

2014

Switch Solar

Babu Ilangkannan



SWITCH SOLAR

[100 KWp Solar Power Plant Technical Proposal]

Nazareth Foods Pvt Ltd

Chennai, Tamil Nadu.

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Technical Proposal

Section A – Bill Of Quantities

| SI.No | DESCRIPTION | UNIT | QTY | Make |
|-------|------------------------------------------------------------------------------------------------|--------|-----|---------------------------------------------|
| 1 | SOLAR MODULES - 250Wp Crystalline Modules | No's | 400 | Lanco, Emmvee or equivalent |
| 2 | 20KW. String inverter | No's | 5 | Refusol, Donfoss or equivalent |
| 3 | Module mounting structure(MS Hot Dip Galvanized with appropriate analysis for Load/Wind speed) | Set | | MNRE/Indian Standard complied |
| 4 | Electrical Accessories including cables & conduit | Set | | MNRE/Indian Electrical Standard complied |
| 5 | Remote Monitoring System | No's | 1 | Part of Inverter accessory |
| 6 | Mounting structure earthing points | POINTS | Set | As per CEIG Rules |
| 7 | Lightning Arrestor and earthing kits (If Required) | POINTS | 1 | As per CEIG recommendation |
| 8 | LT Panel (If Required) | Set | 1 | ABB/Siemens or equivalent |
| 9 | Civil Works(Pile foundations, equipment foundations) | | | M15/M20 with structural strength assessment |
| 10 | Installation and Commissioning | | | Switch Solar Scope |



100 KWp Solar Power Plant

TIN No. 33171026743
C.S.T No. 1209680

Proposal

ADDRESS

Mr.Ashwin Pandian
Nazareth Foods (P) Ltd
Chennai

Proposal No. 1045

Date. 04/01/2014

| ACTIVITY | QUANTITY | RATE | TAX | AMOUNT |
|----------------------------------------------------------------------------|----------|--------------|--------|--------------|
| Switch 100 KW(Grid Connected) 100 KWp system generating 150000 KWh/year | 1 | 99,80,000.00 | 5% VAT | 99,80,000.00 |
| (1) Modules - 250 Wp | 400 | | | |
| (2) Mounting Structure and spares | | | | |
| (3) 20 KW Grid-Connected String Inverter International Make. | 5 | | | |
| (4) Remote Monitoring System | 1 | | | |
| (5) Associated cabling and accessories till the point of distribution. | | | | |
| (6) Installation and Commissioning – Switch Solar Scope | | | | |

WARRANTY

- (1) Solar Panels guaranteed for 25 years.
 - (2) Inverter guaranteed for 5 years.
 - (3) System guaranteed for 5 years.
- *Price inclusive of 5 years AMC.

TERMS OF PAYMENT

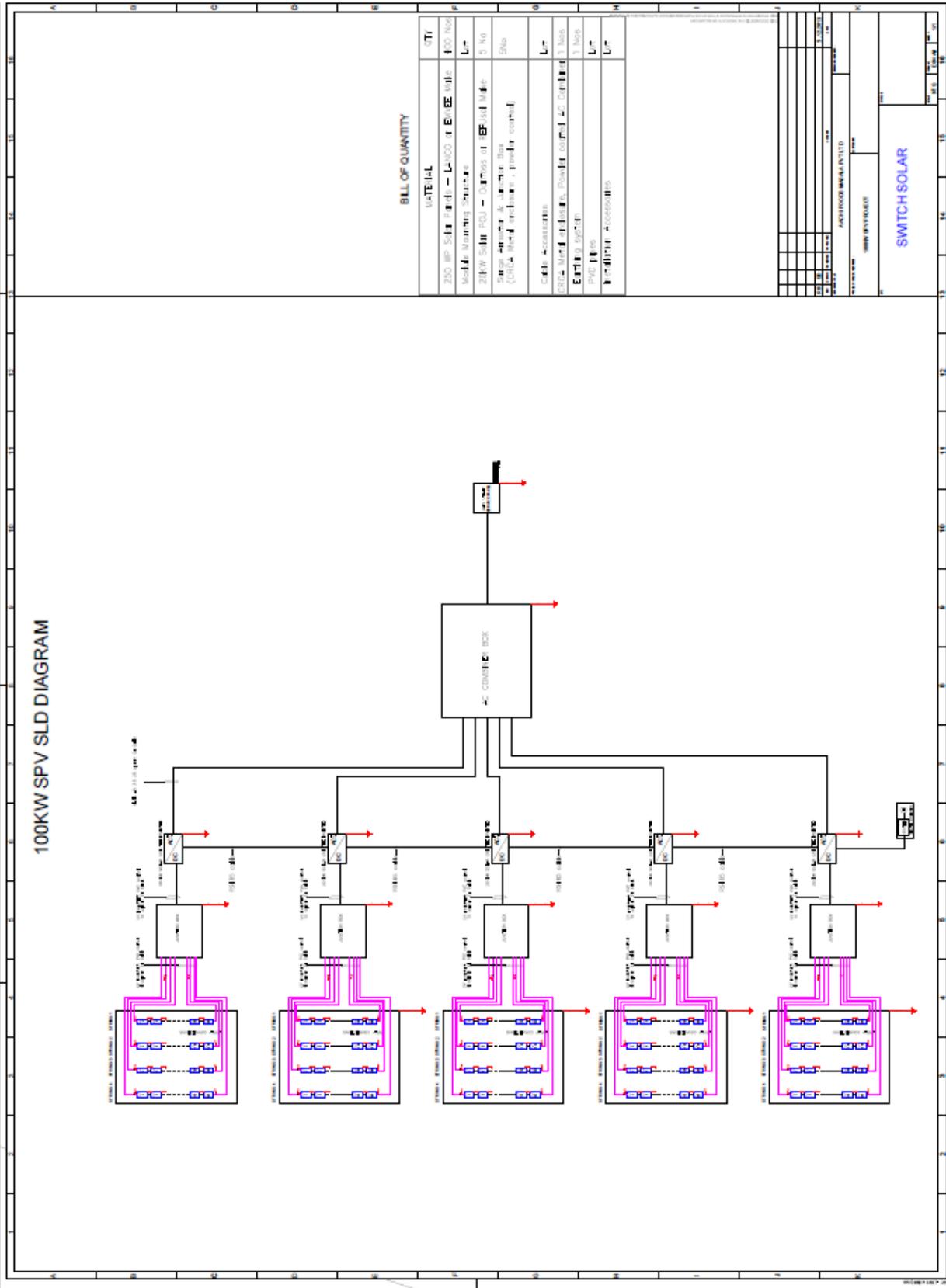
- (1) 20% Advance after confirmation of subsidy approval.
- (2) 80% Against Performa Invoice.

ACCOUNT DETAILS

Switch Solar
Axis Bank, Anna Nagar Branch
A/c No – 913020030215451
IFSC Code – UTIB0000016

SUBTOTAL 99,80,000.00
TAX 4,99,000.00

GRAND TOTAL 1,04,79,000.00



Introduction

This is an initial proposal and all information is subject to change based on site requirements and detailed Engineering document. Please contact us for any more information and clarifications. We look forward for your long lasting Business relationship and we are committed to deliver high quality service & standards to our clients.

Solar Photovoltaic

Solar Photovoltaic (PV) is a method of converting solar irradiation in to direct current electricity using semiconductor that exhibit the Photovoltaic Effect. Photovoltaic power generation employs solar panels composed of a number of solar cell containing a photovoltaic material. Materials presently used for photovoltaic include monocrystalline silicon, poly crystalline silicon, amorphous silicon, Cadmium Telluride (CdTe) and copper indium gallium selenite/sulfide (CIGS) Due to the growing demand for renewable energy sources, the manufacturing of solar cells and photovoltaic system has advanced considerably in recent years.

Solar photovoltaic is growing rapidly, albeit from a small base, to a total global capacity of 69GW at the end of 2011. The total power output of the world's PV capacity run over a calendar year is equal to some 80 billion kWh of electricity. This is sufficient to cover the annual power supply needs of over 20 million households in the world.

Driven by advances in technology and increases in manufacturing scale and sophistication, the cost of photovoltaic has declined steadily since the first solar cells were manufactured and the leveled cost of electricity (LCOE) from PV is competitive with conventional electricity sources in an expanding list of geographic regions. Net Metering and financial incentives, such as preferential feed-in tariffs for solar-generated electricity, have supported solar PV installations in many countries. With current technology, photovoltaic recoup the energy needed to manufacture them in 1 to 4 years.

Why Solar?

While a majority of the world's current electricity supply is generated from fossil fuels such as coal, oil and natural gas, these traditional energy sources face a number of challenges including rising prices, security concerns over dependence on imports from a limited number of countries which have significant fossil fuel supplies, and growing environmental concerns over the climate change risks associated with power generation using fossil fuels. As a result of these and other challenges facing traditional energy sources, governments, businesses and consumers are increasingly supporting the development of alternative energy sources and new technologies for electricity generation. Renewable energy sources such as solar, biomass, geothermal, hydroelectric and wind power generation have emerged as potential alternatives

which address some of these concerns. As opposed to fossil fuels, which draw on finite resources that may eventually become too expensive to retrieve, renewable energy sources are generally unlimited in availability. Solar power generation has emerged as one of the most rapidly growing renewable sources of electricity. Solar power generation has several advantages over other forms of electricity generation:

Reduced Dependence on Fossil Fuels. Solar energy production does not require fossil fuels and is therefore less dependent on this limited and expensive natural resource

Environmental Advantages. Solar power production generates electricity with a limited impact on the environment as compared to other forms of electricity production.

Matching Peak Time Output with Peak Time Demand. Solar energy can effectively supplement electricity supply from an electricity transmission grid, such as when electricity demand peaks in the summer

Modularity and Scalability. As the size and generating capacity of a solar system are a function of the number of solar modules installed, applications of solar technology are readily scalable and versatile.

Government Incentives. A growing number of countries have established incentive programs for the development of solar and other renewable energy sources, such as (i) net metering laws that allow on-grid end users to sell electricity back to the grid at retail prices, (ii) direct subsidies to end users (iii) low interest loans for financing solar power systems and tax incentives; and (iv) government standards that mandate minimum usage levels of renewable energy sources.

Solar Purchase Obligation (SPO)

Tamil Nadu will actively promote the solar energy sector by prescribing a certain percentage of electricity consumption through solar energy as mandatory. This will be progressively increased.

The Government will mandate 6% SPO starting from January 2014 for the following category of consumers:

This category will cover all HT consumers including:

- Special Economic Zones (SEZs)
- Industries guaranteed with 24/7 power supply
- IT Parks, Telecom Towers
- All Colleges & Residential Schools
- Buildings with a built up area of 20,000 sq. m. or more

System Configuration:

Basic components for grid connected system

- ❖ Solar PV module
- ❖ DC cable
- ❖ Structures
- ❖ Inverters/PCU
- ❖ Earthing and Lightning arrestor

PV Module

A solar panel (also solar module, photovoltaic module or photovoltaic panel) is a, connected assembly of solar cell. The solar panel can be used as a component of a larger photovoltaic system to generate and supply solar power in commercial and residential applications. Each panel is rated by its DC output power under standard test conditions, and typically ranges from 100 to 450 watts. The solar cell efficiency of a panel determines the area of a panel given the same rated output - an 8% efficient 230 watt panel will have twice the area of a 16% efficient

230 watt panel. Because a single solar panel can produce only a limited amount of power, most installations contain multiple panels. Electrical connections are made series to achieve a desired output voltage and/or parallel to provide a desired current capability. Separate Diode may

be needed to avoid reverse currents, in case of partial or total shading, and at night. Reverse currents waste power and can also lead to overheating of shaded cells. Solar cells become less efficient at higher temperatures and installers try to provide good ventilation behind solar panels.



Cables

The unique capability of wire harness of connecting parallel strings eliminates the use of array junction box. It provides a more simpler and safer solution. 2 wire harness are used in each array one for connecting all the positive terminals at one side and negative terminals at the other side.



The multi-strand Copper/Aluminum cables will be used for interconnection of electrical components like PV Modules, Junction boxes, distribution Boards & Inverter. All the cabling will be carried out as per the standards. The size and length of the cable will be selected such that there will be minimum voltage drop and the effect of temperature is minimum. The size of cables will be selected considering the short circuit current that can flow through the cables. Cables will be housed inside PVC conduit pipe for unarmored cables and all cables will be underground cabling with the cable trench at a minimum depth of 80 CM.

| CABLES | |
|----------------------------|------------------------------------------------|
| Description | Details |
| Conductor | Multi strand high conductivity Copper/aluminum |
| Protection | UV protected |
| Cable lugs for termination | Provided in installation kit |
| Temperature Range | -10°C70°C |
| Certifications | 650/1.1KV grade as per IS 694 |

Inverters

Solar inverter converts the DC power to AC power to facilitate feeding into the grid. The inverter is the most complicated part of the PV system. It has to act as the interface between the PV array and the Grid. As the PV array output varies with the solar radiation and the inverter has to cope with the same. The inverter has protection features for overvoltage, under voltage, surge etc. The inverter is provided with the features for logging and display of parameters related to Plant operation & faults etc. The inverter will use MPPT to maximize energy drawn from the array. The MPPT will be microprocessor based to minimize power losses. The output from the inverter will be fed to the AC distribution Board.

The main functions carried out by the inverter are as follows:

- ❖ Converting the incoming DC received from PV modules into AC with suitable power quality. The inverter produces sinusoidal AC wave forms with low harmonic distortion.
- ❖ The inverter also has to act as a protective device of the system. It needs to trip out if the voltage, current or frequency goes outside acceptable ranges.
- ❖ Pulse width modulation is used to generate a wave form as near as possible to a sine wave. High speed switching device are used to generate pulses of the devices mainly used for inverter circuitry.
- ❖ Inverter efficiency is expected to be about 98% mainly by deploying new switching topologies.

Structures

Solar Photovoltaic panels connected in series and in parallel giving a DC output out based on incident irradiance. Intensity of the sunlight will be maximum utilized when incident irradiation is perpendicular to PV module, hence Orientation and tilt of these panels are important design parameters, as well as



shading from surrounding obstructions. Structures will be made of galvanized mild steel/ aluminum based on site soil and wind load parameters. Suitable number of Array frames will be provided based on the design and site requirements. The array frames proposed for the site would typically utilize maximum sunlight with a different tilt angle capability and these array frames will be corrosion free.

The array frames are designed for simplicity, low cost and ease of installation at site. The Structure consists of a set of components that can be managed and mounted in the place where the installation is going to be realized. These structures are designed to survive adverse weather conditions with minimum maintenance. The structure will be supplied with all members to be compatible allowing easy installation at the site.

LV ACB Panel

Low Voltage AC Board (LV ACB) panel shall be provided between each transformer and inverter. The metal enclosed outdoor ACB panels shall be dust tight and damp proof with outdoor application IP rating. LV ACB panel with microprocessor based release/thermo magnetic ACB module having following inbuilt protection functions:

- ❖ Long time protection
- ❖ Short time protection

Earthing and Lighting Arrestors

The earthing of all outdoor equipment & provision of associated earthing systems, electrodes & connections will be as per latest IEEE and IS 3043 standards Earth electrodes will be provided throughout plant areas along with the main earth grid. The number of earth electrodes will be taken so as the total earth grid resistance is less than 1 ohm . The earth electrodes will be provided in earth pits. The earth pit will be of two types –treated with earth links & untreated. The main buried grid conductors will be connected to all the earth electrodes to form a total earth grid. Galvanized steel flats will be used as per approved design.

Equipment Earthing

The frames of all electrical equipment & structural work will be earthed by connection to the earth grid by branches of same cross sectional area of earth grid

Lighting Protection

- ❖ Lightning protection will be as per IS Standards and IE rules.
- ❖ Suitable for Solidly Earthed system neutral system and 10kA rating.
- ❖ The arrestor shall be capable of spark over on server switching surges and multiple strokes.
- ❖ The lightening arrestor shall be capable of discharging over voltage occurring during switching of unloaded transformer.
- ❖ Surge counters with insulating base for connection, supporting insulator and necessary hardware shall be provided.

Solar PV Module

High Efficiency Lanco Solar PV Modules



Special Features

- 100% Micro Crack free Cells in PV Module
- Positive oriented Power Tolerance [0-2.5%]
- Configured with RFID Tags
- German Lamination Technology
- American Stringing Process
- Guaranteed Performance as per Best Industry Standards
- High Quality Induction Soldered Joints
- High Fill factor and less series Resistance Solar Modules
- Less Temp Coefficient Solar PV modules Suitable for Indian and European Climates.

Power Warranty

25 Years Power degradation warranty

(5 Years 95%, 12 Years 90%, 18 years 85%, 25 years 80%)

| | Unit | LSP 245 | LSP 250 | LSP 255 | LSP 260 |
|--------------------------------------|------|-----------------------------------------------------------------|---------|---------|---------|
| Electrical Data @ STC | | | | | |
| Power Max | | 245 | 250 | 255 | 260 |
| Power Output | % | +/- 5 % | | | |
| Short Circuit Current - Isc | A | 8.55 | 8.66 | 8.76 | 8.81 |
| Open Circuit Voltage - Voc | V | 36.66 | 36.70 | 36.84 | 37.02 |
| Current at Maximum Power Point -Impp | A | 8.06 | 8.10 | 8.20 | 8.31 |
| Voltage at Maximum Power Point -Vmpp | V | 30.50 | 30.90 | 31.18 | 31.30 |
| System Voltage | V | 1000 | | | |
| Fill Factor | % | 78.43% | 78.75% | 79.23% | 79.75% |
| Module Efficiency | % | 14.88% | 15.19% | 15.49% | 15.80% |
| No. of cells and Matrix | | 60 (10 x 6) | | | |
| Temp coefficient of Current | %/K | 0.08 | | | |
| Temp coefficient of Voltage | %/K | -0.36 | | | |
| Temp coefficient of Power | %/K | -0.43 | | | |
| System Voltage | V | 1000 | | | |
| NOCT | °C | 47 +/- 2 | | | |
| Series Fuse Rating | A | 15 | | | |
| Junction Box | | IP 65 | | | |
| Aluminum Frame | | AL 6063 T5 | | | |
| Solar Glass | | High Transmittance 3.2mm Textured & Tempered Glass | | | |
| Weight | | 19.5Kg | | | |
| Plant Certifications | | ISO 9001:2008, ISO 14001 and OHSAS 18001:2007 | | | |
| Calibration Modules | | Primary Modules are certified by ISE Frohnofer and TUV Germany. | | | |

High Efficiency Lanco Solar PV Modules



Special Features

100% Micro Crack free Cells in PV Module

Positive oriented Power Tolerance [0-2.5%]

Configured with RFID Tags

German Lamination Technology

American Stringing Process

Guaranteed Performance as per Best Industry Standards

High Quality Induction Soldered Joints

High Fill factor and less series Resistance Solar Modules

Less Temp Coefficient

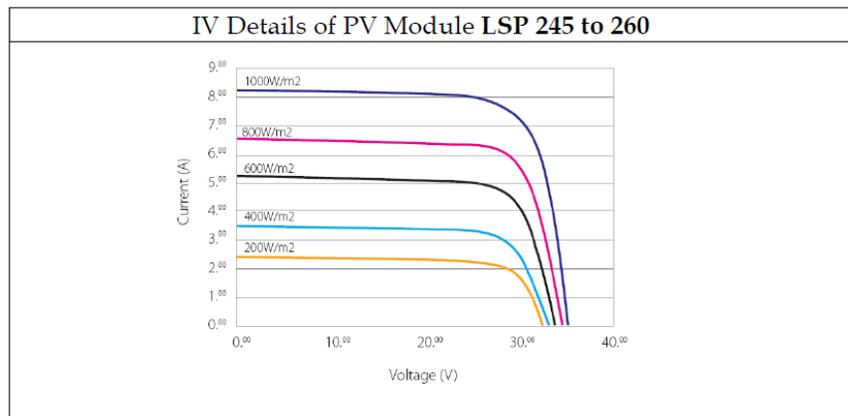
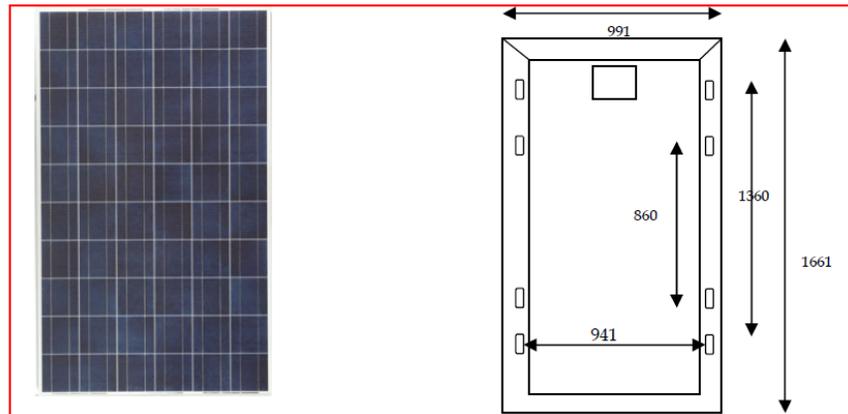
Solar PV modules Suitable for Indian and European Climates.

Power Warranty

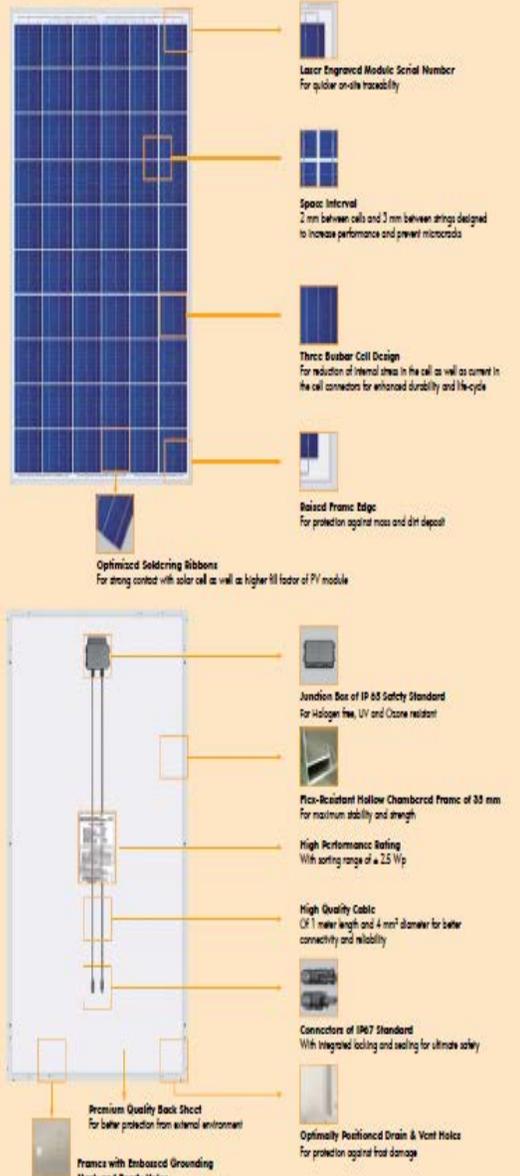
25 Years Power degradation warranty

(5 Years 95%, 12 Years 90%, 18 years 85%, 25 years 80%)

| Mechanical & Packing Details | |
|-------------------------------------------|-------------------------------------------------------------------------------------|
| LSP 245 to LSP 260 | |
| Module size | 1661 x 991 x 40 mm +/- 1mm |
| Module Mounting Dimensions | 1360 X 941 +/- 3mm & 860 X 941 +/- 3mm 1361 Dia of Hole : 9 x 14mm |
| Frame Joint & Drain Hole details |  |
| No. of Modules in pallet | 24 No's |
| No. of Pallets in 40feet Container (High) | 28 No's |
| No. of Modules per Container | 672 No's (154 KW to 164 KW) |



EMMVEE PV Module Key Features

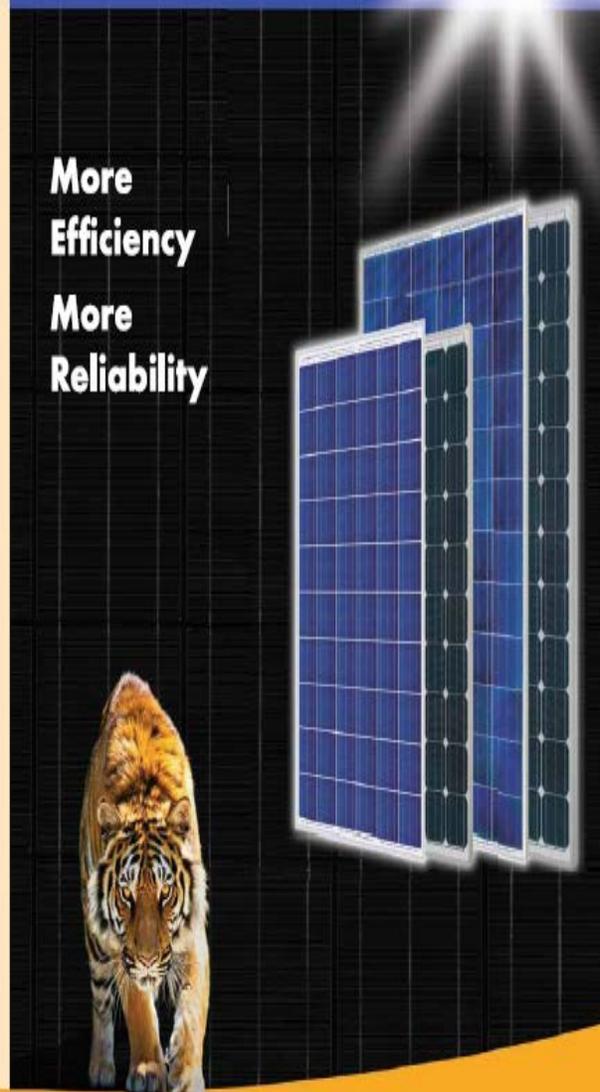


- Laser Engraved Module Serial Number**
For global on-site traceability
- Space Interval**
2 mm between cells and 3 mm between strings designed to increase performance and prevent microcracks
- Three Busbar Cell Design**
For reduction of internal stress in the cell as well as current in the cell connectors for enhanced durability and life-cycle
- Raised Frame Edge**
For protection against moss and dirt deposit
- Optimized Soldering Ribbons**
For strong contact with solar cell as well as higher fill factor of PV module
- Junction Box of IP 65 Safety Standard**
For hydrogen free, UV and ozone resistant
- Pico-Resistant Hollow Chambered Frame of 35 mm**
For maximum stability and strength
- High Performance Backing**
With sorting range of a 2.5 Wp
- High Quality Cable**
Of 1 meter length and 4 mm² diameter for better connectivity and reliability
- Connectors of IP67 Standard**
With V-sealed locking and sealing for ultimate safety
- Premium Quality Back Sheet**
For better protection from external environment
- Optimally Reinforced Drain & Vent Holes**
For protection against frost damage
- Frame with Embossed Grounding Mark and Ready Holes**
For permanent recognition and easy installation



EMMVEE On-Grid Modules Photovoltaic Module

More Efficiency More Reliability



EMMVEE Photovoltaic Power Pvt. Ltd.
#13/7, International Airport Road, Bellur Taluk, Bengaluru - 562 107, India
Phone: +91 80 4323 3544 - info@emmvee.in

EMMVEE Photovoltaics GmbH
Franz-Joseph-Str. 4a - 10369 Berlin, Germany
Phone: +49 (0)30 91 42 68 90 - info@emmveephotovoltaics.com

www.emmvee.com

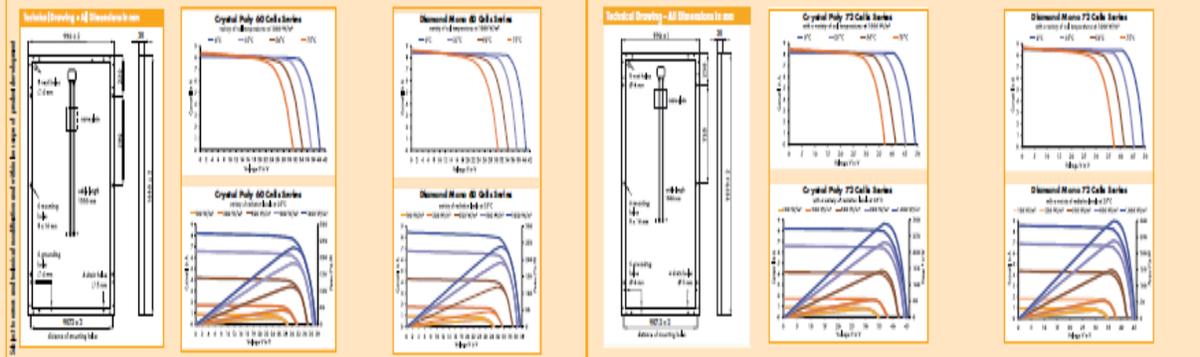
| | Crystal Poly 60 Cells Series | | | | | | Diamond Mono 60 Cells Series | | | | | | Crystal Poly 72 Cells Series | | | | | | Diamond Mono 72 Cells Series | | | | | | | | |
|-------------------------------------------------------------------------------------------------------|------------------------------|--------|--------|--------|--------|--------|------------------------------|--------|--------|--------|--------|--------|------------------------------|--------|--------|--------|--------|--------|------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Electrical Data of 1000W/m², 20°C and A.M. 1.5 (STC in Accordance with IEC 60904-2) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rated Power at STC | 230Wp | 235Wp | 240Wp | 245Wp | 250Wp | 255Wp | 260Wp | 265Wp | 270Wp | 275Wp | 280Wp | 285Wp | 290Wp | 295Wp | 300Wp | 305Wp | 310Wp | 315Wp | 320Wp | 325Wp | 330Wp | 335Wp | 340Wp | 345Wp | 350Wp | | |
| Module Efficiency at STC | 14.00% | 14.30% | 14.60% | 14.91% | 15.21% | 14.80% | 14.60% | 14.91% | 15.21% | 15.52% | 15.62% | 12.82% | 13.33% | 13.84% | 14.10% | 14.30% | 14.61% | 14.87% | 15.13% | 15.38% | 14.36% | 14.61% | 14.87% | 15.13% | 15.38% | 15.64% | 15.89% |
| Open Circuit Voltage - Voc (Vdc) | 36.84 | 37.08 | 37.26 | 37.30 | 37.62 | 36.67 | 36.72 | 36.78 | 36.78 | 36.90 | 36.93 | 42.82 | 43.39 | 43.99 | 44.21 | 44.42 | 44.64 | 44.86 | 45.10 | 45.35 | 44.40 | 44.49 | 44.59 | 44.70 | 44.78 | 44.88 | 44.98 |
| Short Circuit Current - Isc (Amps) | 8.39 | 8.48 | 8.57 | 8.70 | 8.76 | 8.71 | 8.74 | 8.75 | 8.75 | 8.80 | 8.87 | 8.00 | 8.20 | 8.40 | 8.47 | 8.56 | 8.65 | 8.74 | 8.83 | 8.93 | 8.20 | 8.30 | 8.32 | 8.44 | 8.57 | 8.69 | 8.74 |
| Max Power Voltage - Vmp (Vdc) | 29.14 | 29.33 | 29.47 | 29.66 | 29.76 | 28.42 | 28.89 | 29.47 | 30.06 | 30.20 | 30.86 | 33.87 | 34.32 | 34.80 | 34.97 | 35.14 | 35.31 | 35.48 | 35.68 | 35.87 | 36.09 | 36.17 | 36.25 | 36.34 | 36.41 | 36.49 | 36.69 |
| Max Power Current - Imp (Amps) | 7.89 | 8.01 | 8.14 | 8.26 | 8.40 | 8.27 | 8.31 | 8.31 | 8.32 | 8.35 | 8.43 | 7.36 | 7.58 | 7.76 | 7.86 | 7.97 | 8.07 | 8.17 | 8.27 | 8.36 | 7.97 | 7.98 | 8.00 | 8.12 | 8.24 | 8.36 | 8.45 |
| Electrical Data of 800 W/m², 1000 L, 1 m/s Wind Speed and AM 1.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rated Power Pmp | 167.28 | 170.91 | 174.55 | 178.19 | 181.82 | 171.94 | 175.60 | 179.26 | 182.92 | 186.58 | 190.23 | 181.82 | 189.10 | 196.37 | 200.01 | 203.64 | 207.28 | 210.92 | 214.55 | 218.19 | 204.87 | 208.53 | 212.18 | 215.84 | 219.50 | 223.16 | 226.82 |
| Open-circuit Voltage Voc | 33.95 | 34.17 | 34.34 | 34.56 | 34.67 | 33.37 | 33.42 | 33.47 | 33.47 | 33.58 | 33.61 | 39.47 | 39.99 | 40.54 | 40.74 | 40.94 | 41.14 | 41.34 | 41.57 | 41.80 | 40.41 | 40.50 | 40.58 | 40.68 | 40.76 | 40.85 | 40.94 |
| Short-circuit Current Isc | 6.80 | 6.87 | 6.94 | 7.05 | 7.09 | 7.11 | 7.13 | 7.14 | 7.14 | 7.16 | 7.24 | 6.48 | 6.64 | 6.80 | 6.86 | 6.93 | 7.01 | 7.08 | 7.15 | 7.23 | 7.54 | 7.56 | 7.57 | 7.68 | 7.80 | 7.91 | 7.96 |
| Rated Voltage Vmp | 26.51 | 26.68 | 26.81 | 26.98 | 27.07 | 25.53 | 25.95 | 26.47 | 27.01 | 27.40 | 27.72 | 30.81 | 31.22 | 31.65 | 31.81 | 31.96 | 32.12 | 32.27 | 32.45 | 32.63 | 32.85 | 32.92 | 32.99 | 33.07 | 33.14 | 33.21 | 33.39 |
| Rated Current Imp | 6.31 | 6.40 | 6.51 | 6.60 | 6.71 | 6.74 | 6.77 | 6.77 | 6.77 | 6.80 | 6.86 | 5.90 | 6.05 | 6.20 | 6.28 | 6.37 | 6.45 | 6.53 | 6.61 | 6.68 | 7.25 | 7.27 | 7.28 | 7.39 | 7.50 | 7.61 | 7.69 |

| Thermal Data | | | | |
|-----------------------------------------------|----------|----------|----------|----------|
| Temperature Coefficient Open-circuit Voltage | -0.34%/K | -0.33%/K | -0.34%/K | -0.33%/K |
| Temperature Coefficient Short-circuit Current | +0.05%/K | +0.04%/K | +0.05%/K | +0.04%/K |
| Temperature Coefficient Rated Power | -0.4%/K | -0.43%/K | -0.4%/K | -0.43%/K |
| not (normal operating cell temperature) | 48±2°C | 48±2°C | 48±2°C | 48±2°C |

| Mechanical Data | | | | |
|-------------------------------------|------------------------------------------------|--------------------------------------------------------|------------------------------------------------|--------------------------------------------------------|
| Number of Cells and Cell Type | 60 polycrystalline solar cells (156 x 156 mm) | 60 Mono crystalline solar cells (156 x 156 mm) | 72 polycrystalline solar cells (156 x 156 mm) | 72 Mono crystalline solar cells (156 x 156 mm) |
| Dimensions: length x width x height | 1,660 mm x 990 mm x 35mm | 1,660 mm x 990 mm x 35mm | 1,970 mm x 990 mm x 35mm | 1,970 mm x 990 mm x 35mm |
| Weight | 18 kg | 18 kg | 22 kg | 22 kg |
| Front Glass | 3.2 mm high transmission, tempered glass | 3.2 mm high transmission, tempered glass ¹⁾ | 3.2 mm high transmission, tempered glass | 3.2 mm high transmission, tempered glass ¹⁾ |
| Embedding | EVA | EVA | EVA | EVA |
| Back Sheet | composite film, white | composite film, white | composite film, white | composite film, white |
| Junction Box | protection class IP 65 | protection class IP 65 | protection class IP 65 | protection class IP 65 |
| Number of Bypass Diodes | 3 | 3 | 3 | 3 |
| Cables | 4 mm ² solar cables, length 1000 mm | 4 mm ² solar cables, length 1000 mm | 4 mm ² solar cables, length 1000 mm | 4 mm ² solar cables, length 1000 mm |
| Connection | MCA compatible | MCA compatible | MCA compatible | MCA compatible |

| Permissible Operating Conditions | | | | |
|----------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
| Operating temperature range | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C |
| Max. System Voltage | 1000V DC | 1000V DC | 1000V DC | 1000V DC |
| Max. Reverse Current | 12.5 A | 12.5 A | 12.5 A | 12.5 A |
| Maximum Junction Load Capacity | 2400 Pa | 2400 Pa | 2400 Pa | 2400 Pa |
| Resistance Against Hail | Max Ø 24 mm with impact speed of 83 km/h | Max Ø 24 mm with impact speed of 83 km/h | Max Ø 24 mm with impact speed of 83 km/h | Max Ø 24 mm with impact speed of 83 km/h |
| Protection Class | I | I | I | I |

| Warranty and Certificates | | | | |
|---------------------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|
| Product Warranty | 5 years ¹⁾ | 5 years ¹⁾ | 5 years ¹⁾ | 5 years ¹⁾ |
| Performance Warranty | 90% up to 10 years and 80% up to 25 years ¹⁾ | 90% up to 10 years and 80% up to 25 years ¹⁾ | 90% up to 10 years and 80% up to 25 years ¹⁾ | 90% up to 10 years and 80% up to 25 years ¹⁾ |
| Certifications | IEC 61215 Ed. 2, IEC 61730, MCS and CRC accredited | IEC 61215 Ed. 2, IEC 61730, MCS and CRC accredited | IEC 61215 Ed. 2, IEC 61730, MCS and CRC accredited | IEC 61215 Ed. 2, IEC 61730, MCS and CRC accredited |



¹⁾ Please refer Envision standard warranty terms and conditions.
¹⁾ Also available with deep pyramidal textured glass.



Solar Inverter



TLX Inverter Range

Three phase transformerless inverter range from 6-15 kW

The TLX range includes TLX, TLX+, TLX Pro and TLX Pro+



35 kg

The weight of 6-15 kW

Ensuring easy and troublefree installation of high performance inverters

The TLX inverter series, with efficiency of 98 % deliver maximum energy in all conditions Transformer-less design, advanced electronics and optimised internal connections reduce potential energy losses.

Balanced three-phase AC output ensures grid compliance at all times and precise MPP tracking at 99.9% in steady conditions and 99.8% in dynamic conditions enable the inverter to harvest all the energy of the PV modules.

The TLX inverter is designed for high performance. Integrating 1000 V input range, 250-800 V MPP range and multiple DC inputs with each their own individually regulated

MPP tracker, allows for more modules in a series and longer strings, while providing greater flexibility in the PV setup.

The TLX Pro series includes master inverter technology capable of controlling up to 100 inverters from a single inverter.

Likewise, the integrated webserver, which allows you to control, monitor and adjust your PV system from any computer, comes standard on the TLX Pro.

The TLX inverter series includes the Danfoss Smart Technologies: a combination of features, which makes the TLX inverters unique in the market:

EnergySmart™

Excellent MPPT Efficiency, 98 % conversion efficiency, 1000 V_{dc} AC power burst and an excellent cooling concept provides high yield and earlier return on investment. High voltage input and reduces losses on the DC side. Early start up and late stop of power production result in maximised yield while exact cooling minimizes energy losses.

DesignSmart™

A large number of independently regulated MPP trackers along with 1000 V_{dc} and asymmetrical layout options allows for endless layout possibilities. This huge flexibility makes installations from residential to large scale plants possible.

TrackSmart™

Advanced Digital Tracking algorithms with efficiency of 99.9 % creates conditions for accumulating the most energy possible, regardless of ambient conditions, physical obstacles or inclination challenges.

* ControlSmart™

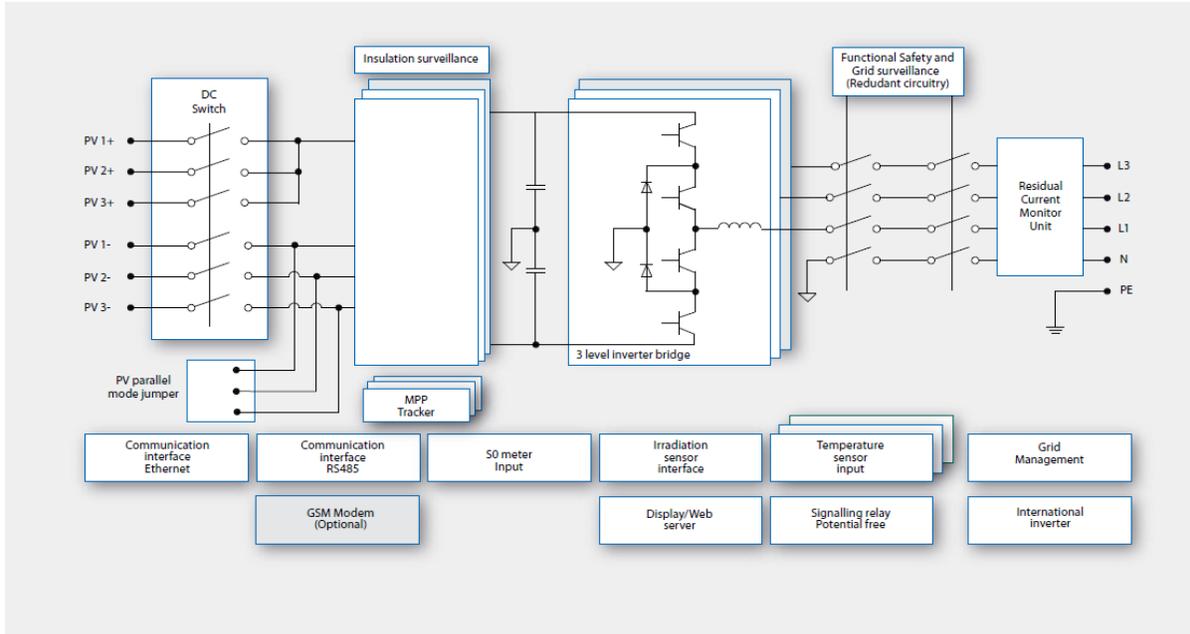
Integrated monitoring and control options through the Master inverter and Web server allows for; management of up to 100 inverters from a single inverter, accumulation of data from all inverters as well as overview of individual inverter parameters, from any computer. Integrated data logging of 34 days detailed and 20 years of accumulated data reduces the need for additional monitoring equipment.

* TLX Pro series only.

www.danfoss.com/solar

Description of inverter

External and internal inverter design



| Nomative References | TLX 6 kW | TLX 8 kW | TLX 10 kW | TLX 12.5 kW | TLX 15 kW |
|---------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------|
| Directive LVD | | | 2006/95/EC | | |
| Directive EMC | | | 2004/108/EC | | |
| Safety | | | IEC 62109-1/IEC 62109-2 | | |
| Integrated PV load switch | | | VDE 0100-712 | | |
| EMC immunity | | | EN 61000-6-1 | | |
| | | | EN 61000-6-2 | | |
| EMC emission | | | EN 61000-6-3 | | |
| | | | EN 61000-6-4 | | |
| Utility interference | | EN 61000-3-2/-3 | | EN 61000-3-11/-12 | |
| CE | | | Yes | | |
| Utility characteristics | | | IEC 61727 | | |
| | | | EN 50160 | | |
| S0 Energy Meter | | | EN62053-31 Annex D | | |
| Approvals & Certifications | | | For transformerless inverter | | |
| Germany | | | VDE 0126-1-1/A1 and VDE AR N 4105 (TLX+, TLX Pro+ only)* | | |
| Greece | | Technical requirements for the connection of independent generation to the grid, Public Power Corporation (PPC) | | | |
| Italy | - | | ENEL Guida Ed. 2.1. | | |
| Spain | | | RD1663 (2000) | | |
| | | | RD661 (2007) | | |
| Austria | | | TOR – Hauptabschnitt D4, TOR – Hauptabschnitt D2 | | |
| Belgium | | | Synergrid C10/11 – revise 12 mei 2009, Synergrid C10/17- revise 8 mei 2009 | | |
| Czech Republic | | | Czech Energy Act (Act No. 458/2000), Article 24, Paragraph 10 part I, II, III rev09 2009 | | |
| France | | | UTE NF C 15-712-1 (UNION TECHNIQUE DE L'ELECTRICITE, GUIDE PRATIQUE, Installations photovoltaïques raccordées au réseau public de distribution). NF C 15-100 (Installations électriques à basse tension). Journal Officiel, Décret n° 2008-386 du 23 avril 2008 relatif aux prescriptions techniques générales de conception et de fonctionnement pour le raccordement d'installations de production aux réseaux publics d'électricité | | |
| Germany | - | - | BDEW- Technische Richtlinie Erzeugungsanlagen am Mittelspannungsnetz Ausgabe, Juni 2008 und Ergänzungen von 01/2009, 07/2010, 02/2011 | | |
| Spain | REE BOE núm. 254 | | | | |
| Portugal | | | VDE 0126-1-1, ISO/IEC Guide 67: 2004 - System No.5 | | |
| UK | | | ER G83/1-1 (for 6k, 8k, 10k), ER G59/2-1 (for all models) | | |

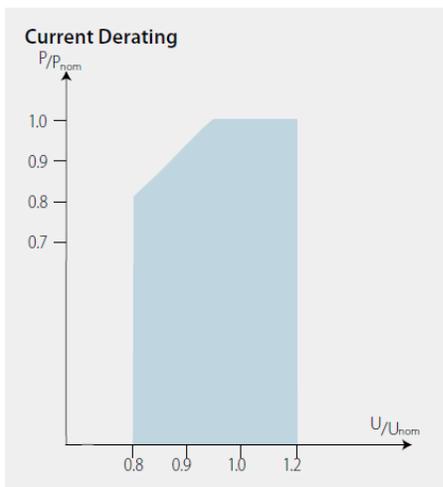
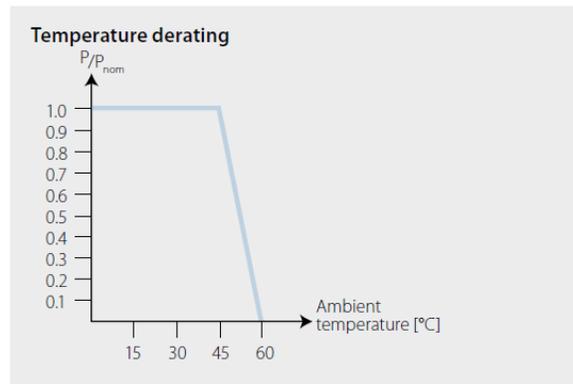
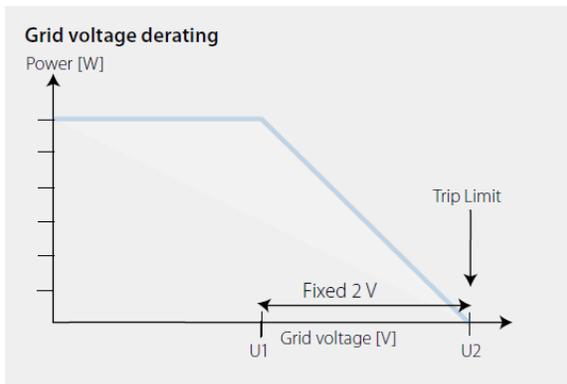
*Deviant from VDE 0126-1-1 section 4.7.1., the isolation resistance measurement limit is set to 200 kΩ, in accordance with authorities

Operating Efficiency

The operating efficiency specified for V_{MPPmax} , $V_{DC,r}$ and V_{MPPmin}

| TPPV/UPV | TLX 6 kW | | | TLX 8 kW | | | TLX 10 kW | | | TLX 12.5 kW | | | TLX 15 kW | | |
|----------|----------|-------|-------|----------|-------|-------|-----------|-------|-------|-------------|-------|-------|-----------|-------|-------|
| | 420 V | 700 V | 800 V | 420 V | 700 V | 800 V | 420 V | 700 V | 800 V | 420 V | 700 V | 800 V | 420 V | 700 V | 800 V |
| 5% | 88,2% | 89,6% | 87,5% | 88,2% | 90,9% | 88,1% | 87,3% | 90,4% | 89,1% | 89,5% | 92,2% | 91,1% | 91,1% | 93,4% | 92,5% |
| 10% | 91,8% | 92,8% | 91,4% | 92,4% | 92,8% | 92,6% | 90,6% | 92,9% | 92,5% | 92,1% | 94,1% | 93,8% | 93,1% | 94,9% | 94,6% |
| 20% | 93,6% | 94,4% | 94,5% | 95,0% | 96,5% | 95,8% | 94,4% | 96,0% | 95,6% | 95,2% | 96,6% | 96,3% | 95,7% | 97,0% | 96,7% |
| 25% | 94,3% | 95,1% | 95,3% | 95,5% | 96,9% | 96,5% | 95,2% | 96,6% | 96,3% | 95,8% | 97,1% | 96,8% | 96,2% | 97,4% | 97,1% |
| 30% | 94,9% | 95,8% | 96,0% | 95,9% | 97,2% | 96,9% | 95,7% | 97,0% | 96,7% | 96,2% | 97,4% | 97,1% | 96,5% | 97,6% | 97,4% |
| 50% | 96,4% | 97,6% | 97,4% | 96,4% | 97,7% | 97,5% | 96,6% | 97,7% | 97,5% | 96,9% | 97,9% | 97,7% | 97,0% | 98,0% | 97,8% |
| 75% | 96,6% | 97,8% | 97,7% | 96,4% | 97,8% | 97,8% | 96,9% | 97,8% | 97,8% | 97,0% | 97,8% | 97,8% | 96,9% | 97,8% | 97,7% |
| 100% | 96,7% | 97,8% | 97,9% | 96,4% | 97,8% | 97,9% | 97,1% | 97,9% | 97,9% | 97,0% | 97,8% | 97,9% | 96,9% | 97,7% | 97,9% |
| EU | 95,4% | 96,5% | 96,3% | 95,7% | 97,0% | 96,7% | 95,7% | 97,0% | 96,7% | 96,1% | 97,3% | 97,3% | 96,4% | 97,4% | 97,4% |

Derating



| | TLX 6 kW | TLX 8 kW | TLX 10 kW | TLX 12.5 kW | TLX 15 kW |
|-------------------------|--------------|--------------|---------------|---------------|---------------|
| PV current, per input | 12 A (+2%) | 12 A (+2%) | 12 A (+2%) | 12 A (+2%) | 12 A (+2%) |
| Grid current, per phase | 9 A (+2%) | 12 A (+2%) | 15 A (+2%) | 19 A (+2%) | 22 A (+2%) |
| Grid power, total | 6000 W (+3%) | 8000 W (+3%) | 10000 W (+3%) | 12500 W (+3%) | 15000 W (+3%) |

To avoid unintentional derating due to measurement inaccuracy, the values in brackets are added to the limits.



| Nomenclature ¹⁾ | Parameter | TLX Pro 6 k ⁶⁾ | TLX Pro 8 k | TLX Pro 10 k | TLX Pro 12.5 k | TLX Pro 15 k |
|----------------------------|------------------------------------------------|---------------------------------------|-------------|--------------|----------------|--------------|
| AC | | | | | | |
| $P_{ac,r}$ | Max./Nom. power AC | 6000 W | 8000 W | 10000 W | 12500 W | 15000 W |
| | Reactive power range | 0-3.6 kVAr | 0-4.8 kVAr | 0-6.0 kVAr | 0-7.5 kVAr | 0-9.0 kVAr |
| $V_{ac,r}$ | Rated output voltage | 3x 230 V | | | | |
| $V_{ac,min}, V_{ac,max}$ | AC voltage range (P-N) | 3x 230 V \pm 20% | | | | |
| | Nominal current AC | 3 x 9 A | 3 x 12 A | 3 x 15 A | 3 x 19 A | 3 x 22 A |
| $I_{ac,max}$ | Max. current AC | 3 x 9 A | 3 x 12 A | 3 x 15 A | 3 x 19 A | 3 x 22 A |
| | AC current distortion (THD %) | < 4% | < 4% | < 5% | < 5% | < 5% |
| $cosphi_{ac,r}$ | Power factor at 100% load | > 0.99 | | | | |
| | Controlled power factor range | 0.8 over-excited 0.8 under-excited | | | | |
| | "Connecting" power loss | 10 W | | | | |
| | Night-time power loss (off grid) | < 5 W | | | | |
| f_r | Rated grid frequency | 50 Hz | | | | |
| f_{min}, f_{max} | Grid frequency range | 50 \pm 5 Hz | | | | |
| DC | | | | | | |
| | Nominal power DC | 6200 W | 8250 W | 10300 W | 12900 W | 15500 W |
| | Max. recommended PV power at STC ²⁾ | 7100 Wp | 9500 Wp | 11800 Wp | 14700 Wp | 17700 Wp |
| $V_{dc,r}$ | Nominal voltage DC | 700 V | | | | |
| V_{mppmin}, V_{mppmax} | MPP voltage-nominal power ³⁾ | 260 - 800 V | 345-800 V | 430-800 V | 358-800 V | 430-800 V |
| | MPP efficiency | 99.9% | | | | |
| $V_{dc,max}$ | Max. DC voltage | 1000 V | | | | |
| $V_{dc,start}$ | Turn on voltage | 250 V | | | | |
| $V_{dc,min}$ | Turn off voltage | 250 V | | | | |
| $I_{dc,max}$ | Max. current DC | 2 x 12 A | | | 3 x 12 A | |
| | Max. short circuit current DC at STC | 2 x 12 A | | | 3 x 12 A | |
| | Min. on grid power | 20 W | | | | |
| Efficiency | | | | | | |
| | Max. efficiency | 97.8 % | 97.9% | 98 % | | |
| | Euro efficiency | 96.5 % | 97.0% | 97.0% | 97.3% | 97.4% |
| Other | | | | | | |
| | Dimensions (H, W, D) | 700 x 525 x 250 mm | | | | |
| | Mounting recommendation | Wall bracket | | | | |
| | Weight | 35 kg | | | | |
| | Acoustic noise level ⁴⁾ | 56 db(A) | | | | |
| | MPP tracker | 2 | | 3 | | |
| | Operation temperature range | -25..60 °C | | | | |
| | Nom. temperature range | -25..45 °C | | | | |
| | Storage temperature | -25..60 °C | | | | |
| | Overload operation | Change of operating point | | | | |
| | Overvoltage category AC | Class III | | | | |
| | Overvoltage category DC | Class II | | | | |
| | PLA ⁵⁾ | Included | | | | |
| | Reactive power | TLX+ and TLX Pro+ | | | | |
| | Relative humidity | 95% (non-condensing) | | | | |
| Functional Safety | | | | | | |
| | Safety (protective class) | Class I | | | | |
| | PELV on the communication and control card | Class II | | | | |
| | Islanding detection-loss of mains | Three-phase monitoring, ROCOF | | | | |
| | Voltage magnitude | Included | | | | |
| | Frequency | Included | | | | |
| | DC content of AC current | Included | | | | |
| | Insulation resistance | Included | | | | |
| | RCMU-Type B | Included | | | | |
| | Indirect contact protection | Yes (class I, grounded) | | | | |
| | Short circuit protection | Yes | | | | |

¹⁾ According to EN 50524: 2009

²⁾ For fixed systems with semi-optimal conditions

³⁾ At identical input voltages. At unequal input voltages V_{mppmin} can be as low as 250 V depending on total input power.

⁴⁾ SPL (Sound Pressure Level) at 1.5 m.

⁵⁾ Grid Management Box (TLX Pro, TLX Pro+) or 3rd party product

⁶⁾ Only TLX + and TLX Pro + variants

REFUsol 008K-020K

For medium-sized to megawatt installations



- Light & compact
- Highest efficiency (98.2%)
- Easy installation
- Outdoor (IP65)
- Maintenance free

The three-phase string inverters in the 8.25 to 19.2 kW power classes are perfect for rooftop systems from 8 kW upwards, right through to megawatt parks. They comply with all requirements for IP65 protection – their housing provides reliable protection from dust and water, including high pressure washing. These systems can therefore be installed out in the open without any problem. All five string inverters are **easy to handle and compact**. For example, they can be installed on an area smaller than three A4 pages laid side by side. Operation and monitoring are easy, further facilitated by the graphic display, the integrated RS485 interface and an Ethernet connection.

Fast MPP tracking and a wide input voltage range also ensure the high levels of efficiency that are typical in REFUsol systems. Even at low irradiation, the three-phase inverters

achieve an **efficiency of up to 98.2%**. As a result of these high efficiency levels convection cooling is all that's needed to dissipate the heat. Thanks to the low voltage fluctuations against earth, the transformerless devices can also be used for many thin-film modules.

The integrated data-logger can send all important operating data to the REFUlog internet portal. For visualization and evaluation purposes, data can be transferred via the standard cable or an optional wireless connection using the new REFUconnect radio module. Comprehensive information on operating conditions and the productivity of your plant is available at any time.



Also available as UL model

| TECHNICAL DATA | REFUso/008K | REFUso/010K | REFUso/013K | REFUso/017K | REFUso/020K |
|-----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Art. no. | 803R008 | 803R010 | 802R013 | 802R017 | 802R020 |

| DC DATA | | | | | |
|--------------------------------|-------------|-------------|-------------|-------------|-------------|
| Recommended max. PV power, kWp | 9.3 | 11.2 | 13.9 | 18.5 | 21.6 |
| MPPT range, V | 370 ... 850 | 410 ... 850 | 420 ... 850 | 445 ... 850 | 480 ... 850 |
| DC start voltage, V | 350 | | | | |
| Max. DC voltage, V | 1000 | | | | |
| Max. DC current, A | 23 | 25 | 30 | 38.5 | 41 |
| MPP tracker | 1 | | | | |
| Number of DC connections | 3 x MC4 | 3 x MC4 | 4 x MC4 | 6 x MC4 | 6 x MC4 |
| DC disconnection switch | Yes | | | | |

| AC DATA | | | | | |
|--------------------------------|-----------------------|--------|----------|--------|--------|
| Rated AC power, kVA | 8.25 | 10.0 | 12.4 | 16.5 | 19.2 |
| Max. AC active power, kW | 8.25 | 10.0 | 12.4 | 16.5 | 19.2 |
| AC grid connection | 3AC 400V + N, 50–60Hz | | | | |
| Rated power factor | 1 | | | | |
| Adjustable displacement factor | 0.9i ... 1 ... 0.9c | | | | |
| Max. AC current, A | 3 x 12 | 3 x 18 | 3 x 18.5 | 3 x 29 | 3 x 29 |
| Distortion factor THD, % | < 2.5 | < 1.8 | < 1.8 | < 1.8 | < 1.8 |
| Max. efficiency, % | 98.0 | 98.0 | 98.0 | 98.2 | 98.2 |
| European efficiency, % | 97.3 | 97.4 | 97.5 | 97.8 | 97.8 |
| Feed-in starting power, W | 20 | | | | |
| Nighttime power consumption, W | < 0.5 | | | | |

| COOLING, AMBIENT CONDITIONS, EMC | |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Cooling | Natural convection |
| Ambient temperature, °C | -25 ... +55 |
| Elevation | Up to 2000m above sea level |
| Noise, dBA | < 45 |
| Emitted interference | EN 61000-6-4:2007 |
| Interference immunity | EN 61000-6-2:2005 |
| Internal overvoltage protection, type | 3 (acc. to EN 61643-11) |
| Protection class | I (acc. to IEC 62103) |
| Overvoltage category | DC: II, AC: III (acc. To IEC 60664-1) |
| Environment classification | 4K4H acc. to DIN IEC 721-3-4 |
| Certification | Current certificates can be found at http://europe.refusol.com/certifications.pdf |
| SZS or grid protection | Acc. to VDE 0126-1-1 |
| Interfaces | Ethernet & RS485 |

| GENERAL DATA | | | | | |
|-----------------------------------|----------------------|-------------|-------------|-------------|-------------|
| Type of protection | IP65 as per EN 60529 | | | | |
| Dimensions Width/Height/Depth, mm | 535/601/225 | 535/601/225 | 535/601/277 | 535/601/277 | 535/601/277 |
| Weight, kg | 28.5 | 28.5 | 35.5 | 41.5 | 41.5 |

Subject to modification. Technical specifications are subject to change without notice.

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REFUso/008-020K_Datasheet_EN-V06-20130314

Thank You for Choosing Switch Solar