



## LARGE SUBMERSIBLE SOLAR PUMP KIT

### Description

The Large Submersible Solar Pump Kit is a 7.5kW pump set made up of pump end, motor, controller and accessories, and designed to give maximum flexibility according to borehole yield, daily water demand and available solar energy. The solar power requirement will be determined according to available solar energy (irradiation) as well as required flow and head.

The pump is fitted with a non-return valve on its outlet to prevent water from flowing back into the borehole when pump is switched off; nevertheless, it is recommended that an additional non-return valve be installed on the surface delivery pipe as default especially on long pipelines.

To ensure borehole sustainability and avert pump failure due to over pumping, the pumped output should not exceed 70% of the tested borehole yield, in other words if the borehole yield is 10m<sup>3</sup>/hr, the maximum abstraction will be 7m<sup>3</sup>/hr

For a solar scheme the size of the storage tank should be determined by the daily demand and should be large enough to store as much water as possible during sun hours. A tank that is at least 1.5 - 3 times the daily demand is recommended. Areas that have significant seasonal variations in irradiation (due to weather) the tank would be greater than in areas where there is less variation.

### Specification and Technical data

This is a stainless steel multi-stage centrifugal submersible pump fitted with an electric 7.5kW 3 phase AC motor with no electronics in the motor. At maximum power input, it has a rated flow of 8.5m<sup>3</sup>/hr at rated head of 140m, this varying according to actual power input and borehole conditions.

The pump is suitable for clean, chemically non-aggressive liquids without solids and fibres. The maximum permitted sand content is 50ppm, a higher sand content will reduce the pump life considerably due to wear.

An inverter converts incoming DC power from the PV array to AC power to power the AC pump motor. The inverter also outputs a variable frequency that allows the pump to run at variable speed depending on the available power supply from the PV modules. It also protects and monitors pump operation.

The fact that this pump is AC makes it versatile to be powered by an alternative energy source such as a diesel generator or grid power via a changeover switch.

### Performance Range & Curves

For ease of reference a simulation for pump performance at various power inputs at 4, 5 and 6 Peak Sun Hours has been done and the results summarised in table 1 below. As actual performance will depend on the actual irradiation, the table should only be used as an estimation guide. The table also gives the approximate equipment cost (pump, inverter, DC accessories, modules, cables and drop pipes) and the return on investment period (solar vs diesel).



#### Key Pump Parameters

Peak Flow:	5.5-12m <sup>3</sup> /hr
Head range:	80-180m
Max water temp:	+30°C
Min well diameter:	152mm



Lorentz PSK2-9 Inverter



Grundfos RSI 7.5kW Inverter

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The Oxfam KS820 kit comprises of 4 x 205W solar modules. Click [here](#) for more details

The 205W module was used to simulate the pump performances on table 1, and is of monocrystalline type with the below characteristics.

**Peak Voltage,  $V_{mp} = 37.4V$**   
**Open Circuit Voltage,  $V_{oc} = 45.8V$**   
**Short Circuit Current,  $I_{sc} = 5.9A$**

Module characteristic can easily be found on a sticker at the back of every module.

Equivalent modules can be used, in which case the voltage limits in series connection should be checked so as not to exceed 850VDC (Lorentz), 800V (Grundfos); and as far as possible maintain a minimum optimum  $V_{mp}$  of 575V (Lorentz), 530V (Grundfos).

**Caution!!** If using a Grundfos pump set, the total voltage in a series connection should not exceed 800 to avoid blowing up the inverter. Therefore, the module arrangement in table 1 should be changed to comply with this.

This document should be used together with: -

- ⇒ [Lorentz PSk2 Manual for Installation and Operation & Solar Pumping Planning Guide Lorentz manuals](#)
- ⇒ [Grundfos RSI Installation and Operation Manual Grundfos RSI 7.5kW Manuals](#)
- ⇒ [GSWI Solar Pump Manual](#)
- ⇒ [GSWI O&M kit](#)

**Special Note**

The PSk2-9 controller comes fitted with an internal DataModule for easy configuration and remote monitoring of the pumping system. Access to this feature must be done through the supplier of the system who **will provide access rights**. This feature is optional and does not need to be activated for the system to

**Table 1: Flow and head simulation for different power inputs**

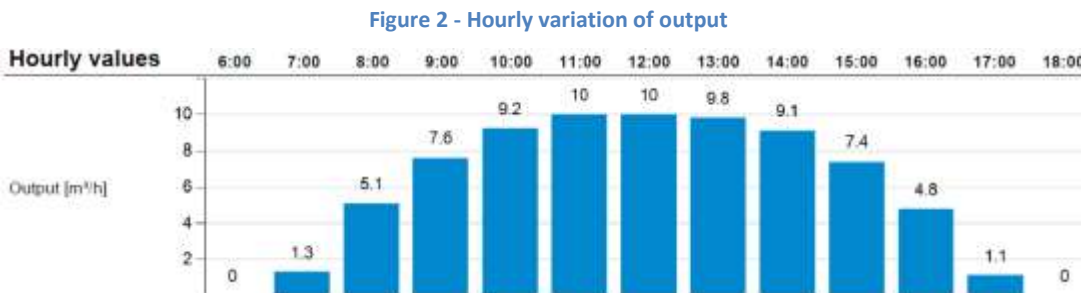
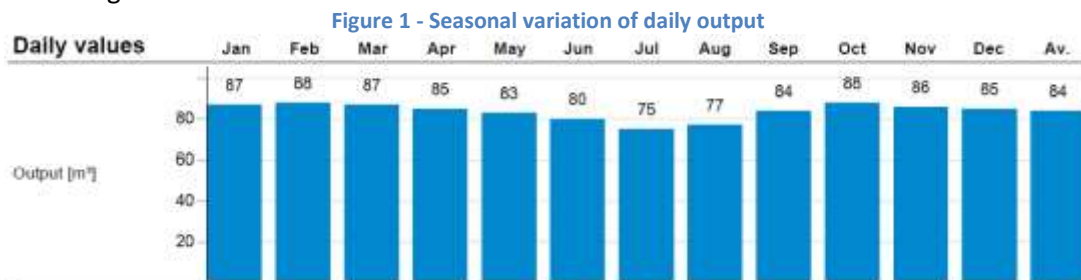
Solar PV Generator Size NB: One solar kit (Oxfam KS820) = 205W x 4 = 820W				8 Solar Kits (6560W)	10 Solar Kits (8200W)	13.5 Solar Kits (11,070W)	15 Solar Kits (12,300W)	17 Solar Kits (13,940W)	19 Solar Kits (15,580W)
Solar Module Wiring for Lorentz System				16 (series) x 2 (parallel) x 205W	20 (series) x 2 (parallel) x 205W	18 (series) x 3 (parallel) x 205W	20 (series) x 3 (parallel) x 205W	17 (series) x 4 (parallel) x 205W	19 (series) x 4 (parallel) x 205W
Installation area required [m <sup>2</sup> ]				55	68	92	103	116	130
Equipment cost (USD) <sup>1</sup>				\$19,700	\$21,800	\$25,600	\$27,300	\$29,400	\$31,600
Pay back period <sup>2</sup>				0.3 years	0.6 years	1.3 years	1.5 years	1.1 years	1.3 years
Peak Sun Hours [PSH]	Cable Size	Cable length [m]	Head [m]	Estimated Expected Flow at the above power inputs [m <sup>3</sup> /day]					
4	6mm <sup>2</sup>	100	80	37.0	49.0	69.0	77.0	83.0	89.0
	10mm <sup>2</sup>	150	130	-	-	44.0	50.0	58.0	67.0
		200	180	-	-	-	-	34.0	43.0
5	6mm <sup>2</sup>	100	80	44.0	57.0	77.0	84.0	94.0	101.0
	10mm <sup>2</sup>	150	130	-	34.0	52.0	59.0	67.0	76.0
		200	180	-	-	-	-	35.0	45.0
6	6mm <sup>2</sup>	100	80	56.0	72.0	94.0	102.0	109.0	113.0
	10mm <sup>2</sup>	150	130	33.0	46.0	67.0	75.0	86.0	92.0
		200	180	-	-	42.0	51.0	60.0	65.0

<sup>1</sup> South Sudan, 2018

<sup>2</sup> Assuming a diesel cost of \$1 per litre and a real interest rate of 10%

The appropriate PV power size should be selected from the table based on the performance required from the pump. For example, if the requirement is 75m<sup>3</sup>/day at 130m head in a location that has 6 Peak Sun Hours (e.g. Sanaa, Yemen and Lodwar, Kenya), going up and across the table (highlighted in blue) you will need 15 KS820 solar kits (12300W) i.e. 60\*205W modules wired 20 in series and 3 in parallel. Such a system would cost approximately \$27,300 (complete equipment only without installation) and compared to an equivalent diesel option will take 1.5 years to pay back its capital cost.

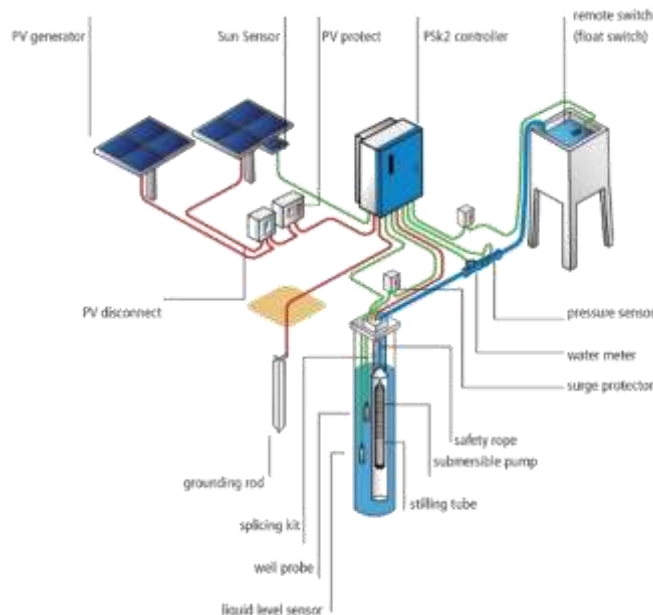
It should also be noted that the flow output will vary both by season and by time of day, according to variation of sunlight intensity. For this example, the projected seasonal and hourly variation is shown in Fig 1 & 2 below.



## Installation Considerations

- ⇒ For optimum performance, the modules should always face the equator (i.e. face south if in the northern hemisphere and face north if in the southern hemisphere) and should be mounted at a tilt equal to the latitude but not less than 15° for self-cleaning when it rains.
- ⇒ PV installation must be equipped with a PV disconnect switch between the Controller and the PV generator of min voltage rating 1000V DC and min current rating of 40A
- ⇒ The pump system must be fitted with a low-level sensor for dry run protection. A water tank level float switch can also be fitted for automatic control switching.
- ⇒ Install the controller close to the PV array to minimize cable length and cable losses on the input side and reduce the risk of lightning damage.
- ⇒ Install the pump above the main aquifer and within a plain casing to ensure efficient cooling of the motor and to keep the sand content in the water low. If this is not possible, fit the pump with a flow sleeve.
- ⇒ Mount the controller on a solid board/wall in a shaded, well ventilated location.
- ⇒ It is important for the system (pump, controller, PV generator) to be correctly grounded and earthed for safety of both the installation and users. Lightning protection should also be installed.
- ⇒ No other electrical load should be connected to the PV generator except the pump.
- ⇒ Check that the motor wires are in the right order to prevent reverse rotation of the motor which could damage the pump. The correct rotation direction for submersible pumps is counter-clockwise, viewed from the top.
- ⇒ Regularly clean the modules according to level of dirt.

## Installation Layout



## Kit Requirements

### Pump and Electrical Equipment

Line	Qty	Unit	Description
1	1	Pc	Lorentz C-SJ8-44 c/w 7.5kW AC motor <u>OR</u> Grundfos SP9-32 c/w 7.5kW AC motor
2	1	Pc	Lorentz PSk2-9 inverter <u>OR</u> Grundfos RSI 7.5kW inverter, 380-415V
3	1	Pc	PV disconnect switch 1000VDC/40A, 6 string
4	1	Pc	Surge protection unit, DC
5	1	Pc	Dry run sensor kit
6	1	Pc	Sun sensor <i>(for Lorentz system only)</i>
7	1	Pc	Float switch with 3m cable
8	1	Pc	10mm <sup>2</sup> cable splicing kit
9	200	Metres	6 or 10mm <sup>2</sup> Submersible Cable, 4-core - Refer to table 1 for size and length
10	200	Metres	0.75mm <sup>2</sup> low level sensor cable, 2-core
11	20	Metres	10mm <sup>2</sup> armoured cable, 4-core
12	40	Metres	1.5mm <sup>2</sup> armoured cable, 2-core
13	100	Metres	6mm <sup>2</sup> twin flat DC cabling
14	1	Lot	Copper earth rod and 6mm <sup>2</sup> copper earth cable, 10m
15	1	Lot	Lightning arrester and 6mm <sup>2</sup> copper earth cable, 10m
16	1	Pc	7.5kW electro mechanical control panel <i>(for Lorentz hybrid operation)</i>
17	1	Pc	40A AC Changeover switch <i>(for Lorentz and Grundfos hybrid operation)</i>

### Wellhead and Fittings

Line	Qty	Unit	Description
18	1	Pc	2" Wellhead Assembly for 6-8" borehole complete with cover plate, 90° bend, gate valve, inspection tee, junction box, pressure gauge connection, all Galvanised Iron
19	200	Metres	Flexible rising main, 2" complete, pump adaptor, well head adaptor and 6mm <sup>2</sup> SS safety Wire - change length according to pump installation depth
20	1	Pc	Pump to Flexible Rising main adaptor, 2", Stainless steel
21	1	Pc	Wellhead to flexible rising main adaptor, 2", Stainless steel
22	1	Pc	Elbow F-F, 90°, 2", Galvanised Iron
23	2	Pc	Hex Nipple, 2", Galvanised Iron
24	1	Pc	Ball Valve, 2" Galvanised Iron
25	2	Pc	Barrel Nipple, 2", 300mm long, Galvanised Iron
26	1	Pc	Bulk Water Meter, DN50, with pulse cable
27	Lot	Pc	Water meter fittings including flanges, rubber gasket, bolts, washers and nuts

### Solar Modules and Support Structure

Line	Qty	Unit	Description
28	Refer to table 1		Solar Panel kit, 820Wp - quantity according to required flow and head from table 1

## Hybrid Operation

The Pump system can be powered by an alternative AC power source in the following manner.

**Lorentz:** Hybrid operation is done through a separate AC electro mechanical control panel on the generator/grid power supply side, with a manual changeover to switch between DC and AC power. Alternatively, Lorentz can provide a fully automated changeover solution using the Lorentz smart PSUk2.

**Grundfos:** The Grundfos inverter is AC and DC compatible, meaning a separate AC control panel is not required on the AC side for hybrid operation. The Grundfos inverter is used for both DC and AC power supply, via a changeover switch.

**Caution!!** Make sure that AC and DC power are never supplied to the inverter simultaneously. An interlocked changeover switch MUST be installed for switching between DC and AC power supply.