

SMART Centres

Small Solar Pumps

Manual for assembly and installation
Pump models ZL50-20N and ZL38-13N

Simple
Market based
Affordable
Repairable
Technologies

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This manual is for 2 small solar pump models (ZL38 and ZL50) that are fit for household use and small-scale irrigation. If water is used for drinking, make sure that water is treated with a point of use treatment like boiling, chlorine, or a good quality household water filter.

Selection and installation of solar pumps have details which can be best learned with practical training. Therefore, it is highly recommended to use this manual in combination with practical hands-on training that can be provided by a SMART Centre. Information see www.smartcentregroup.com

For other manuals on electric / submersible pumps see the website of the Jacana SMART centre; <https://jacana.help/resources/solar/> or www.smartcentrezambia.com

If you have observations or suggestions on this technology and or manual, please contact us at info@smartcentregroup.com. We intend to update this manual every year.

This manual is part of a range of SMART Centre manuals including:

Wells&Drilling

- Geology and site selection
- Well digging
- SHIPO drilling
- Mzuzu drilling
- Training of drilling companies. Business, financial and marketing planning

Pumps:

- Rope pump model 1 Standard model
- Rope pump model 2 Economy model
- Rope pump model 3 With wood poles
- Rope pump model 4 With 1 pole of Gi pipe
- Pump care-taker training
- EMAS pump

Water storage tanks

Groundwater recharge

Irrigation

Water treatment

Workshop skills

Business skills:

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Model ZL38-13N

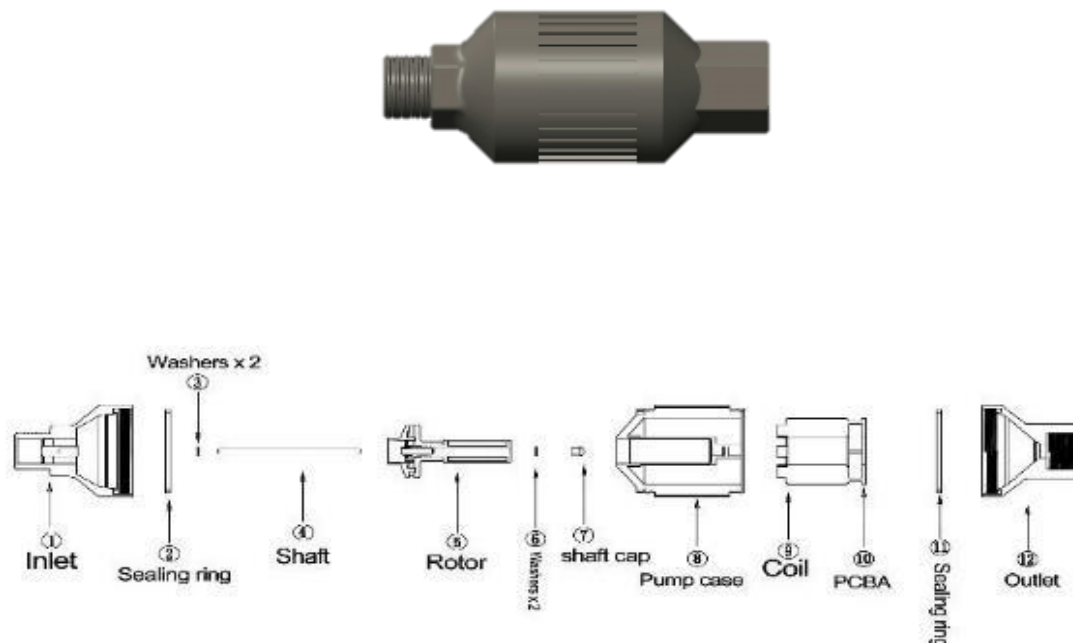


Figure 1. Parts of the pump, model ZL38-13N

Technical features model ZL38-13N

- Brushless DC pump
- Work environment; inline or submersible
- Maximum temperature of liquid: $\leq 70^{\circ}\text{C}$
- Functions with panels of 60 Watt - 12/18Volt
- Working voltage: 8-24 Volt DC
- Nominal voltage: 24 Volt DC
- Rated power: ca 25 Watt
- The pumps stop at: 30 Volt DC
- Pump lifetime: 10,000 – 20,000 hrs. (5 -10 years, with 5 hours of sun /day)
- Noise level: 50dB
- In- and outlet connection: $\frac{1}{2}$ "NPT
- Pump diameter: 54 mm, length 116 mm
- Minimum diameter casing, inside: 56 mm
- Can be installed vertical or horizontal
- Diameter outlet pipe: > 20mm (outside diameter)

Electric cable between panel and 1 pump:

- 1.5 mm² if length is < 30m
- 2.5 mm² if length is 30 to 50m
- 4 mm² if length is 50 to 90m

Performance/ maintenance

Max pump head 8 metres with 1 panel of 60 Watt (12/18 Volt)

Pump head and/or pump flow can be increased by adding an extra pump, see figure 2.

For each additional pump add 1 panel of 60 Watt and adjust the electric cable.

Prevent that pump runs dry.

To prevent dirt or sand entering the pump, mount a suction filter with a fine cloth.

Impeller and washers can be replaced

Datasheet ZL 38-13N

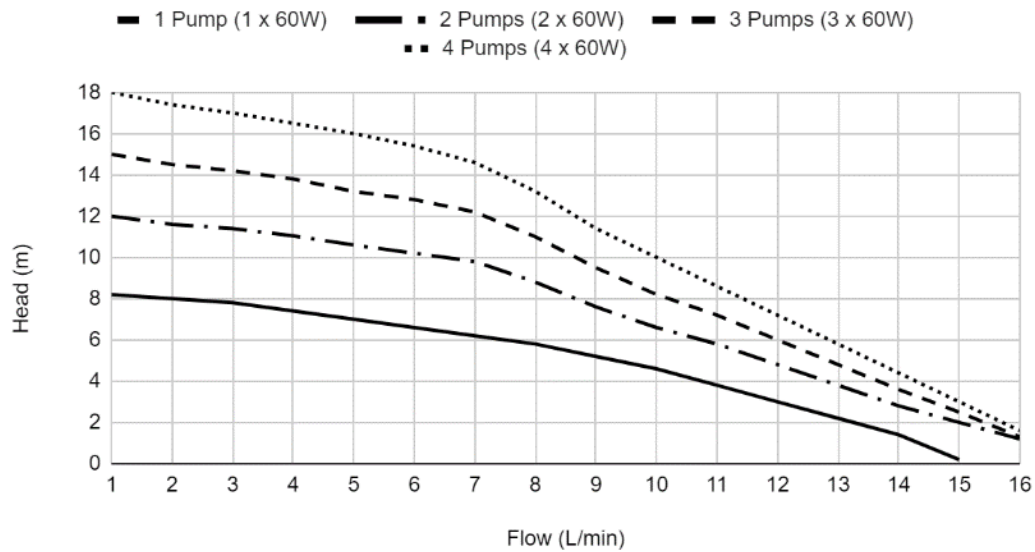


Figure 2; Curves with pump head and pump flow with pumps in series. Per pump 1 panel of 60Watt

Model ZL50-20N

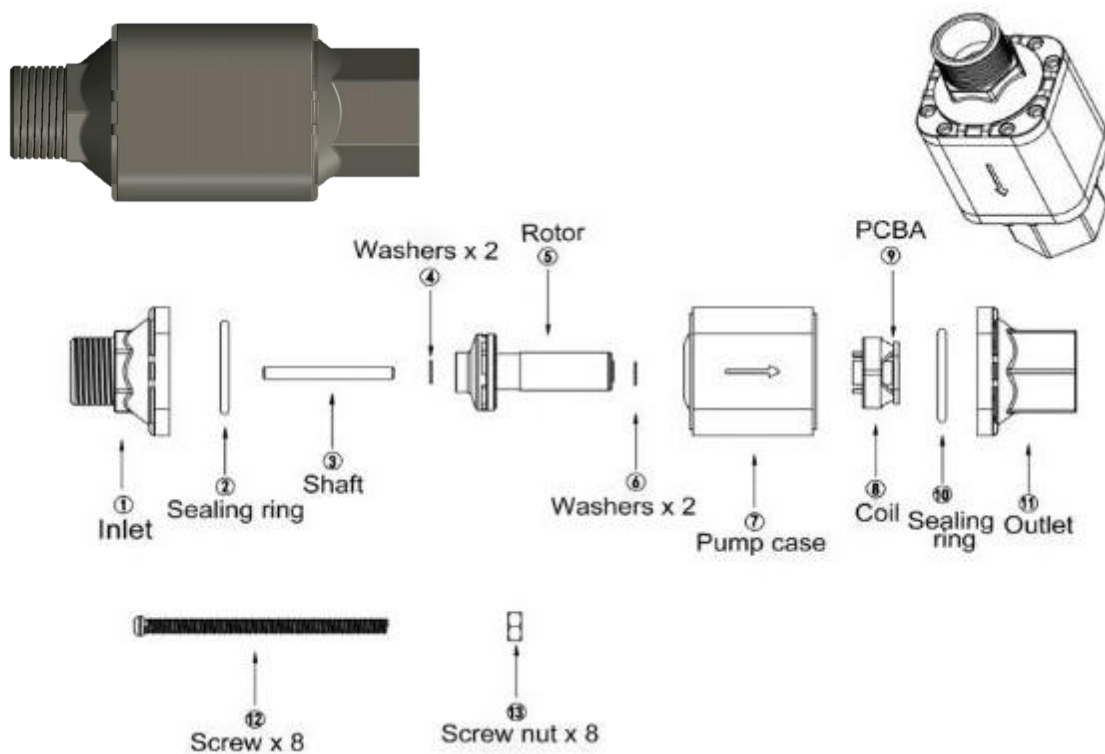


Figure 3: Parts of pump model ZL50-20N

Technical features Model ZL50-20N

- Brushless DC pump
- Work environment; inline or submersible
- Maximum temperature of liquid: $\leq 70^{\circ}\text{C}$
- Functions with panels of 100 Watt - 12/18Volt
- Working voltage range: 8-24 Volt DC
- Nominal voltage: 24 Volt DC
- Rated power/ pump: ca. 50 Watt
- Pump stops at: 30 Volt DC
- Pump lifetime: 10,000 – 20,000 hrs. (5 - 10 years with 5 hours of sun /day)
- Noise level: 50dB
- In and outlet connection: 1" NPT
- Dimensions: Diameter 63 mm. Length 146 mm
- Minimum inside diameter of the casing (borehole); 87 mm
- Can be installed vertical or horizontal
- Diameter outlet pipe; 25mm or more (outside diameter)

Electric cable size per pump:

- 2.5 mm² if length is < 30m
- 4 mm² with lengths of 30m to 50m
- 6 mm² with lengths of 50m to 70m

Performance/ maintenance

Max pump head ca 10 meters with 1 panel of 100 Watt (12/18 Volt)

Pump head and/or pump flow can be increased by adding an extra pump, see figure 4.

For each additional pump add 1 panel of 100 Watt and adjust the electric cable.

Prevent that pump runs dry.

To prevent dirt or sand entering the pump, mount a suction filter with a fine cloth.

Impeller and washers can be replaced

Datasheet ZL 50-20N

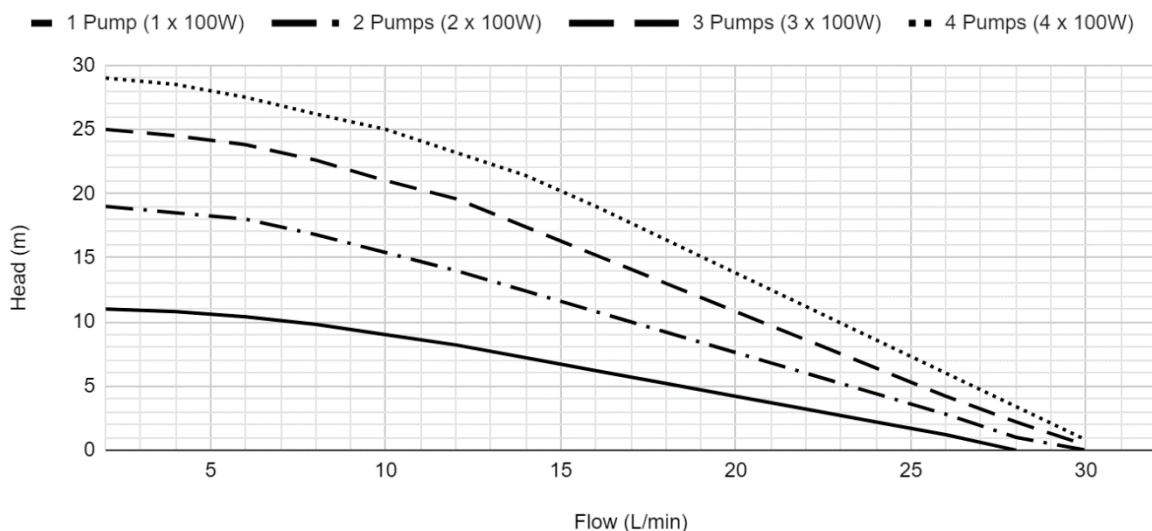


Figure 4. Pump curves for head and yield of pumps in series. Per pump 1 panel of 100Watt

Solar panels /electric system

- In general, the required solar panel output in Watt peak (Wp) must be 30% higher than the rated power of the installed pump(s). Also, to compensate partly cloudy weather it is recommended to choose a larger panel size.
 - The recommended panel size for model ZL 38-13N is 60 Wp.
 - The recommended panel size for model ZL 50-20N is 100 Wp.
- If you buy several panels make sure to buy identical panels (same brand, same features).
- Note that the power (Watt) indicated on a panel is often less than the real output in Watt
- If more brands of panels are available, find the most effective panel by testing several brands with the same pump configuration and compare head or flow.

Electric system

- Note that electric losses in cables with DC are much higher than with AC. Also, parts like switches need to be stronger for DC than for AC pumps
- To reduce the electric losses in the cable to a minimum, mount the panels as close as possible to the pump.
- Use good quality cable. Cheap cable may have a high resistance.
- The size of the cable (mostly measured in cross sectional area so in mm²) between pump and panel depends on the current and the length of the cable. With the indicated panels:
- one pump ZL 38-13N has a current of ca 1.7 Ampere.
- one pump ZL 50-20N has a current of ca 3 Ampere.
- The cable size can be found in Figure 5. This graph is created for pump models ZL50-20N and ZL38-13N with solar panels and based on a (low) loss of 2%. This may result in high cost for cables. If you allow a higher loss, for instance 4%, the cable can be 50% smaller.
- The required cable length is obtained by adding the horizontal distance of the solar panel to the borehole and the depth of the pump in the well or borehole.
- If two or more 12/18 Volt panels are used, they need to be connected in parallel.

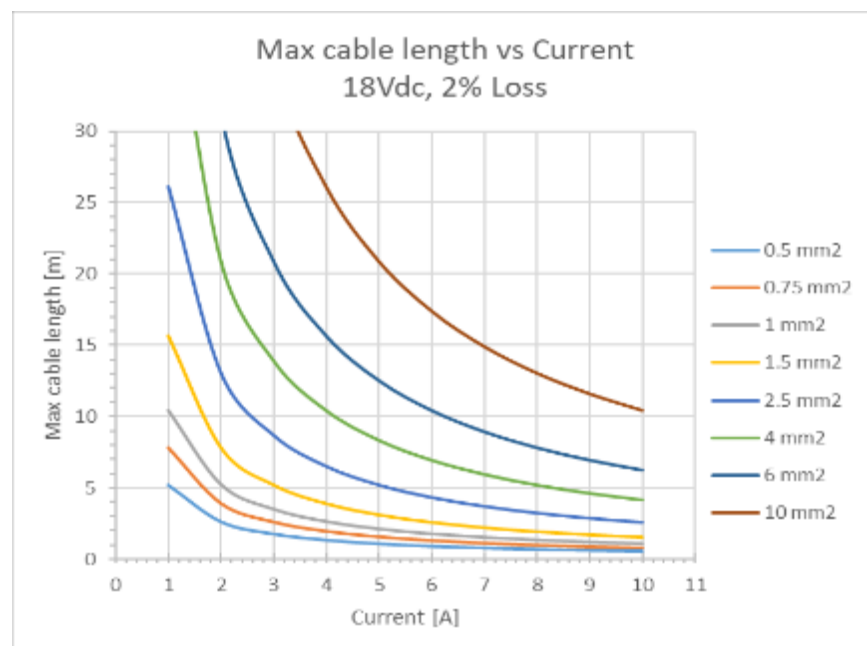


Figure 5: Maximal cable (wire) length per type of cable. The length is measured from pump to solar panel. Do not use cables of 0.5 or 0.75 mm²

Water source / pumps

If the source is a borehole, make sure that the pump will fit in the casing. Find out at what depth the filter screen (slotted casing) is installed and if possible, install the pump above the filter screen so that particles entering the casing will settle on the bottom and do not enter the pump. If it is an open well or river, make sure that the pump is installed at least 0.2m above the bottom. Avoid that dirt or sand will enter the pump.

Pump selection

This chapter describes the selection of the pump. An example is given later in this document.

To select the type of pump and the number of pumps in series find the following data:

1. Volume per day

What is the amount of water needed per day.

What is the number of sun-hours per day that the pump can work (if unknown, use 5 hours/day).

From this, calculate the required flow per minute.

2. The total pump head

The total pump head is calculated with:

$$\text{Total Pump Head} = \text{dynamic water level} + \text{height of pipe outlet} + \frac{\text{total length of pipe}}{x}$$

With the abbreviations used in Figure 6, the equation becomes:

$$\text{Total Pump Head} = H_{\text{dwl}} + H_{\text{out}} + \frac{H_{\text{pid}} + H_{\text{dwl}} + L_{\text{h}} + H_{\text{out}}}{x}$$

The factor x can be found in the following table¹:

Outlet pipe inner diameter	Model ZL38-13N (assumed flow: <12L/min)	Model ZL50-20N (assumed flow: <19L/min)
Ca 18mm (Pipe ½")	x ≈ 31	x ≈ 13
Ca 23mm (Pipe ¾")	x ≈ 91	x ≈ 40

Table 1: Friction based on inner pipe diameter and pump type. In general PVC pipes ½" and ¾" have an inside diameter of 18 and 23mm and an outside diameter of respectively 20 mm and 25 mm.

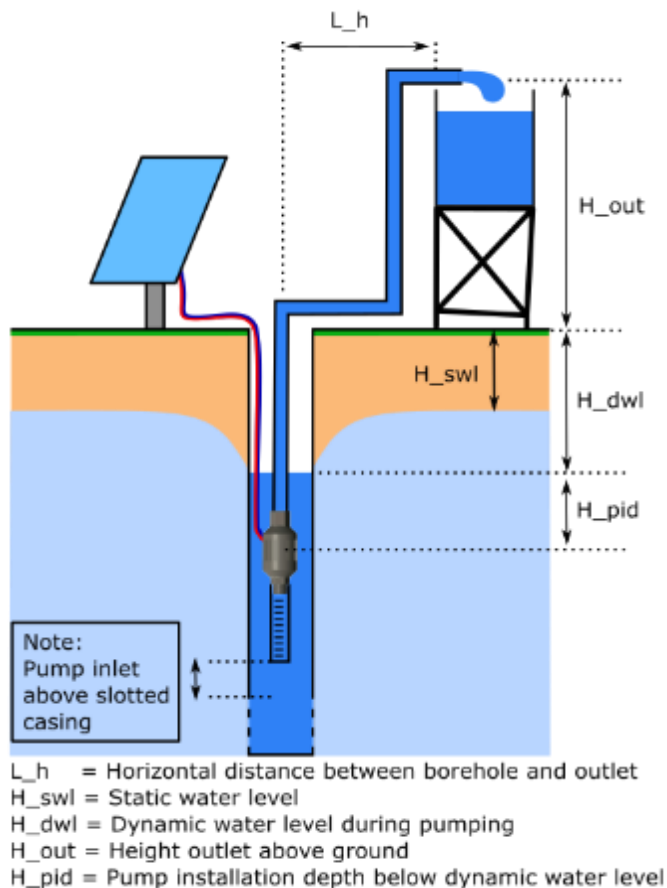
Non return valve

In general it is not needed to install a non return valve for these pumps. If the pumps stops water that flows back may somehow clean the filter (back washing) and it makes sure that the pump starts smoothly without having to push water in a full pump pipe.

Cautions:

- Never run the pump dry.
- Do not place the pump on the bottom of a pond or well to avoid dirt entering the pump.
- Do not use the electrical wire to lift the pump from a well.
- Make sure the outlet hose is free of kinks or folds.
- When pumping to a tank, make sure that the outlet of the pipe or hose is mounted at the top of the tank so that the water cannot syphon back when the pump is shut off.
- Do not allow children to play with the appliance.

¹ This is based on the flow the pumps can deliver at 3 meters of head. In most cases this is an over estimation: in reality, the pipe friction will be lower, and the yield higher. For an exact calculation of the pressure drop in pipes see: <http://www.pressure-drop.com/Online-Calculator>



The dynamic water level H_{dwl} is the depth of the water during pumping. If unknown, use the static water level H_{swl} (depth of water in well without pumping) and add: 0.5 meter for a high yield well and 5 meters for a low yield well.

Note 1: It is recommended to test the well with a (manual) pump before installing a solar pump! This prevents disappointments and work in case the borehole does not have sufficient recharge.

Note 2: Consider that the water table might fluctuate with seasons.

Figure 6: Pump installation and abbreviations.

Selection pump/ cable; example

This is an example to select the model and number of pumps with the following data

- Water volume per day; 3.000 litre
- The top of the storage tank; 6 meters high
- The depth of the dynamic water level; 7 meters.
- The horizontal distance from the well to the tank; 10 meters.

The client does not want a tank sensor. If the tank is full, the water will come out of the overflow and he will disconnect the pump manually.

Step 1: Calculate the pump flow

Assuming there are 5 hours of sun every day, then the pump flow is $3000/5 = 600 \text{ Litre/hour} = 600/60 = 10 \text{ Litre/minute}$.

Step 2: Calculate the pump head

To know the total pump head, add the dynamic water level, the height of the tank and 10% of the horizontal pipe so $7\text{m} + 6\text{m} + 1\text{m} = 14 \text{ meter}$.

Step 3: Pump model and number of pumps

To select a pump, we look at the pump curves of both models.

Select the flow of 10L/min on the horizontal axis, go up until you hit the pump curve and you find the corresponding pump head on the vertical axis.

Datasheet ZL 38-13N

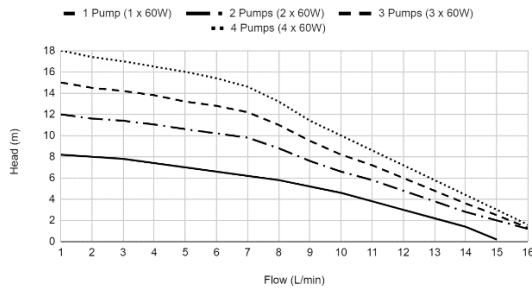


Figure 1: Pump curve of ZL38-13N

Datasheet ZL 50-20N

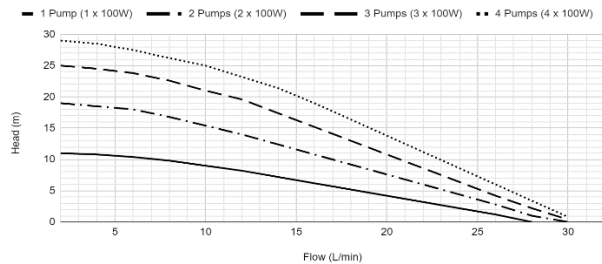


Figure 4 Pump curve of ZL50-20N

4 Pumps in series of model ZL38-13N has a pump head of 10 metre so not enough.
2 pumps in series of model ZL 50-20N has a pump head of 15 metre, so we select this

Step 4: Select cable size

With two pumps ZL50 and two panels in series the current is 6 Ampere.

If the solar panels are mounted 2 meters from the borehole, the cable length is the sum of the dynamic water level, the depth of the pump under water and the 2 meters distance

If the pump is 2 meters under water the total cable length is $7+2+2 = 11$ meters.

In figure 10 we find that if we allow 2% of loss, the cable size at a length of 11 meters and 6 Ampere is 6mm^2 . If we allow 5% of loss, the cable size can be 2.5mm^2

Note: High Amps in a thin wire is like pushing a lot of water through a small pipe. It results in high friction and heating the wire, eventually causing burned wires. In general, a bigger wire is better but there comes a point that the extra costs are not benefitting the system.

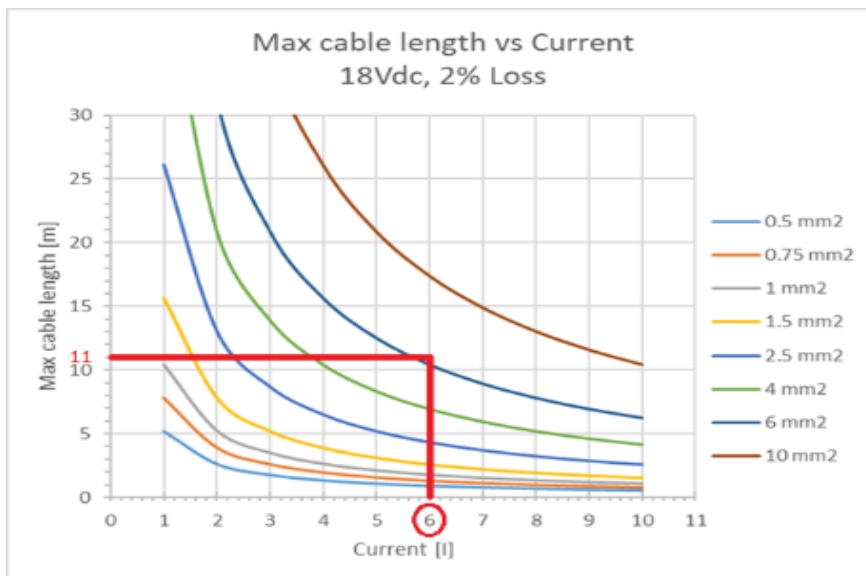


Figure 2: Selection of cable size using length and current



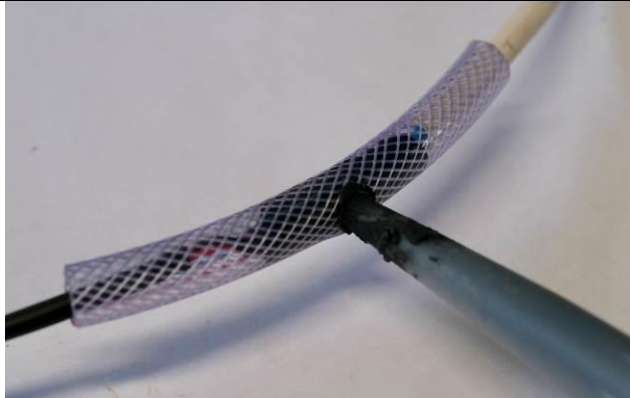



Step 5: Cost calculation

From the above calculations, we can make the list of required materials and calculate the total cost.



Item	Quantity	Price/unit	Price total	Observations
Pump ZL50-20N	2			
Solar panel 100Wp	2			
Pipe (inner diameter 22mm)	23 meters			
Cable, 2 core 6mm^2	11 meters			

Connection of electric cable to pump

To ensure a long functionality of the pump, the electric cables must have a waterproof connection. If moisture comes in contact with copper wires, they will corrode and after some time the pump stops working. There are several options to make waterproof connections (e.g. sealing heat shrink sleeves). Under an example of a simple and affordable solution.



	
Solder wires of pump together at different lengths, so exposed wires cannot touch each other so will not make a shortcut.	Slide a flexible tube over the soldered connection with a small hole in the middle. Via a hole inject Silicon Sealant
	
Inject the Silicon sealant, so it spreads to both sides of the flexible tube.	When sealant is coming out of one side, close it with tape. Inject sealant until it comes out the other side.
	
Close the other end with electric tape and wipe the excess silicon from the injection hole.	Seal the hole with electric tape to avoid spreading silicon sealant everywhere.

Pump assembly

	
<p>Model ZL 50-20N can be disassembled with a screwdriver (PH2). Note; the impeller is adjusted with washers. So a pump may have 2 to 4 washers</p>	<p>Model ZL30-13N can be disassembled without tools by turning the end covers anti clockwise. If the top cap is loose, mount it with some drops of super glue</p>

Pump suction filter

A filter on the pump inlet is important to avoid sand and particles to enter the pump. Sand will shorten the lifetime of the pump and might block the pump. Under a few examples how to make a suction filter out of a PVC pipe.

	
<p>Model ZL 38-13N. 2 pumps in series. Pumps fit in a PVC pipe of 2 inch, (57 mm inside diameter).</p>	<p>A suction filter made of a PVC pipe with slots cut with a hacksaw. Also add a cloth filter!</p>



A filter can be made with a hack saw. Grind the hacksaw to reduce the slots to 1 mm



To connect the filter to the pump use an adapter or heat the pipe, mount it and close with a rubber strip

Example of installation and applications



Installation of 2 pumps model ZL 50-20N



This pump fits in a casing of 86 mm inside (90 mm outside)



Slot in the casing to accommodate cables in the casing.



Cover the borehole



A wheelbarrow pump. A pump, panel, hose and cable mounted on a wheelbarrow. It is easily transported to distance fields for irrigation



A wheelbarrow pump pumping from a river to irrigate vegetables



1 pump ZL 50-20N is replacing a Rope pump. It pumps into a tank and is used for drip irrigation.



4 pumps ZL50-20N in series powered by 4 panels of 100 Watt. Water is used for communal water supply

Increase flow of model ZL 38

The hole in the outlet of a pump ZL38-13N is 8 mm. The pump volume of this model in the mid range can be increased by 20% or more by increasing the hole to 13 or more



8 mm Hole in outlet of Pump model ZL 38-13N



You can drill a hole of 15 mm with a home made drill



Materials needed; round bar 8mm, pipe of 15 mm



Drilling a hole with a home made drill



Remover the cutting with a screw driver



The holes can also be made with a drill bit 13 or 15 mm



Sometimes the top cap of the pump model 38 can become loose, especially if more pumps are mounted in series



To prevent this, mount the cap with a few drops of super glue. Glueing is OK since there is no need to open this cap.

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