
| Voltage Range MPP ⁽²⁾ | 580 - 820 V | 595 - 820 V | 610 - 820 V |
| Maximum voltage ⁽³⁾ | 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 ⁽⁴⁾ | 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 ⁽⁵⁾ | 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) ⁽⁶⁾ | <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 | 98.9% | | |
| Euroefficiency | 98.6% | 98.5% | |
| Max. consumption aux. services | 2,500 VA | | |
| Stand-by or night consumption ⁽⁷⁾ | 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 ⁽⁸⁾ | 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: ⁽¹⁾ Depending on the type of installation and geographical location. Data for STC conditions ⁽²⁾ V_{mpp,min} is for rated conditions (V_{ac}=1 p.u. and Power Factor=1) ⁽³⁾ Consider the voltage increase of the 'Voc' at low temperatures ⁽⁴⁾ 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 ⁽⁵⁾ For P_{out}>25% of the rated power ⁽⁶⁾ For P_{out}>25% of the rated power and voltage in accordance with IEC 61000-3-4 ⁽⁷⁾ Consumption from PV field when there is PV power available ⁽⁸⁾ 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 1165TL B420 V_{dc} = 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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EARTH SCIENCES

SINCE
1974

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)

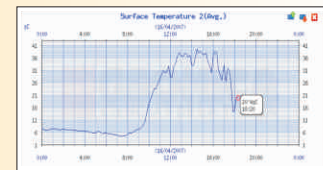


PLANT SENSORS
and
WEBCAMS

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.

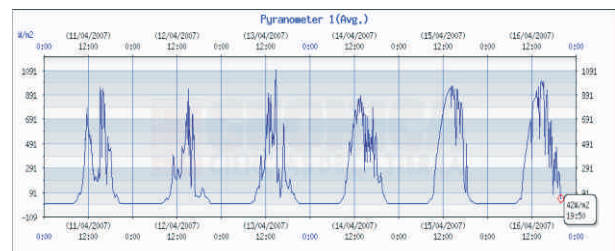
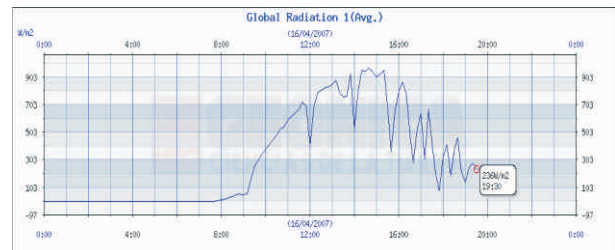
WEB POSTING

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

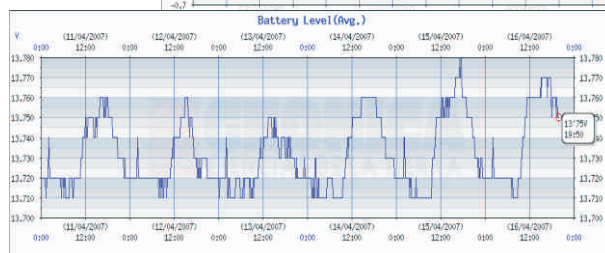
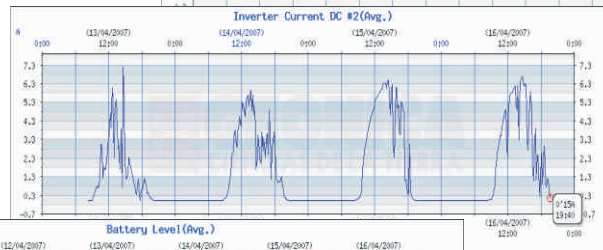
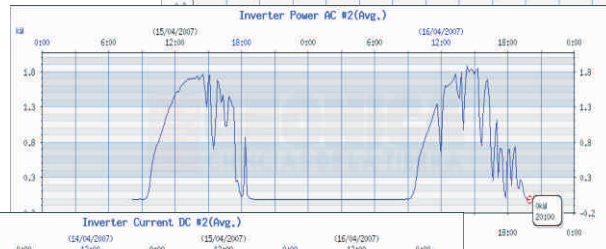
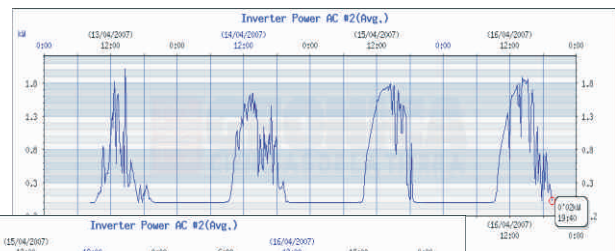
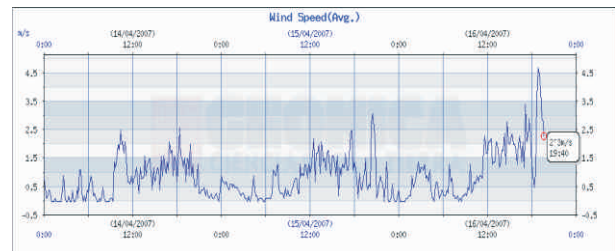
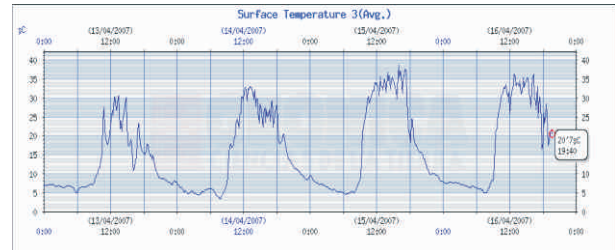
Remote diagnostic monitoring and efficiency analysis
In real-time via internet

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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ENVIRONMENTAL MONITORING INSTRUMENTATION

Grid-Connected System: Simulation parameters

Project : **PEF2827 Armenia Talin TMY client**

Geographical site: **Site 15 Armenia TMY client** Country **Armenia**

Situation Latitude 40.4°N Longitude 43.9°E

Time defined as Legal Time Time zone UT Altitude 1635 m

Albedo 0.20

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

Simulation variant : **Dashtadem Feasibility initial TMY shd**

Simulation date 27/09/16 16h33

Simulation parameters

Collector Plane Orientation Tilt 28° Azimuth 0°

Models used Transposition Perez Diffuse Imported

Horizon Average Height 1.4°

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 2052 strings

Total number of PV modules Nb. modules 38988 Unit Nom. Power 320 Wp

Array global power Nominal (STC) **12476 kWp** at operating cond. 11202 kWp (50°C)

Array operating characteristics (50°C) U mpp 636 V I mpp 17613 A

Total area Module area **75650 m²** Cell area 68326 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 9 units Total Power 10476 kWac

PV Array loss factors

Array Soiling Losses Loss Fraction 2.0 %

Thermal Loss factor U_c (const) 29.0 W/m²K U_v (wind) 0.0 W/m²K / m/s

Wiring Ohmic Loss Global array res. 0.61 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 - b₀ (1/cos i - 1) b₀ Param. 0.04

System loss factors

AC wire loss inverter to transfo Inverter voltage 420 Vac tri

Wires: 3x15000.0 mm² 504 m Loss Fraction 4.4 % at STC

External transformer Iron loss (24H connexion) 12285 W Loss Fraction 0.1 % at STC

Resistive/Inductive losses 0.2 mOhm Loss Fraction 1.1 % at STC



Grid-Connected System: Simulation parameters (continued)

User's needs : Unlimited load (grid)

Auxiliaries loss

| | | |
|------------------------|-----------------------------|--------|
| Constant (fans) | 15750 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 Talin TMY client

Simulation variant : Dashtadem Feasibility initial TMY shd

Main system parameters

Horizon

System type **Grid-Connected**

Average Height 1.4°

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 38988

Pnom total **12476 kWp**

Inverter

INGECON SUN 1165TL B420 CP1000

Pnom 1164 kW ac

Inverter pack

Nb. of units 9.0

Pnom total **10476 kW ac**

User's needs

Unlimited load (grid)

Horizon

Average Height 1.4°

Diffuse Factor 1.00

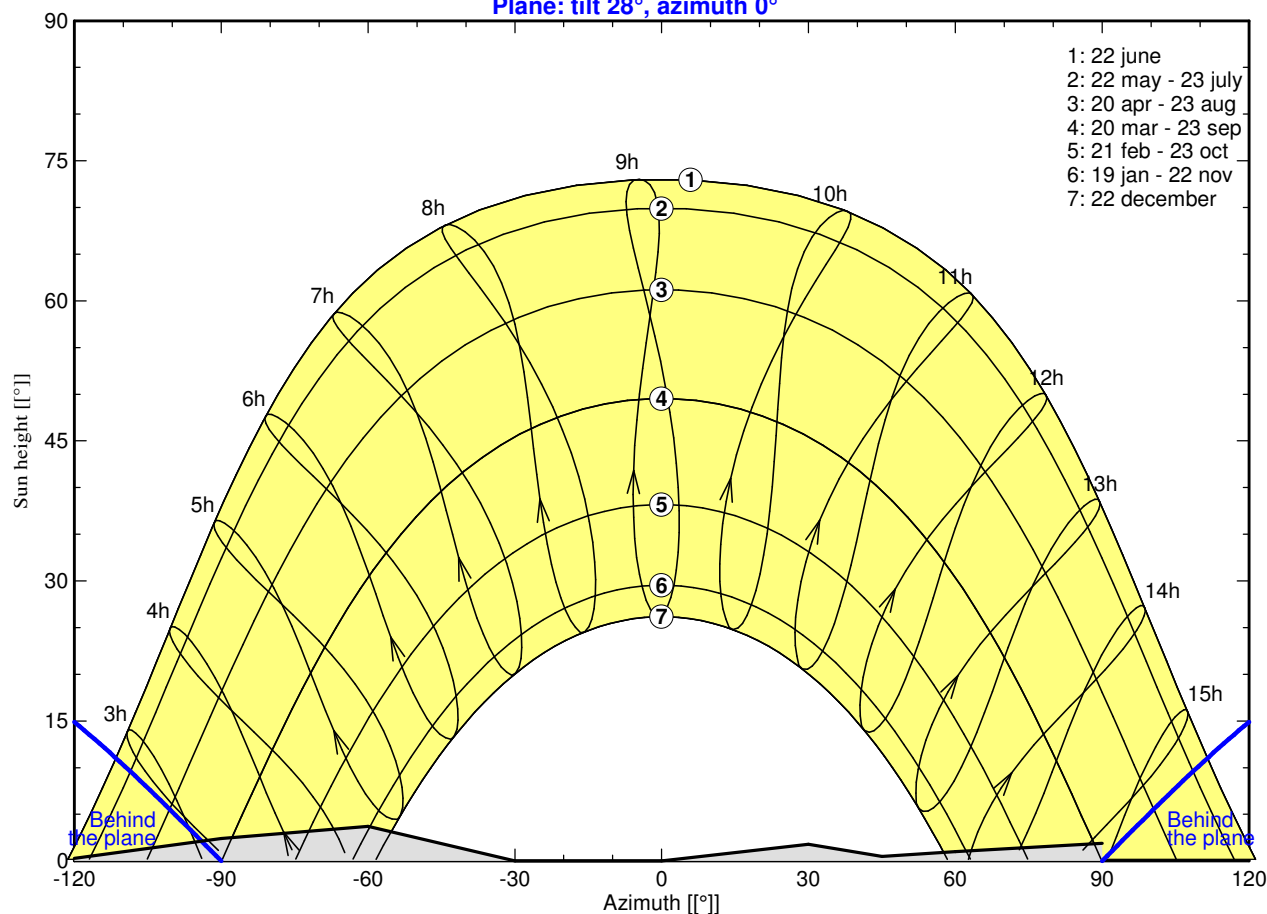
Albedo Factor 100 %

Albedo Fraction 0.96

| | | | | | | | | | |
|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|
| Height [°] | 0.3 | 2.4 | 3.7 | 0.0 | 0.0 | 1.8 | 0.5 | 1.0 | 1.9 |
| Azimuth [°] | -120 | -90 | -60 | -30 | 0 | 30 | 45 | 60 | 90 |

Horizon line at Talin_site15 Armenia Legal Time

Plane: tilt 28°, azimuth 0°



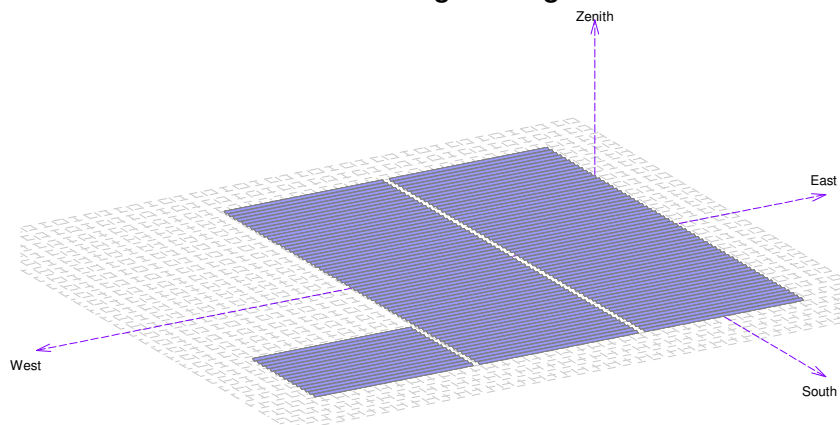
Grid-Connected System: Near shading definition

Project : PEF2827 Armenia Talin TMY client

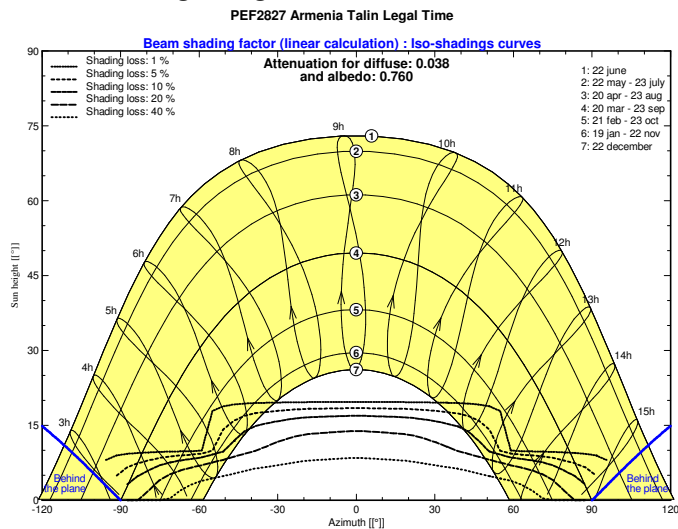
Simulation variant : Dashtadem Feasibility initial TMY shd

| | | | | |
|-------------------------------|-------------------------|-----------------------|------------|--------------------|
| Main system parameters | System type | Grid-Connected | | |
| Horizon | Average Height | 1.4° | | |
| 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 | 38988 | Pnom total | 12476 kWp |
| Inverter | INGECON SUN 1165TL B420 | Pnom | 1164 kW ac | |
| Inverter pack | Nb. of units | 9.0 | Pnom total | 10476 kW ac |
| User's needs | Unlimited load (grid) | | | |

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Main results

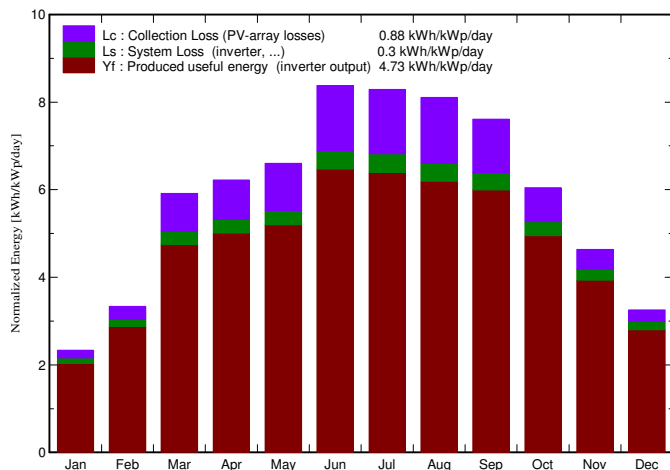
Project : PEF2827 Armenia Talin TMY client
Simulation variant : Dashtadem Feasibility initial TMY shd

Main system parameters
Horizon System type **Grid-Connected**
Average Height 1.4°
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 38988 Pnom total **12476 kWp**
Inverter INGECON SUN 1165TL B420 0P1000 Pnom 1164 kW ac
Inverter pack Nb. of units 9.0 Pnom total **10476 kW ac**
User's needs Unlimited load (grid)

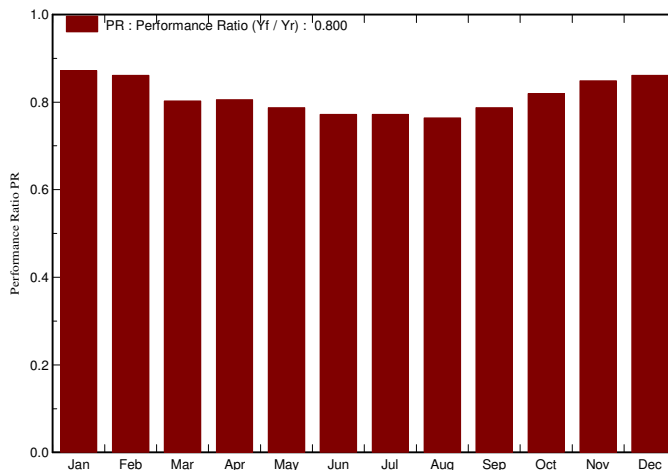
Main simulation results

System Production **Produced Energy 21517 MWh/year** Specific prod. 1725 kWh/kWp/year
Performance Ratio PR 80.0 %

Normalized productions (per installed kWp): Nominal power 12476 kWp



Performance Ratio PR



Dashtadem 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 | 50.6 | -6.72 | 72.3 | 65.3 | 835 | 786 | 15.27 | 14.38 |
| February | 71.4 | -5.38 | 93.4 | 85.9 | 1064 | 1003 | 15.06 | 14.21 |
| March | 149.5 | 0.03 | 183.3 | 171.3 | 1954 | 1836 | 14.09 | 13.24 |
| April | 172.0 | 6.37 | 186.6 | 173.6 | 1992 | 1875 | 14.11 | 13.28 |
| May | 204.4 | 11.16 | 204.7 | 191.7 | 2139 | 2011 | 13.81 | 12.98 |
| June | 261.3 | 17.42 | 251.3 | 236.1 | 2577 | 2421 | 13.56 | 12.73 |
| July | 260.1 | 20.81 | 256.9 | 241.9 | 2637 | 2475 | 13.57 | 12.73 |
| August | 233.7 | 20.25 | 251.3 | 236.7 | 2553 | 2396 | 13.43 | 12.60 |
| September | 187.2 | 15.30 | 228.3 | 215.7 | 2389 | 2243 | 13.83 | 12.99 |
| October | 134.4 | 7.58 | 187.4 | 176.5 | 2039 | 1915 | 14.39 | 13.51 |
| November | 85.2 | 0.29 | 139.0 | 128.5 | 1566 | 1472 | 14.90 | 14.00 |
| December | 59.4 | -5.93 | 101.0 | 92.4 | 1156 | 1085 | 15.13 | 14.20 |
| Year | 1869.1 | 6.83 | 2155.4 | 2015.5 | 22900 | 21517 | 14.04 | 13.20 |

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

PEF2827-049-Dashtadem 1-BOM

Bill of Quantities.23/09/2016

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. | 38,988.00 |
| 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 | 9.00 |
| 1.3 | | TRANSFORMERS | |
| 1.3.1 | | 2330kVA Transformer | |
| | Nos | Oil-inmersed distribution Transformer 2330 kVA, ONAN, 10/0.42/0.42kV, Dynyn11, Double Secondary winding. | 4.00 |
| 1.3.2 | | 1200kVA Transformer | |
| | Nos | Oil-inmersed distribution Transformer 1200 kVA, ONAN, 10/0.42kV, Dyn11, Single Secondary winding. | 1.00 |
| 1.3.3 | | 10kVA Transformer | |
| | Nos | Oil-inmersed distribution Transformer 10 kVA, ONAN, 420/400V, Dyn11. ITCs Auxiliary Services. | 5.00 |
| 1.3.4 | | 50kVA Transformer | |
| | Nos | Oil-inmersed distribution Transformer 50 kVA, ONAN, 10/0.4kV, Dyn11. Control Center and Warehouse Auxiliary Services. | 1.00 |

| SL.NO | UOM | DESCRIPTION | QTY |
|--------------|-----|--|-----------------|
| 1.4 | | MV SWITCHGEAR | |
| 1.4.1 | | MV Line connection Switchgear. 24kV, 400A | |
| | Nos | MV Line connection Switchgear . 24kV, 400A. Frequency 50Hz, Gas insulated SF6.Circuit breaker. Earth-Switch disconnecter. | 8.00 |
| 1.4.2 | | MV Transformer Protection Switchgear . 24kV, 400A. | |
| | Nos | MV Transformer Protection Switchgear . 24kV, 400A. Frequency 50Hz, Gas insulated SF6.Circuit breaker or fuse. Earth-Switch disconnecter. | 5.00 |
| 1.4.3 | | MV Line connection Switchgear. 24kV, 630A | |
| | Nos | MV Line connection Switchgear . 24kV, 630A. Frequency 50Hz, Gas insulated SF6.Circuit breaker. Earth-Switch disconnecter. | 4.00 |
| 1.4.4 | | MV Transformer Protection Switchgear . 24kV, 630A. | |
| | Nos | MV Transformer Protection Switchgear . 24kV, 630A. Frequency 50Hz, Gas insulated SF6.Circuit breaker or fuse. Earth-Switch disconnecter. | 1.00 |
| 1.4.5 | | MV Measurement Switchgear . 24kV, 630A. | |
| | Nos | MV Measurement Switchgear . 24kV, 630A. Frequency 50Hz, Gas insulated SF6.Voltage and current transformers. | 2.00 |
| 1.4.6 | | MV Coupling Switchgear . 24kV, 630A. | |
| | Nos | MV Coupling Switchgear . 24kV, 630A. Frequency 50Hz, Gas insulated SF6.Voltage and current transformers. Earth-Switch disconnecter. | 1.00 |
| 1.5 | | COMBINER BOXES | |
| 1.5.1 | | LV metal-enclosed switchboar DC strings combiner. | |
| | Nos | Low voltage metal-enclosed switchboar DC strings combiner. 0,6/1kV. Max. 30 inputs.Fuse & switch disconnecter included. | 72.00 |
| 1.6 | | CABLES | |
| 1.6.1 | | M.V. Cable | |
| 1.6.1.1 | m | MV cable 12/15 kV 1 x 240 mm2 Al. Single core conductor. Isolation: XLPE. Conductor: Aluminium. Oversheath: PVC. Metallic screen. | 5,727.00 |

| SL.NO | UOM | DESCRIPTION | QTY |
|----------------------------------|----------------|--|------------|
| 1.6.2 L.V. DC Cable | | | |
| 1.6.2.1 | m | LV DC cable XLPO 0,6/1 kV 1 x 6 mm ² Cu. Single core conductor. Conductor: Electrolytic copper. Insulation: XLPE. Sheath: EVA 120°C (Ethylene-Vinylacetat-Copolyme) | 129,830.00 |
| 1.6.2.2 | m | LV DC cable XLPE 0,6/1 kV 1 x 240 mm ² Al. Single core conductor. Isolation: XLPE. Conductor: Aluminium. Sheath: Special mix of low smoke emissions. | 19,151.00 |
| 1.6.2.3 | m | LV DC cable XLPE 0,6/1 kV 1 x 300 mm ² Al. Single core conductor. Isolation: XLPE. Conductor: Aluminium. Sheath: Special mix of low smoke emissions. | 28,676.00 |
| 1.6.3 L.V. AC Cable | | | |
| 1.6.3.1 | m | LV AC cable XLPE 1.8/3 kV 1 x 240 mm ² Cu. Single core conductor. Isolation: XLPE. Conductor: Electrolytic copper. Sheath: Special mix of low smoke emissions. | 794.00 |
| 1.7 GROUNDING | | | |
| 1.7.1 Cu conductor | | | |
| | m | Bare copper conductor Cu 35mm ² . Supply and installation. | 9,192.00 |
| | Nos | Electrical copper steel rod Cu . L=2 m, diameter 16 mm ² . Supply and installation. | 69.00 |
| | Nos | Exothermic welding .Cadwel type for bare copper conductor and electrical rods. (Connection type wire-wire and wire-rod) Supply and execution. | 178.00 |
| 1.8 EVACUATION POWER LINE | | | |
| 1.8.1 OHL 10kV | | | |
| | m | Overhead 10kV double circuit line. Supply and installation of supports, cable, isolators and all necessary equipment including foundations and civil works. | 8,000.00 |
| 2 CIVIL WORKS | | | |
| 2.1 Earthmovements | | | |
| 2.1.1 | m ² | Clearing and grubbing of the site area. | 260,271.00 |
| 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. | 7,482.00 |



| <i>SL.NO</i> | <i>UOM</i> | <i>DESCRIPTION</i> | <i>QTY</i> |
|---------------------|-------------------|---|-------------------|
| 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. | 1,019.00 |
| 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. | 110.00 |

| SL.NO | UOM | DESCRIPTION | QTY |
|--|-----|--|-----------|
| 2.2 Urbanization | | | |
| 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. | 3,016.00 |
| 2.3 Access, perimeter and internal road | | | |
| 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). | 300.00 |
| 2.3.3 | m | Perimeter road.(5 m wide). | 3,016.00 |
| 2.4 Foundations | | | |
| 2.4.1 | m | Foundation of the photovoltaic structure. Drive steel profiles. According to photovoltaic structures providers the supporting structure of photovoltaic modules normally is hot-dip galvanized steel (according to EN ISO 1461).Supply and installation. | 12,996.00 |
| 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 |
| 2.5 Photovoltaic structure | | | |
| 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 3 rows of 19 modules in landscape position per structure. | 684.00 |

| SL.NO | UOM | DESCRIPTION | QTY |
|---------------------|-----|--|----------|
| 2.6 Building | | | |
| 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. | 5.00 |
| 2.6.3 | Nos | Connection center (CC). Prefabricated concrete building with approximately dimensions 9,6 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 |
| 2.7 Drainage | | | |
| 2.7.1 | m | Drainage system. Triangular or rectangular channel. | 2,812.80 |
| 3 Security | | | |
| 3.1. | Nos | Fixed thermal camera to be installed in the perimeter near the fence | 25.00 |
| 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 | 26.00 |
| 3.4. | m | Communication cable from Control Building to cameras | 3,378.00 |
| 3.5. | m | Power cable from ATCs to cameras | 3,378.00 |
| 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 |



| <i>SL.NO</i> | <i>UOM</i> | <i>DESCRIPTION</i> | <i>QTY</i> |
|---------------------|-------------------|--|-------------------|
| 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 |

| SL.NO | UOM | DESCRIPTION | QTY |
|-------|-----|--|----------|
| 4 | | I&C | |
| 4.1. | m | Fiber optic, multimode for ITC communication ring | 2,115.00 |
| 4.2. | m | Multicore cable, 6x2x1.5 mm2 | 4,165.74 |
| 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 |
| 4.5. | Nos | Rack to be installed in Control Building for SCADA hardware, (19", 24U, frontal door, with ventilation and internal illumination), including terminals, cable glands, and accessories | 1.00 |
| 4.6. | Nos | Rack (800x600x300 mm, frontal door, with ventilation) installed in ITC, including switch FO-FO, datalogger, UPS, gateways | 5.00 |
| 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) | 2.00 |
| 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 |