# The Solar Water Pumping System



# PROJECT FINAL REPORT

## Prepared by

NEGAWATT
Energy & Industrial Engineers

P.O. Box 20117, Lilongwe, Biwi, Along Chidzanja Road. Email: info@negawattmw.com; negawattengineers@gmail.com
Website: http://www.negawattmw.com; Facebook: http://www.facebook.com/negawattengieers

## Prepared for

Don Bosco Youth Technical Institute

Lilongwe, Malawi

**Brown**
Project Supervisor (EEE)

**Patrick**
Project Engineer (RETs)

**Ackim**
Project Technician (EEE)

**26th June 2026**

## Acknowledgement

Negawatt Energy & Industrial Engineers is pleased to acknowledge an uncommon co-operation and support received at Don Bosco Youth Technical Institution in Lilongwe during the Solar Water Pumping System project.

The company would also like to acknowledge *Father J. Musonda* and *Mr. Saulos,* who facilitated various stages of the project out of passion and sincerity, inspecting and verifying components of the project to ensure everything was going as planned, and where there was an amiss, promptly communicated to the teams.

Negawatt also recognizes the praiseworthy efforts by other Fathers, Brothers, staff *(more especially the wielding workshop department)* & the entire community who collaborated, whenever their advice, resources and services were required to expedite implementation of various aspects of the project.

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## Abstract

This report presents the building blocks of the Don Bosco Youth Technical Institution Water project conducted by Negawatt Energy & Industrial Engineers. The work spanned from 3rd February, 2026 up to 22nd May, 2026.The whole project involved a cordial collaboration of several key players from hydrologists, renewable energy engineers, plumbers, electrical and electronics engineers, technicians, welders and brick layers to reach such fruition. In this report, as will be seen, facts and informed metrics, were the plumbline for identifying winning concepts, starting from borehole drilling, solar panels orientation, construction of a tank tower, type and sizes of cables up to electronic equipment topologies, etc. In terms of product brands, the Product specifications have been presented in the Appendices.

# 1.0 Borehole Drilling & Development

Negawatt successfully drilled and developed a borehole using Air Rotary drilling method. Soil samples were taken at every rod in order to guide on the laying out of Pvc pipes as it is being shown in the figure below;



*Figure 1: Soil Samples*

The development took up eleven (11) Plain PVC pipes of diameter 125mm at the following depths, 0-12m, 15-24m, 36-50m while five (5) Perforated PVC were installed at the following depth, 12-15m, 24-36m; as shown below.



*Figure 2: Well construction (Casing)*

The table below presents the data for the drilled borehole

| Line Number | Description | Borehole Parameter |
|---|---|---|
| 1 | Borehole Depth | 50m |
| 2 | Static Water Level | 2.5m |
| 3 | Dynamic Water Level | 47.5m |
| 4 | Borehole Casing | 125mm |

*Figure 3: Table showing borehole parameters*

## 2.0 The Solar Hybrid Water Pumping System

Generally speaking, solar water systems are reliable. The solar pumps require no fuel and minimal maintenance. Nevertheless, the system was installed to achieve versatility in a way that it has capability be powered by both solar power (DC) and alternative power source (Escom) in the form of AC, whenever the need arises. Up to four (4) High Voltage solar panels of a reliable brand (see Appendices), were installed on a rooftop facing northwards in order to absorb as much light as possible, to supply the generated power to the pump via a dedicated rugged Grundfos CU200 controller.



*Figure 4: The Installed Solar Panels*



*Figure 5: Hybrid pump & controller*

Bearing in mind that all days are not Sundays (or sunny), a provision through a separate wiring was implemented by incorporating an alternative Grid power resource input. Below is a schematic of the standalone solar PV water pumping system.

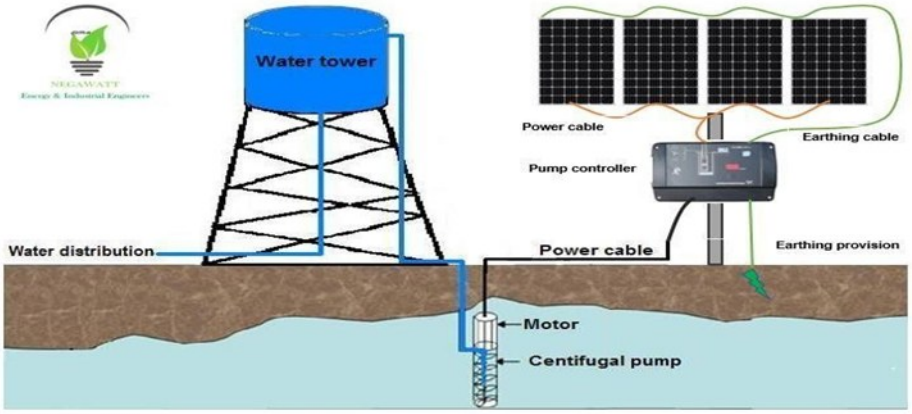



*Figure 6: The water system layout*

## 3.0 Water Storage System

The storage system comprises of two gigantic water tanks of 10,000L each, summing up to 20,000 litres. The tanks are sited on steel tank stand of 6 meters high that is sitting on 6 columns of IBeams, 100 x 50 x 5mm U channel, 80 x 80 x 6mm angle irons with reliable cross bands, strong enough to support its super structure. The foundation of the tower is made of y16 deformed bars. The base of the tower is made of strong concrete to make it easy for overflowing water from the tanks to find its way to the drainage system, thereby preventing water from sinking in to the base of the tower.



*Figure 7: Two water tanks on top of the constructed steel tank stand*

## 4.0 The Expected Yield Capacity

The expectation shows that the months from December up to early March are the lower water yielding months than the rest of the months. Ironically, this is a period associated with rainfall and higher groundwater levels. However, the lower water yield is associated with the power output from the installed four (4) solar panels. Provided there is a need, this can, of course, be turned around by boosting the power supply through a changeover provision so that the pump gets its supply from the Escom Grid power system. The predicted water yield achievable by the system was plotted as follows;

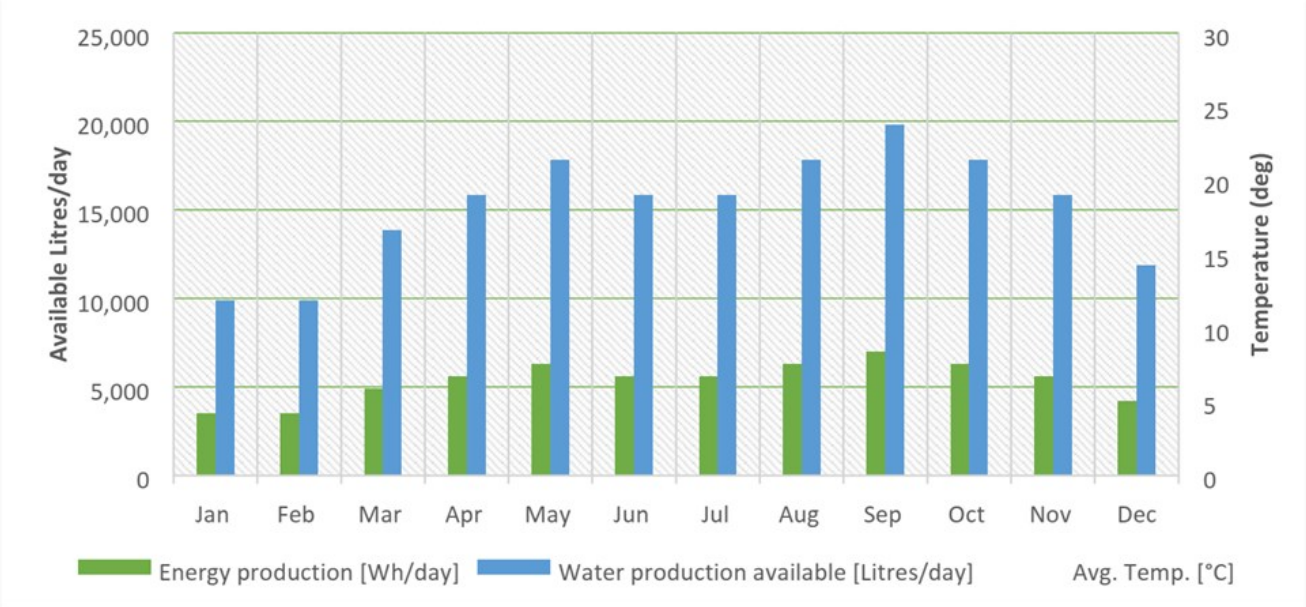



*Figure 5: Estimated yield capacity of the system (standalone solar)*

## 5.0 Pump Security

Following several reports of pumps being stolen from different water pumping systems, Negawatt came up with a solution to prevent reoccurrence of such incidents. Figure 9 below is a pump manhole with a secured anti-theft lockable steel flat sheet door.




*Figure 8: Inside the Pump Manhole*




*Figure 9: The secured Anti-theft concrete manhole*

## 6.0 Conclusion

This report has succinctly presented the outline of the main aspects of the Solar Water Pumping project. It gives much confidence, as substantiated by the plumbline of engineering facts employed herein, that the system continues to perform optimally for a very long time, as at the writing of this report. The users of the system were shown how to operate it, how to identify the minor fault alarms as well as how to look after the system.

In conclusion, the system has passed all design assessment criteria as governed by the Malawi Institution of Engineers (MIE) and MERA electrical/solar guidelines, whereby, the inevitable inspection of the system by the reinforcers will surely be a straightforward process. The Appendix (subsequent) gives more information about the project's building blocks.

**Authorised By:**

Signature: 

Name: **PATRICK WISDOM CHIPAO**

Position: **OPERATIONS DIRECTOR**

Date: **26/ 06/2026**
*DD/MM/YY*

Authorised for and on behalf of:

Company: **NEGAWATT ENERGY AND INDUSTRIAL ENGINEERS**

Address: P.O BOX 20117, LILONGWE, MALAWI



## 6.0 Specification of main components

### 6.1 Grundfos Hybrid Pump and Control Unit CU200

GRUNDFOS LENNTECH

GRUNDFOS **DATA BOOKLET**

**SQF 2.5-2 Rp 1 1/4 cpl.**

**Grundfos pump 95027330**



| Qty. | Description |
|---|---|
| 1 | **CU 200** |



**Note! Product picture may differ from actual product**

Product No.: On request

The CU 200 control unit is a combined status, control and communication unit especially developed for the SQFlex system. Furthermore, the CU 200 enables connection of a level switch.

The CU 200 incorporates cable entries for ...
-power supply connection,
-pump connection,
-earth connection,
-level switch connection.

Communication between the CU 200 and the pump takes place via the pump power supply cable. This is called mains borne signalling (or Power Line Communication), and this principle means that no extra cables between the CU 200 and the pump are required.

It is possible to start, stop and reset the pump by means of the on/off button.

The CU 200 control unit offers:
-System monitoring
-Alarm indication.

The following indications allow the operation of the pump to be monitored:
-Water reservoir is full (level switch)
-Pump is running
-Input power.

The CU 200 offers the following alarm indications:
-Dry running
-Service needed in case of:
- no contact to pump
- overvoltage
- overtemperature
- overload.

-Insufficient energy supply.

In addition, the CU 200 shows the symbols of the energy supply options.

**Technical:**

| | |
|---|---|
| Approvals on nameplate: | CE |

**Installation:**

| | |
|---|---|
| Range of ambient temperature: | 30 .. 50 °C |
| Relative humidity: | 95 % |

**Electrical data:**

| | |
|---|---|
| Power consumption: | 5 W |
| Rated voltage ac: | 1 x 90-240 V |
| Rated voltage dc: | 30-300 V |
| Enclosure class (IEC 34-5): | IP55 |

**Others:**

| Position | Qty. | Description |
|---|---|---|
| | 1 | **SQF 2.5-2** |



Note! Product picture may differ from actual product

Product No.: On request
The 3" SQFlex pump with helical rotor is for high heads and low flow rates.

The SQFlex system is a reliable water supply system based on renewable energy sources, such as solar and wind energy.
Thanks to its flexible energy supply and performance, the SQFlex system can be combined and adapted to meet any need on the installation site.

The SQFlex system has a wide voltage range, built-in maximum power point tracking (MPPT) as well as dry-running, voltage and overload protection.

**Liquid:**

| | |
|---|---|
| Pumped liquid: | Water |
| Maximum liquid temperature: | 40 °C |
| Liquid temperature during operation: | 20 °C |
| Density: | 998.2 kg/m³ |

**Technical:**

| | |
|---|---|
| Approvals on motor nameplate: | CE,RCM,EAC |
| Approvals on pump nameplate: | CE,EAC |

**Materials:**

| | |
|---|---|
| Pump: | Stainless steel<br>DIN W.-Nr. 1.4301<br>AISI 304 |
| Impeller: | DIN W.-Nr. 1.4301 |

**Installation:**

| | |
|---|---|
| Maximum ambient pressure: | 15 bar |
| Pump outlet: | Rp 1 1/4 |
| Minimum borehole diameter: | 76 mm |

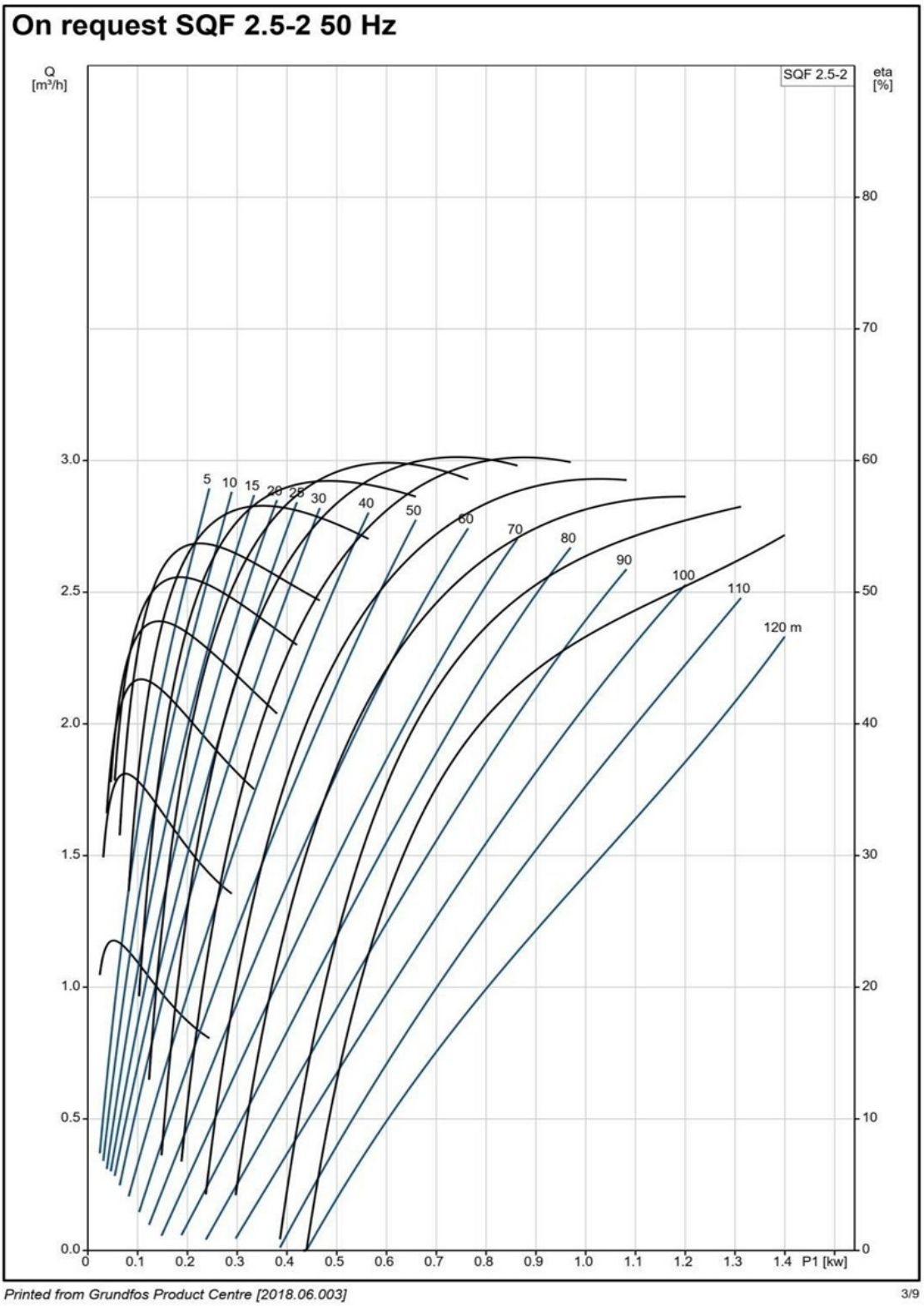
**Electrical data:**

| | |
|---|---|
| Motor type: | MSF3 |
| Power input - P1: | 1.4 kW |
| Rated voltage ac: | 1 x 90-240 V |
| Rated voltage dc: | 30-300 V |
| Rated current: | 8.4 A |
| Power factor: | 1.0 |
| Rated speed: | 500-3600 rpm |
| Start. method: | direct-on-line |
| Enclosure class (IEC 34-5): | IP68 |
| Insulation class (IEC 85): | F |
| Length of cable: | 2 m |
| Udc: | 300 V<br>30 V |

**Others:**
Minimum efficiency index, MEI ≥: -.--

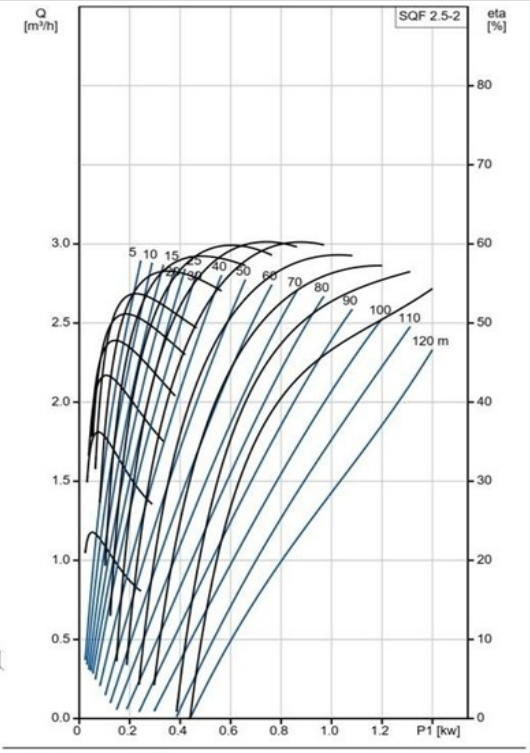
*Printed from Grundfos Product Centre [2018.06.003]* 1/9

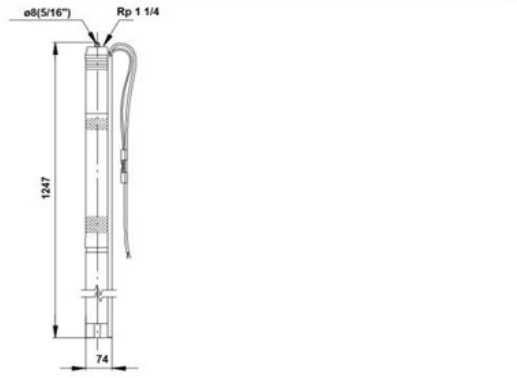
## On request SQF 2.5-2 50 Hz

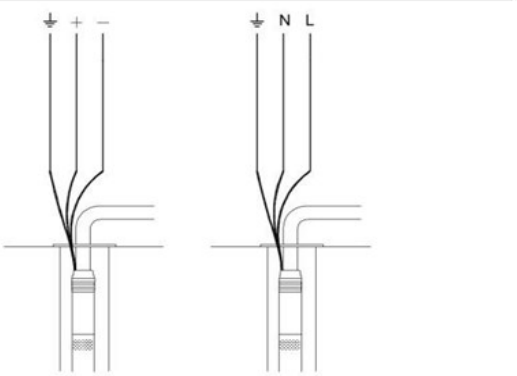



*Printed from Grundfos Product Centre [2018.06.003]* 3/9

| Description | Value |
|---|---|
| **General information:** | |
| Product name: | SQF 2.5-2 |
| Product No: | On request |
| EAN number: | On request |
| **Technical:** | |
| Stages: | 2 |
| Approvals on motor nameplate: | CE,RCM,EAC |
| Approvals on pump nameplate: | CE,EAC |
| Pump No: | 95027414 |
| Valve: | pump with built-in non-return valve |
| **Materials:** | |
| Pump: | Stainless steel |
| | DIN W.-Nr. 1.4301 |
| | AISI 304 |
| Impeller: | DIN W.-Nr. 1.4301 |
| Rotor: | Stainless steel |
| | DIN W.-Nr. 1.4301 |
| | AISI 304 |
| Stator: | Stainless steel / EPDM |
| | DIN W.-Nr. 1.4301 |
| | AISI 304 |
| **Installation:** | |
| Maximum ambient pressure: | 15 bar |
| Pump outlet: | Rp 1 1/4 |
| Minimum borehole diameter: | 76 mm |
| **Liquid:** | |
| Pumped liquid: | Water |
| Maximum liquid temperature: | 40 °C |
| Liquid temperature during operation: | 20 °C |
| Density: | 998.2 kg/m³ |
| **Electrical data:** | |
| Motor type: | MSF3 |
| Power input - P1: | 1.4 kW |
| Rated voltage ac: | 1 x 90-240 V |
| Rated voltage dc: | 30-300 V |
| Rated current: | 8.4 A |
| Power factor: | 1.0 |
| Rated speed: | 500-3600 rpm |
| Start. method: | direct-on-line |
| Enclosure class (IEC 34-5): | IP68 |
| Insulation class (IEC 85): | F |
| Motor protec: | Y |
| Thermal protec: | internal |
| Length of cable: | 2 m |
| Motor No: | 96275336 |
| Udc: | 300 V |
| | 30 V |
| **Others:** | |
| Minimum efficiency index, MEI ≥: | -.-- |
| Net weight: | 10.2 kg |
| Gross weight: | 11.3 kg |
| Shipping volume: | 0.024 m³ |
| Sales region: | Europe/South America/Japan |






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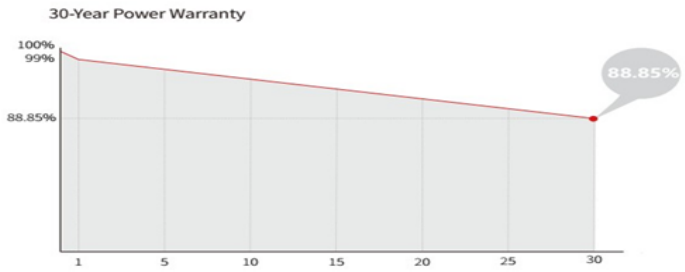
## 6.2 Solar Panels

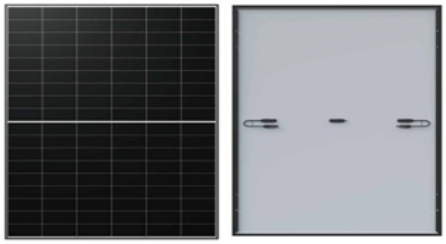
# Hi-MO X10 Explorer

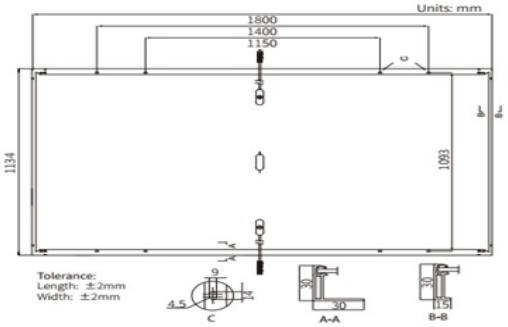
## LR7-54HVH 475~490M

| 24.0% | 0~3% | <1% | 0.35% | BC-CELL |
|---|---|---|---|---|
| MAX MODULE EFFICIENCY | POWER TOLERANCE | FIRST YEAR POWER DEGRADATION | YEAR 2-30 POWER DEGRADATION | LOWER OPERATING TEMPERATURE |

### Additional Value






### Mechanical Parameters

| | |
|---|---|
| Cell Orientation | 108 (6×18) |
| Junction Box | IP68, three diodes |
| Output Cable | 4mm², +400, -200mm/±1200mm length can be customized |
| Glass | Single glass, 3.2mm coated tempered glass |
| Frame | Anodized aluminum alloy frame |
| Weight | 21.6kg |
| Dimension | 1800×1134×30mm |
| Packaging | 36pcs per pallet / 216pcs per 20' GP / 864pcs per 40' HC |

### Electrical Characteristics

STC : AM1.5 1000W/m² 25°C NOCT : AM1.5 800W/m² 20°C 1m/s Test uncertainty for Pmax: ±3%

| Module Type | LR7-54HVH-475M | | LR7-54HVH-480M | | LR7-54HVH-485M | | LR7-54HVH-490M | |
|---|---|---|---|---|---|---|---|---|
| Testing Condition | STC | NOCT | STC | NOCT | STC | NOCT | STC | NOCT |
| Maximum Power (Pmax/W) | 475 | 362 | 480 | 365 | 485 | 369 | 490 | 373 |
| Open Circuit Voltage (Voc/V) | 40.18 | 38.18 | 40.29 | 38.29 | 40.40 | 38.39 | 40.52 | 38.51 |
| Short Circuit Current (Isc/A) | 15.03 | 12.08 | 15.13 | 12.16 | 15.23 | 12.24 | 15.33 | 12.32 |
| Voltage at Maximum Power (Vmp/V) | 33.16 | 31.52 | 33.28 | 31.63 | 33.40 | 31.74 | 33.51 | 31.85 |
| Current at Maximum Power (Imp/A) | 14.33 | 11.49 | 14.43 | 11.57 | 14.53 | 11.65 | 14.63 | 11.73 |
| Module Efficiency(%) | 23.3 | | 23.5 | | 23.8 | | 24.0 | |

### Operating Parameters

| | |
|---|---|
| Operational Temperature | -40°C ~ +85°C |
| Power Output Tolerance | 0 ~ 3% |
| Maximum System Voltage | DC1500V (IEC) |
| Maximum Series Fuse Rating | 25A |
| Nominal Operating Cell Temperature | 45±2°C |
| Protection Class | Class II |
| Fire Rating | IEC Class C |

### Mechanical Loading

| | |
|---|---|
| Front Side Maximum Static Loading | 5400Pa |
| Rear Side Maximum Static Loading | 2400Pa |
| Hailstone Test | 25mm Hailstone at the speed of 23m/s |

### Temperature Ratings (STC)

| | |
|---|---|
| Temperature Coefficient of Isc | +0.050%/°C |
| Temperature Coefficient of Voc | -0.200%/°C |
| Temperature Coefficient of Pmax | -0.260%/°C |

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Specifications included in this datasheet are subject to change without notice.
LONGi reserves the right of final interpretation. (20241118 BGV02 Draft)

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## 6.3 Pholtovotaic (DC) Cable

### CHARACTERISTICS OF PHOTOVOLTAIC CABLES



### PHOTOVOLTAIC CABLES

Whether it is an off-grid application or a grid connected PV-System, our cables meet the same high expectations that are demanded from the solar modules, **which are a long service life and high weather/UV resistance.**

Our double insulated, XLPO cables meet the highest requirements for solar cables in the most important photovoltaic markets of Asia & the Middle East and can be used unrestrictedly as a module or connecting cable.

### ADVANTAGES

- BS EN 50618 & BS EN 60228 compliance
- XLPO compounds
- UV, weather resistant
- High temperature resistance upto 120°C for 20,000 hours maximum so they do not melt or flow
- Very long service life, good cold flexibility
- Compatible to all popular connectors

*We reserve the right to make technical modifications.*

FastGreen

## HALOGEN FREE
## FLAME RETARDANT



### Applications

- Double insulated, XLPO cables for photovoltaic power applications

### Construction

| | |
|---|---|
| Conductor | Tinned fine copper strands acc. to IEC 60228, Class 5 |
| Insulation | XLPO, flame retardant, halogen free |
| Jacket | XLPO, flame retardant, halogen free, UV and weather resistant |
| Jacket colour | Black |

### Electrical Characteristics

| | |
|---|---|
| Rated value | 1500 V DC (max. permitted voltage 1800 V DC) |

### Thermal Characteristics

| | |
|---|---|
| Operating temperature | –40 °C up to +120 °C for 20000 hours maximum |
| Ambient temperature | –40 °C up to +90 °C |

### Bending Radius

| | |
|---|---|
| For fixed installation | > 4 × D |
| Occasionally moved | > 6 × D |

### Standards / Material Properties

- Fire performance: IEC 60332-1
- Smoke emission: IEC 61034; EN 61034-2
- Compliance standards: EN 50395, EN 50396, BS EN 50618



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# PHOTOVOLTAIC WIRE

## Single core Photovoltaic Wire



### Application

- XLPO/XLPO Single core PV cable meet the varying needs of the Solar Industry. Applications include connection to module junction boxes.

### Construction

- Conductor: Fully annealed flexible stranded tinned copper, Class 5 as per IEC 60228
- Insulation/Jacket (sheath): Low-Smoke, Zero-Halogen Cross-linked polyolefin

### Technical Data

- Rated Voltage: DC 1500 V
- Temperature Rating: -40 °C to +90 °C
- Bending Radius: 6 x D

| Nominal Cross Sectional Area of Conductor (mm²) | Mean Overall Diameter Sheathed Upper Limit Informative Value (mm) | Metal Coated Flexible Conductor Resistance Ω/Km Maximum at 20°C | Minimum Insulation Resistance at 20°C MΩ.Km | Minimum Insulation Resistance at 90°C MΩ.Km | Short Circuit Current Rating (KA) for 1 sec | PV Single Cable Current Rating in Air at 60°C (Amp) |
|---|---|---|---|---|---|---|
| 1x1.5 | 5.4 | 13.7 | 860 | 0.86 | 0.21 | 30 |
| 1x2.5 | 5.9 | 8.21 | 690 | 0.69 | 0.36 | 41 |
| 1x4 | 6.6 | 5.09 | 580 | 0.58 | 0.57 | 55 |
| 1x6 | 7.4 | 3.39 | 500 | 0.5 | 0.86 | 70 |
| 1x10 | 8.8 | 1.95 | 420 | 0.42 | 1.43 | 98 |
| 1x16 | 10.1 | 1.24 | 340 | 0.34 | 2.29 | 132 |
| 1x25 | 12.5 | 0.795 | 340 | 0.34 | 3.58 | 176 |
| 1x35 | 14 | 0.565 | 290 | 0.29 | 5.01 | 218 |

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