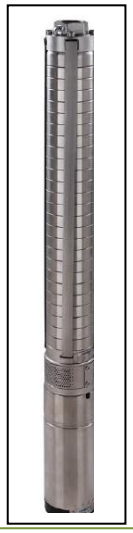
MEDIUM SUBMERSIBLE SOLAR PUMP KIT



Key Pump Parameters	
Peak Flow:	**3.5-7m3/hr**
Head range:	**60-140m**
Max water temp:	**+40^{0}C**
Min well diameter:	**110mm**

Lorentz PS2-4000 Controller

Grundfos RSI 4kW Inverter

Description

The Medium Submersible Solar Pump Kit is a 4kW 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 7m^3/hr, the maximum abstraction will be 4.9m^3/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.

Lorentz C-SJ5-25 – The pump is fitted with a ECDRIVE 4000-C 4kW maintenance-free brushless DC motor with no electronics in the motor. The pump is connected to a PS2-4000 4kVA-D electrical controller that supplies DC power to the pump, controls, protects and monitors pump operation.

Grundfos SP5A-33- The pump is fitted with an electric 3kW 3 phase AC motor. A 4kw 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.

At maximum power input, the pump has a rated flow of 5m^3/hr at rated head of 120m, this varying according to actual power input and borehole conditions. When using the Grundfos model at 60m head, the pump should be throttled to increase the pumping head and bring the performance within an acceptable range for this pump.

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.

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).

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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 375VDC (Lorentz), 800V (Grundfos); and as far as possible maintain a minimum optimum V_{mp} of 238V (Lorentz), 530V (Grundfos).

Caution!! If using a Grundfos pump set, the module arrangement in table 1 should be changed to meet the power requirement and comply with Grundfos RSI voltage requirements stated above.

This document should be used together with: -

⇒ **Lorentz PS2 Manual for Installation and Operation & Solar Pumping Planning Guide** Lorentz manuals

⇒ **Grundfos RSI Installation and Operation Manual** Grundfos RSI 4kW Manuals

⇒ **GSWI Solar Pump Manual**

⇒ **GSWI O&M kit**

Special Note

The PS2-4000 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 function.

Table 1: Flow and head simulation for different power inputs

Solar PV Generator Size NB: One solar kit (Oxfam KS820) = 205W x 4 = 820W				3 Solar Kits (2460W)	4.5 Solar Kits (3690W)	6 Solar Kits (4920W)	7 Solar Kits (5740W)	9 Solar Kits (7380W)	12 Solar Kits (9840W)
Solar Module Wiring for Lorentz System				6 (series) x 2 (parallel) x 205W	6 (series) x 3 (parallel) x 205W	6 (series) x 4 (parallel) x 205W	7 (series) x 4 (parallel) x 205W	6 (series) x 6 (parallel) x 205W	6(series) x 8 (parallel) x 205W
Installation area required [m^2]				21	31	41	48	62	82
Equipment cost (USD) [1]				$9,200	$10,900	$12,600	$13,700	$16,000	$19,400
Pay back period [2]				0 years	0.15 years	0.4 years	0.6 years	0.9 years	1.5 years
Peak Sun Hours [PSH]	Cable Size	Cable length [m]	Head [m]	Estimated Expected Flow at the above power inputs [m^3/day]					
4	6mm^2	100	60	19.0	31.0	41.0	46.0	54.0	60.0
			100			27.0	32.0	39.0	45.0
	10mm^2	150	140	-	-	-	-	-	29.0
5	6mm^2	100	60	22.0	36.0	47.0	53.0	**60.0**	65.0
			100	-	-	31.0	37.0	43.0	49.0
	10mm^2	150	140	-	-	-	-	-	31.0
6	6mm^2	100	60	29.0	44.0	55.0	61.0	65.0	69.0
			100	-	-	39.0	45.0	49.0	53.0
	10mm^2	150	140	-	-	-	29.0	31.0	36.0

[1] South Sudan, 2018 [2] 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 60m^3/day at 60m head in a location that has 5 Peak Sun Hours (e.g. Bangui, CAR and Damascus, Syria), going up and across the table (highlighted in blue) you will need 9 KS820 solar kits (7380W) i.e 36*205W modules arranged 6 in series and 6 in parallel. Such a system would cost approximately $16,000 (complete equipment only without installation) and compared to an equivalent diesel option will take 0.7 years (8.5 months) 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.

Figure 1 - Seasonal variation of daily output

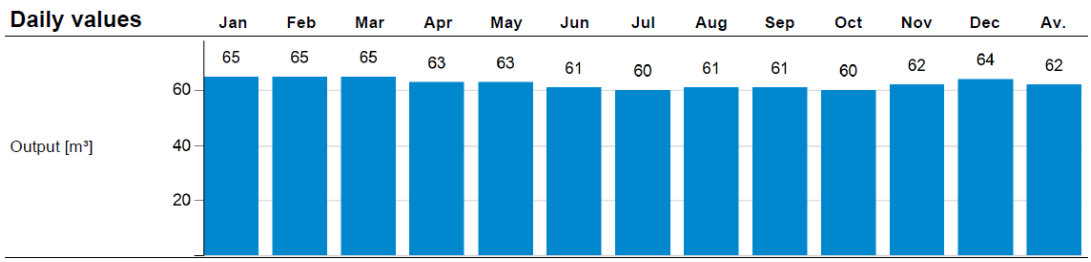
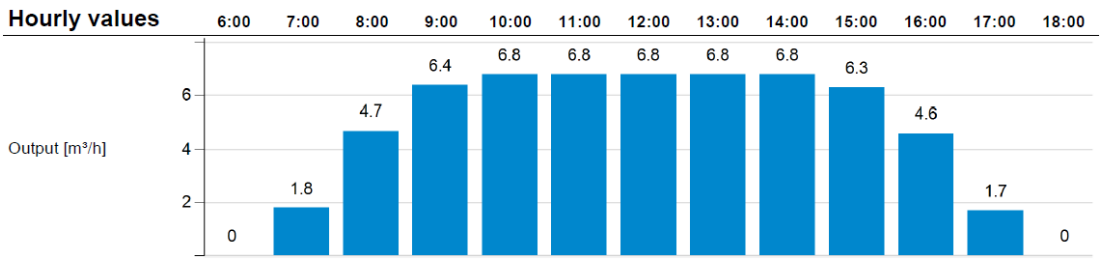


Figure 2 - Hourly variation of output



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^{0}C 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/current rating of 440V/20A (Lorentz), 1000V/40A (Grundfos)

⇒ 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.

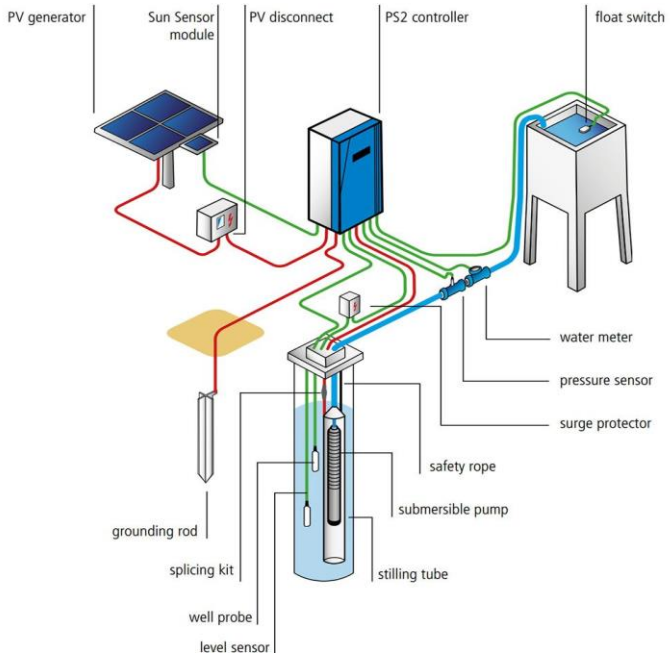
⇒ It is important for the system (pump, controller, PV generator) to be correctly grounded and earthed for safety of both the installation and users. Lightning protection should also be installed.

⇒ 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



Hybrid Operation

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

Lorentz: Hybrid operation is done through an AC-DC converter called a PowerPack that converts AC power from generator/grid power supply to DC, which then passes through the PS2 controller to the pump.

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.

Kit Requirements

Pump and Electrical Equipment

Line	Qty	Unit	Description
1	1	Pc	Lorentz C-SJ5-25c/w 4kW DC motor OR Grundfos SP5A-33 c/w 3kW AC motor
2	1	Pc	Lorentz PS2-4000 controller OR Grundfos RSI 4kW inverter, 380-415V
3	1	Pc	PV disconnect switch 440VDC/20A *(Lorentz),* 1000VDC/40A *(Grundfos),* 6 string
4	1	Pc	Surge protection unit, DC
5	1	Pc	Dry run sensor kit
6	1	Pc	Sun sensor *(for Lorentz system only)*
7	1	Pc	Float switch with 3m cable
8	1	Pc	10mm^2 cable splicing kit
9	150	Metres	6 or 10mm^2 Submersible Cable, 4-core - *Refer to table 1 for size and length*
10	150	Metres	0.75mm^2 low level sensor cable, 2-core
11	20	Metres	10mm^2 armoured cable, 4-core
12	40	Metres	1.5mm^2 armoured cable, 2-core
13	50	Metres	6mm^2 twin flat DC cabling
14	1	Lot	Copper earth rod and 6mm2 copper earth cable, 10m
15	1	Lot	Lightning arrestor and 6mm2 copper earth cable, 10m
16	1	Pc	Lorentz PP4000 AC PowerPack *(for Lorentz hybrid operation)*
17	1	Pc	20A AC Changeover switch *(for Grundfos hybrid operation)*

Wellhead and Fittings

Line	Qty	Unit	Description
18	1	Pc	1.5" Wellhead Assembly for 4-8" borehole complete with cover plate, 90^0 bend, gate valve, inspection tee, junction box, pressure gauge connection, all Galvanised Iron
19	150	Metres	Flexible rising main, 1.5" complete, pump adaptor, well head adaptor and 6mm^2 SS safety Wire - *change length according to pump installation depth*
20	1	Pc	Pump to Flexible Rising main adaptor, 1.5", Stainless steel
21	1	Pc	Wellhead to flexible rising main adaptor, 1.5", Stainless steel
22	1	Pc	Elbow F-F, 90^0, 1.5", Galvanised Iron
23	2	Pc	Hex Nipple, 1.5", Galvanised Iron
24	1	Pc	Ball Valve, 1.5" Galvanised Iron
25	2	Pc	Barrel Nipple, 1.5", 300mm long, Galvanised Iron
26	1	Pc	Bulk Water Meter, DN40, with pulse cable
27	1	Lot	Water meter installation fittings

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*