Solar water pump

Intensive

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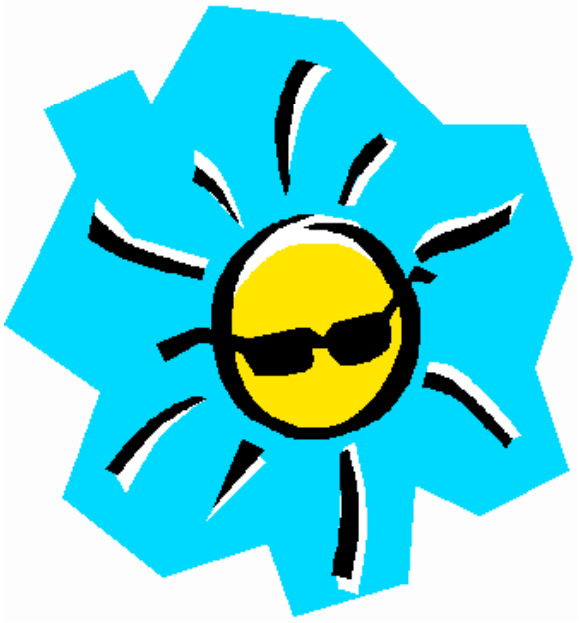
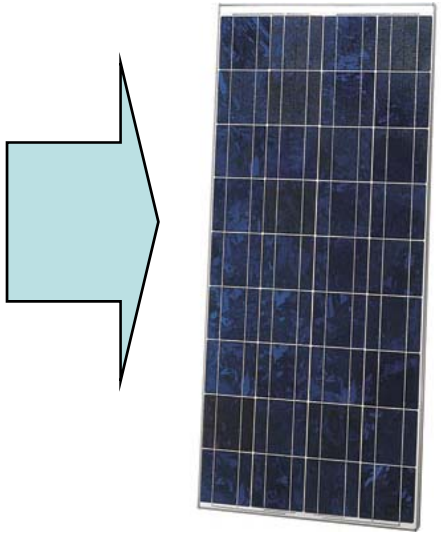
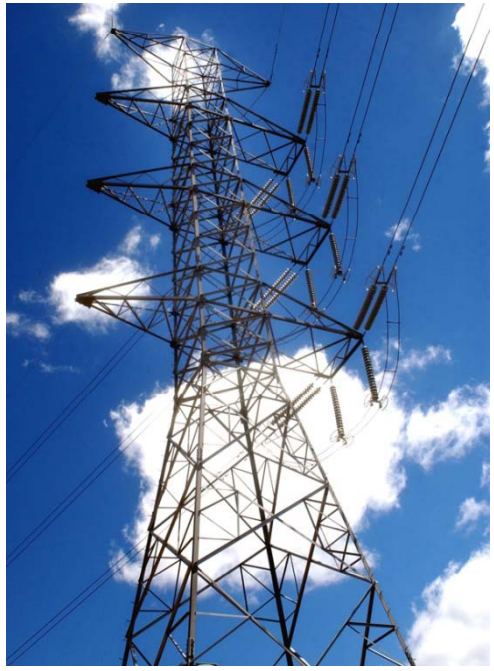
Understand solar photovoltaic (Solar PV)



SUN



Solar PV



Electricity

Solar PV types

Amorphous

Poly crystalline

Mono crystalline

Specification : Amorphous

Benefit:

- Good operates at Low irradiant
- Low price

Weak point :

- Eff = 5-6%
- Life time = 10 years

Specification : Crystalline PV

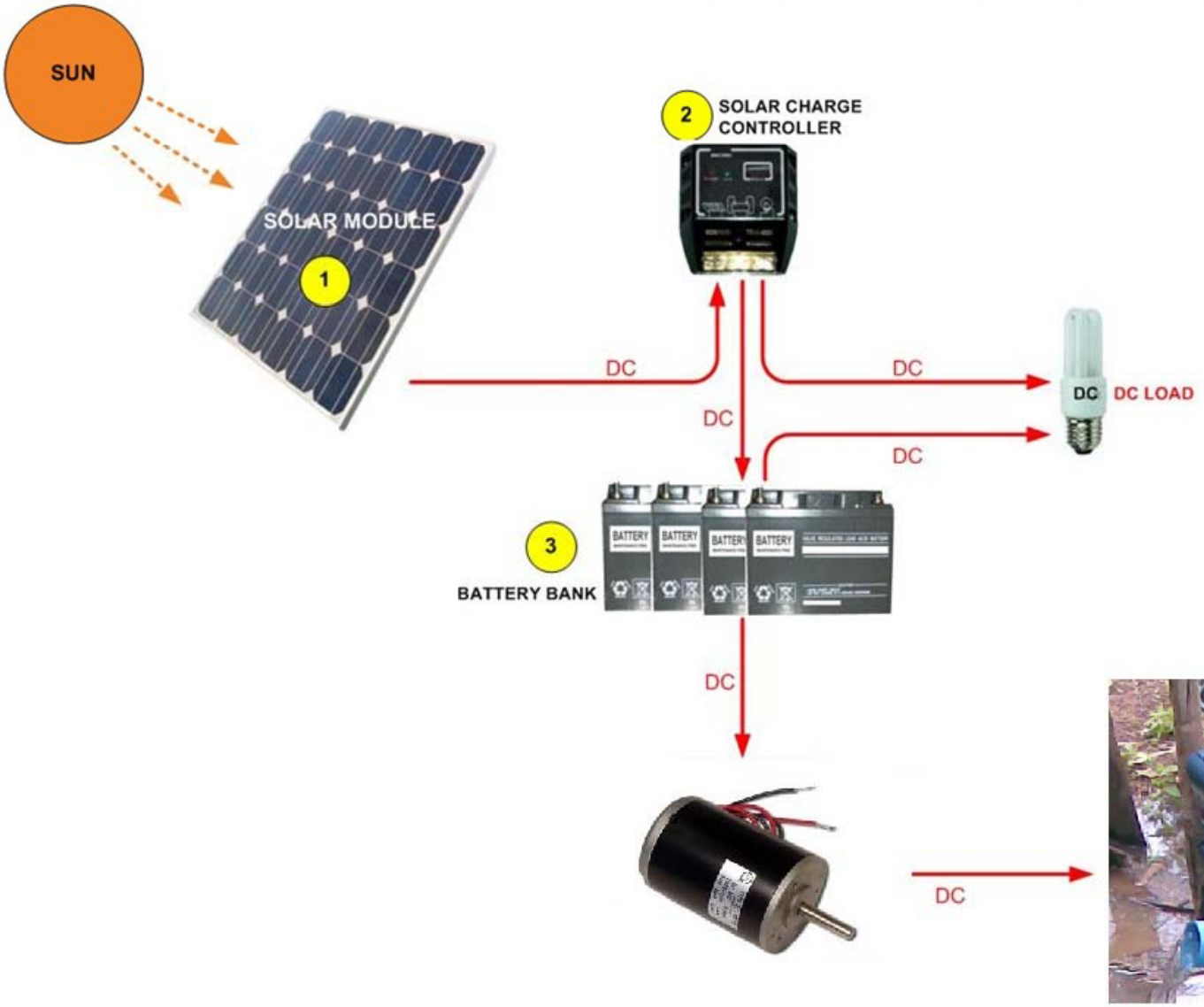
Poly crystalline

Mono crystalline

Benefit

- Good for strong sun
- Life time 25 years
- Eff = 13-15%
- appropriate for ASIA area

SOLAR WORKING PROCESS



How many solar PV

DC motor = 500 watt/hr

If used 3 hrs per day = 500x3 = 1,500 watt/day

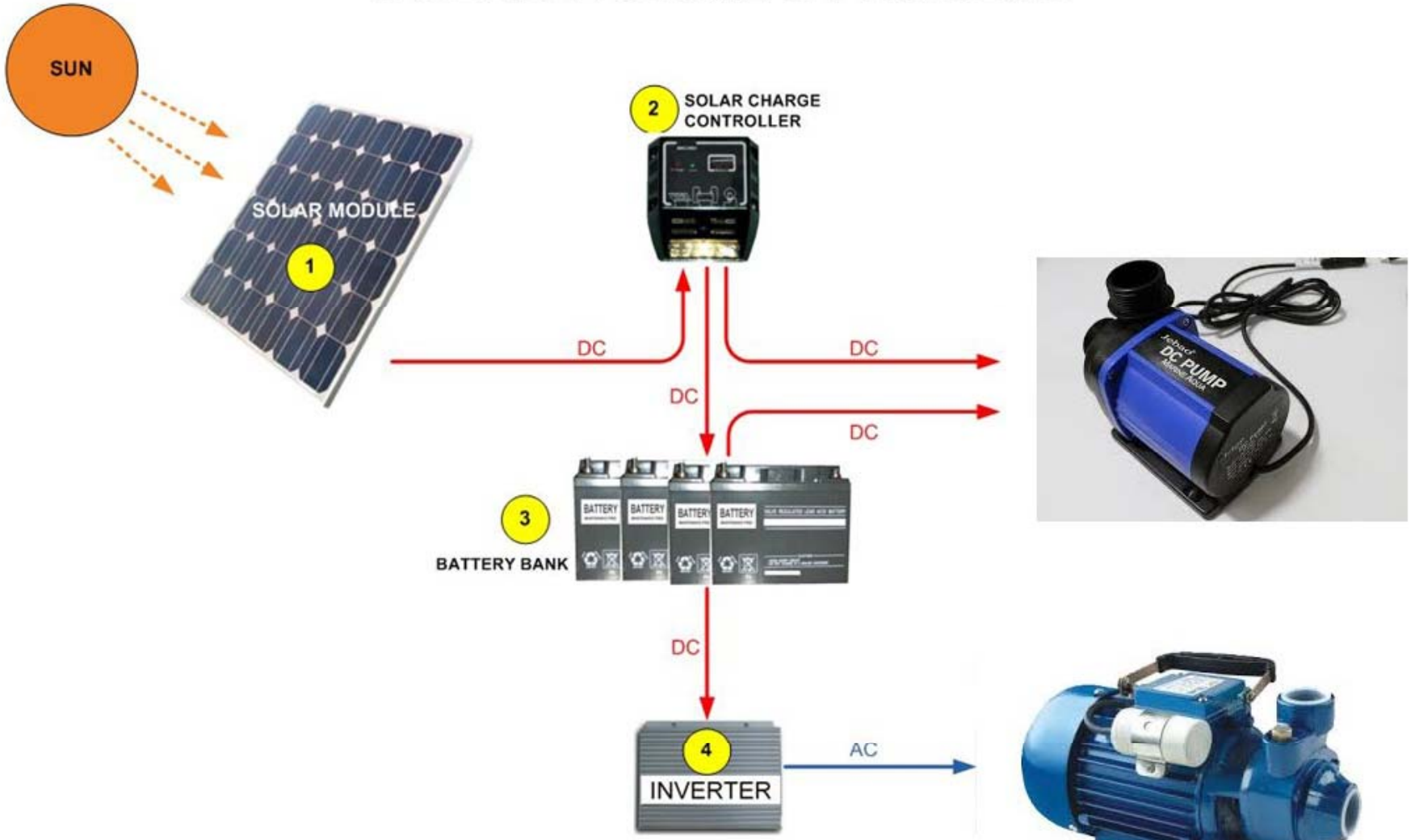
Then solar PV must = 1,500 watt/day

If the sun 3 hrs per day

Then solar PV are = 1,500/3 = 500 watt

Low efficiency

SOLAR WORKING PROCESS



AC water pump

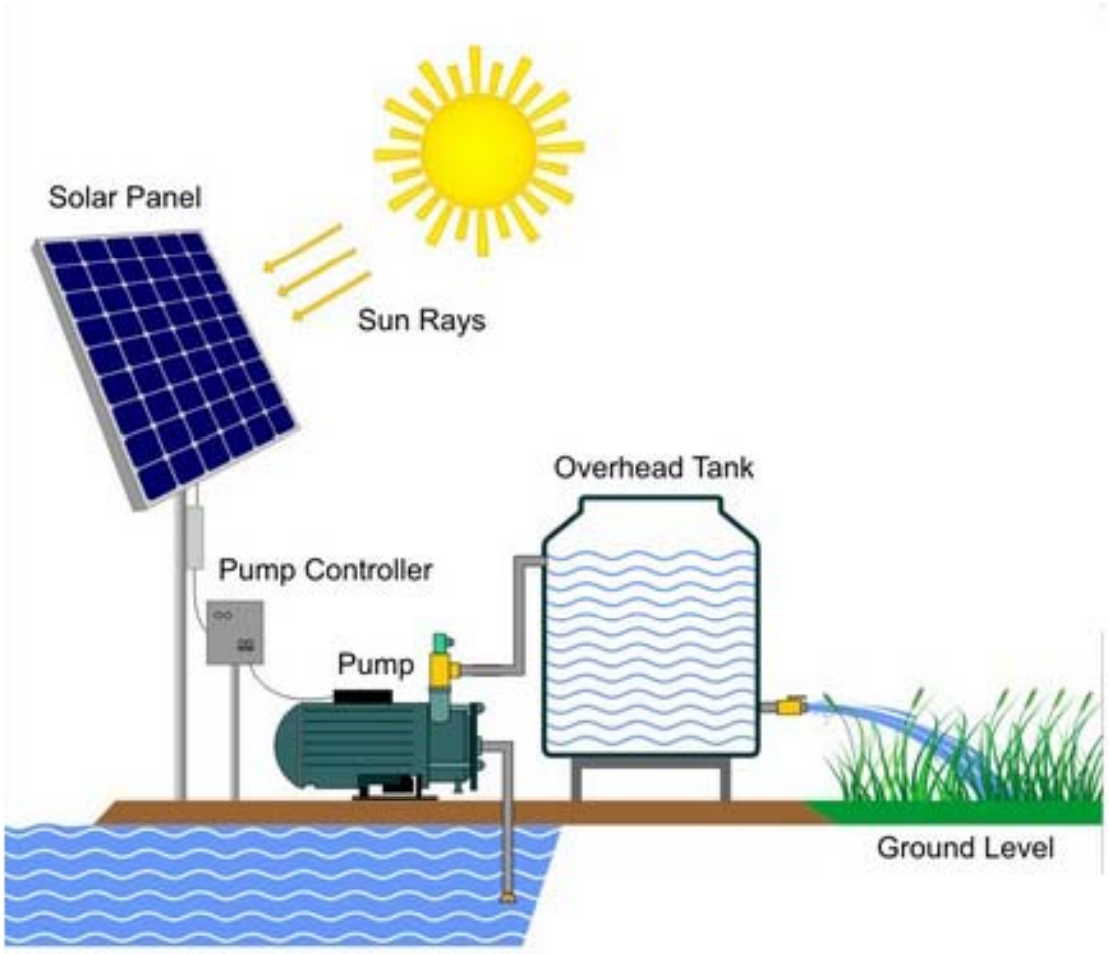
Water pump types

1. Surface water pump



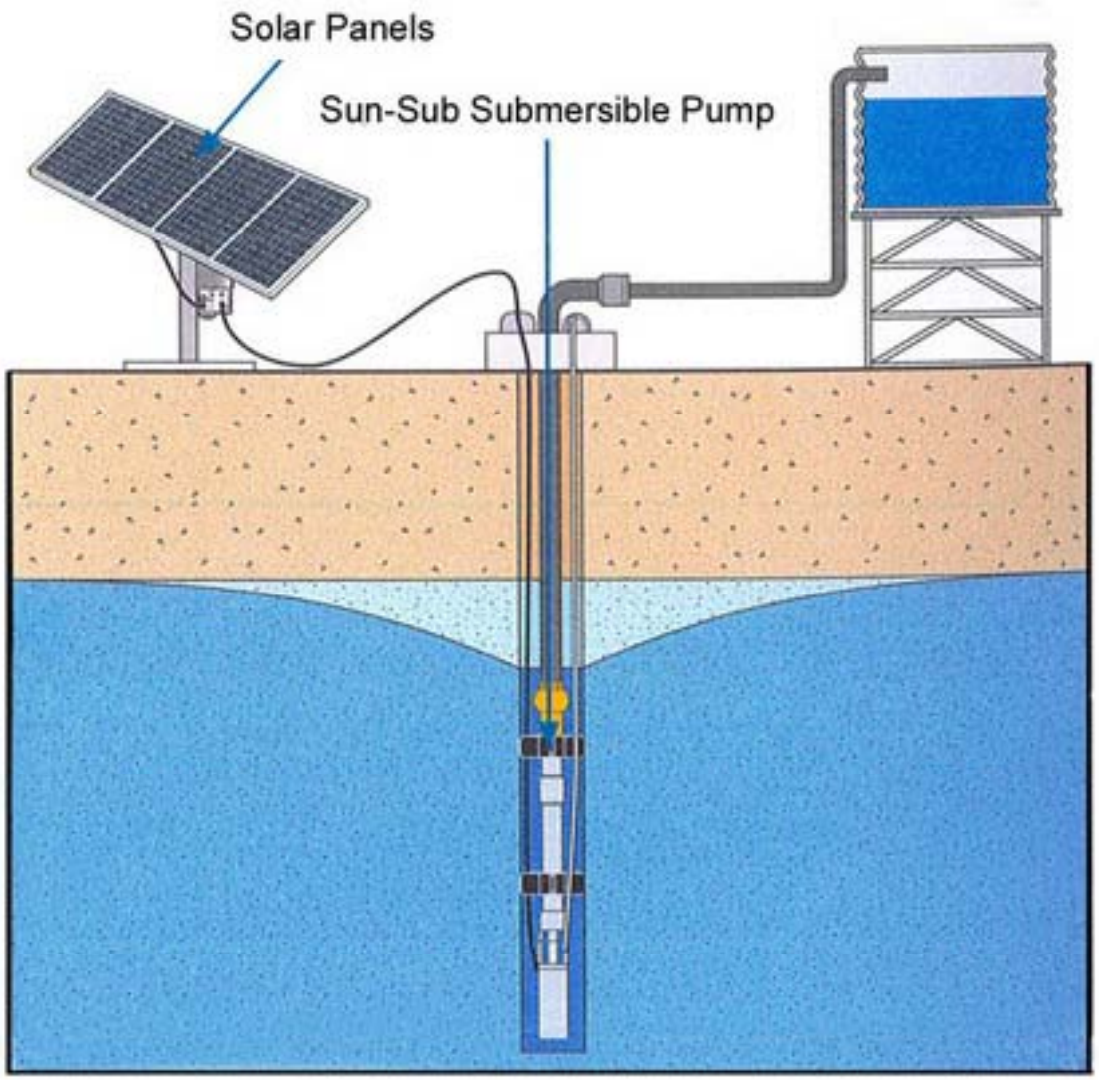

2. Under ground water pump


1. Surface water pump



SURFACE PUMP

2. Under ground water pump



Famus technology of solar water pump system

1. Low AC voltage

2. Integrated power inverter into internal pump

3. Using Frefrency inverter

1. Low AC voltage

This type, the motor for water pump was designed as AC , 3 Phase and Low voltage

1. Low AC voltage

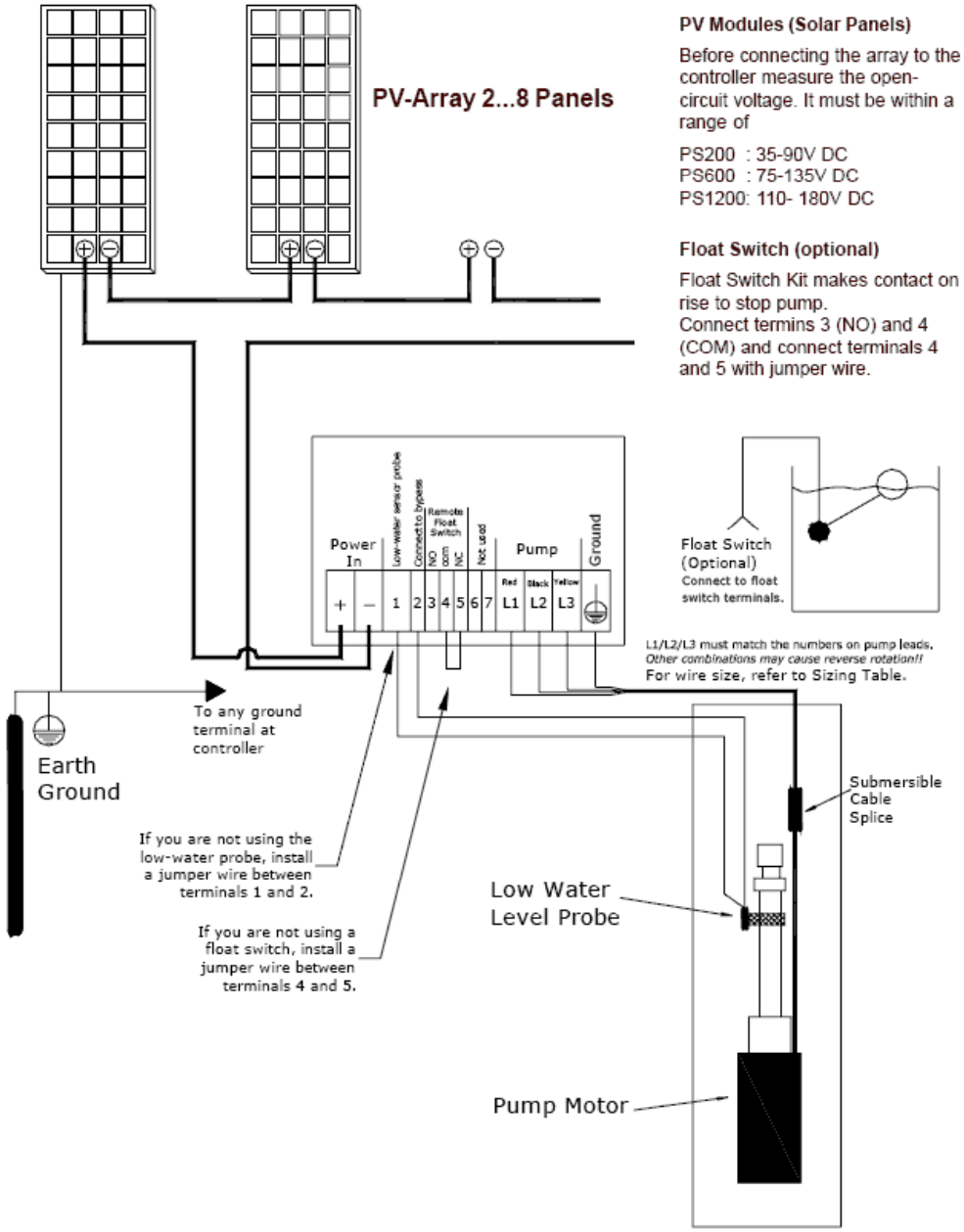
Controller with inverter

AC Pump 3 F
Low Voltage

pump system		PS200 HR	PS600 HR	PS1200 HR	PS1800 HR	PS4000 HR
max. total dynamic head (TDH)	[m]	50	180	240	250	450
max. flow rate	[m³/h]	2.6	2.6	2.5	3.9	2.5
solar operation:						
max. power voltage (Vmp)*	[V DC]	>34	>68	>102	>102	>238
open circuit voltage (Voc)	[V DC]	max. 100	max. 150	max. 200	max. 200	max. 375
nominal voltage	[V DC]	24–48	48–72	72–96	72–96	168–192
battery operation:						
nominal voltage	[V DC]	24 and 48	48	96	96	n.a.

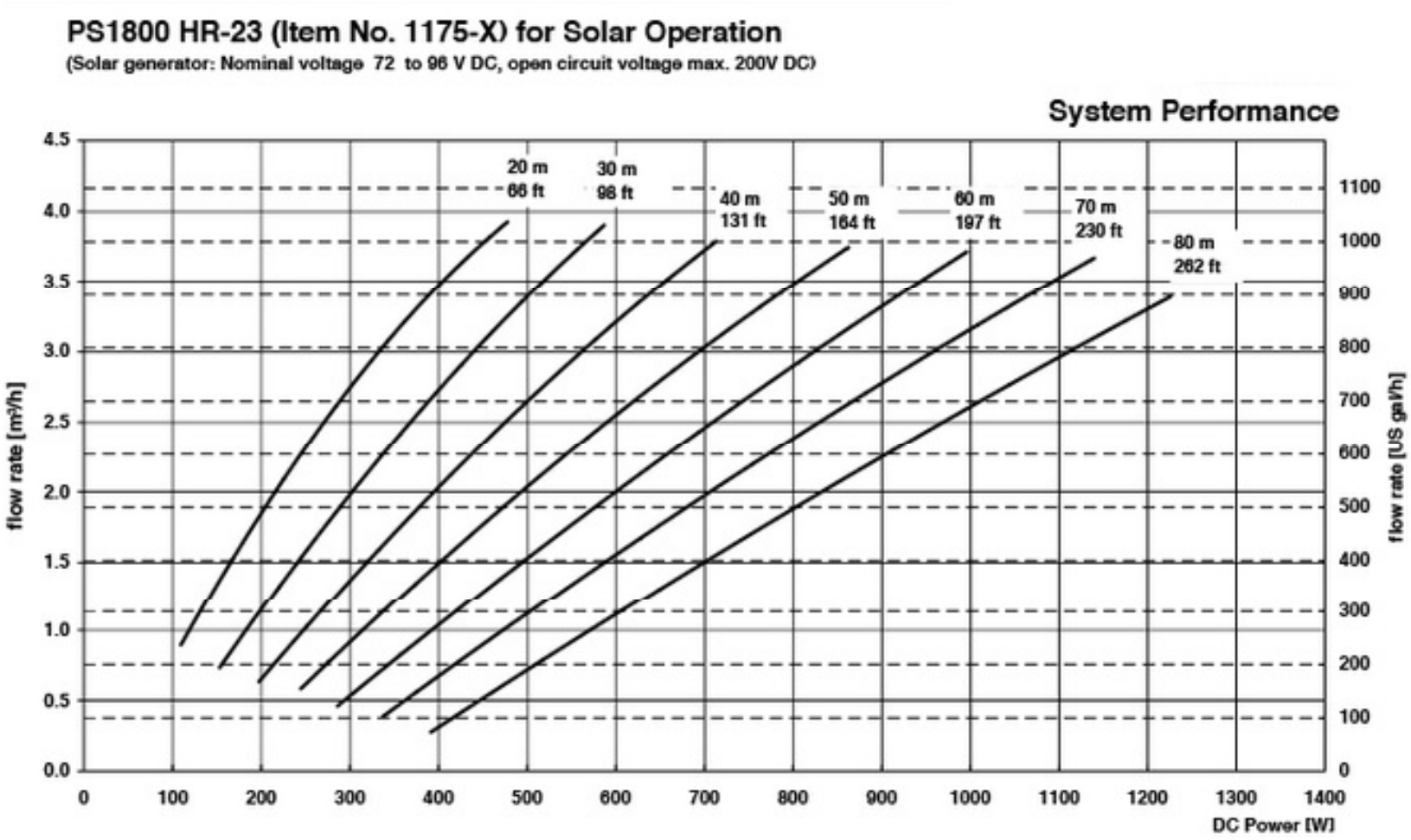
*) PV modules at standard test condition: AM = 1.5, E = 1,000W/m², cell temperature: 25 °C

1. Schematic diagram of Low AC voltage



How to select pump model?

1. Total water head
2. Flow rate



Population technology of solar water pump system

1. Low AC voltage

2. Integrated power inverter into internal pump

3. Using Frefrency inverter

2. Integrated power inverter into internal pump

This type, including converter and MPPT controller in inside the pump

SQFlex pumps have built-in protection features that protect the pump itself and in many cases the well. Among these features are:

- Protection against dry-running, overloading and overheating
- Automatic restart when water returns to the well or when the motor temperature returns to the safety range
- Continuous load condition and voltage monitoring

Pump casing
Stainless steel for long pump life.

Bearings
Powerful carbon/ceramic bearing system ensures high reliability.

Motors
Two motor sizes are available for the SQFlex system with built-in unique features: 3000 rpm for helical pumps and 3600 rpm for centrifugal pumps segmented stator and permanent magnet rotor for high efficiency and starting torque.

Power transmission
The unique Grundfos micro frequency converter ensures power transmission to the motor.

Any voltage
A wide voltage range enables the motor to operate at any voltage between 30V and 300V DC or 90-240V AC, which makes installation and sizing especially easy.

Helical rotor pump (3")
Based on original pumping principles, the helical rotor pump uses a few, simple components for effective pumping – medium to high head and medium to low flow.

Communication
Two-way communication between control unit and pump eliminates the need for additional wires.

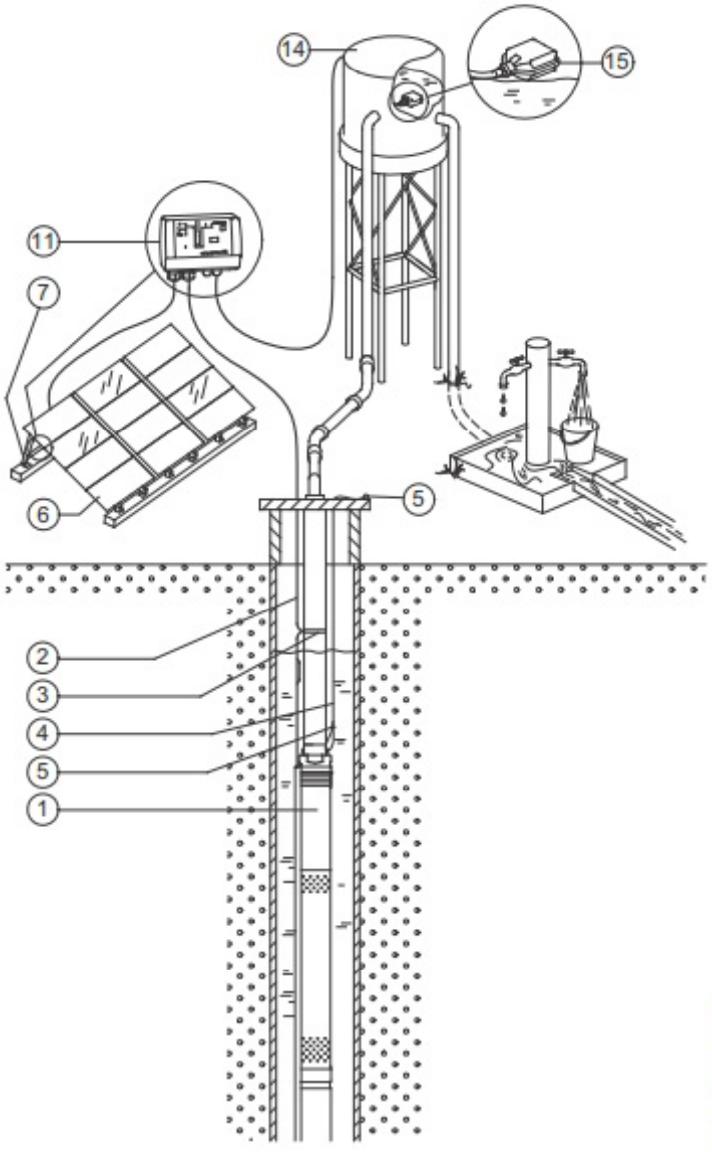
System efficiency
Maximum Power Point Tracking (MPPT) means even and high system efficiency regardless of power source.

Sand slinger
To ensure maximum protection of the motor and thus extended motor life, the SQFlex pumps are equipped with a composite sand slinger on the motor shaft as standard. The sand slinger rotates with the shaft, thereby pushing sand away from the centre and out through three grooves in the pump sleeve. Another distinctive benefit is that pump and motor can be replaced independently of one another, in case one of them wears out.

Dry-running protection
This unique feature shuts down the pump if it detects water shortage. It protects the well from being over-pumped and the motor from burning out. The pump restarts automatically when water returns to the well.

Centrifugal pump (4")
Technology based on 30 years' experience enables high flow in shallow water conditions. Stainless steel components give high wear resistance.

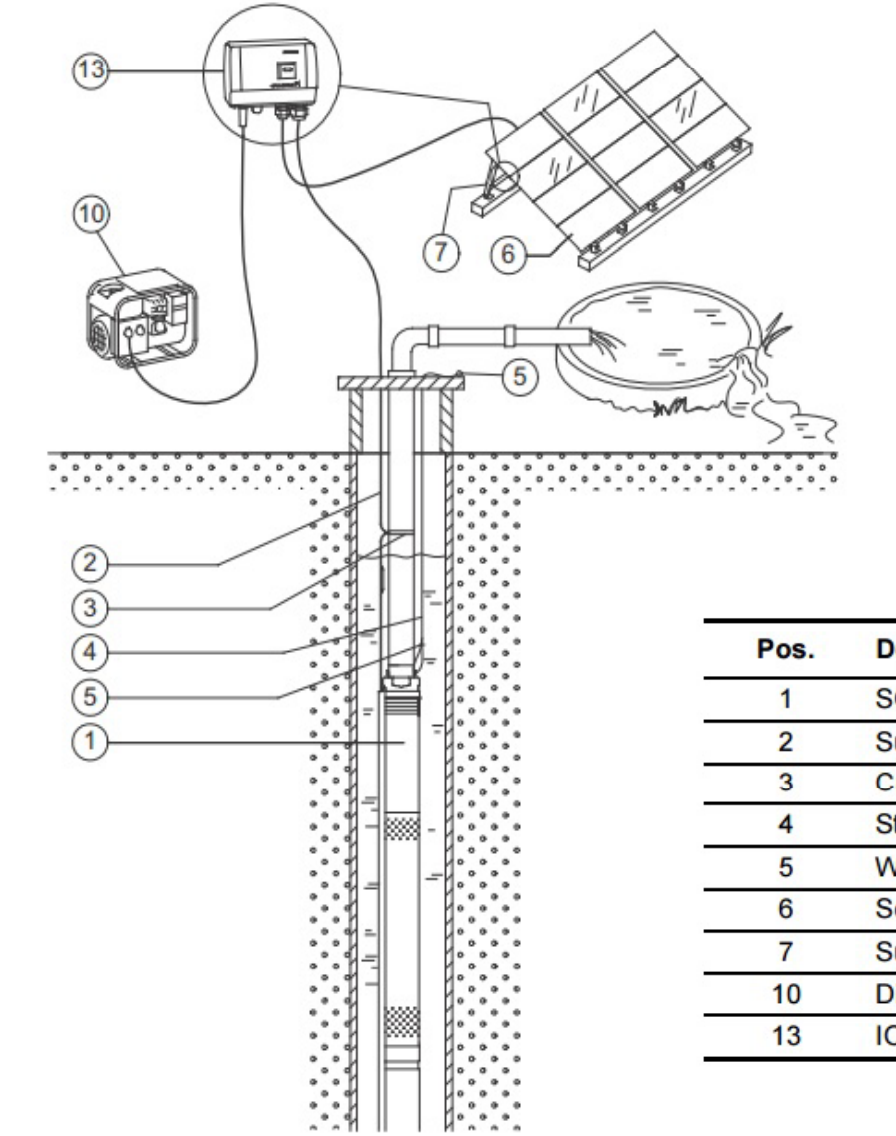
2. Integrated power inverter into internal pump



Solar PV directs connection

Pos.	Description
1	SQF pump
2	Submersible drop cable
3	Cable clips
4	Straining wire
5	Wire clamps
6	Solar panels
7	Support structure
11	CU 200 SQFlex control unit
14	Water reservoir
15	Level switch

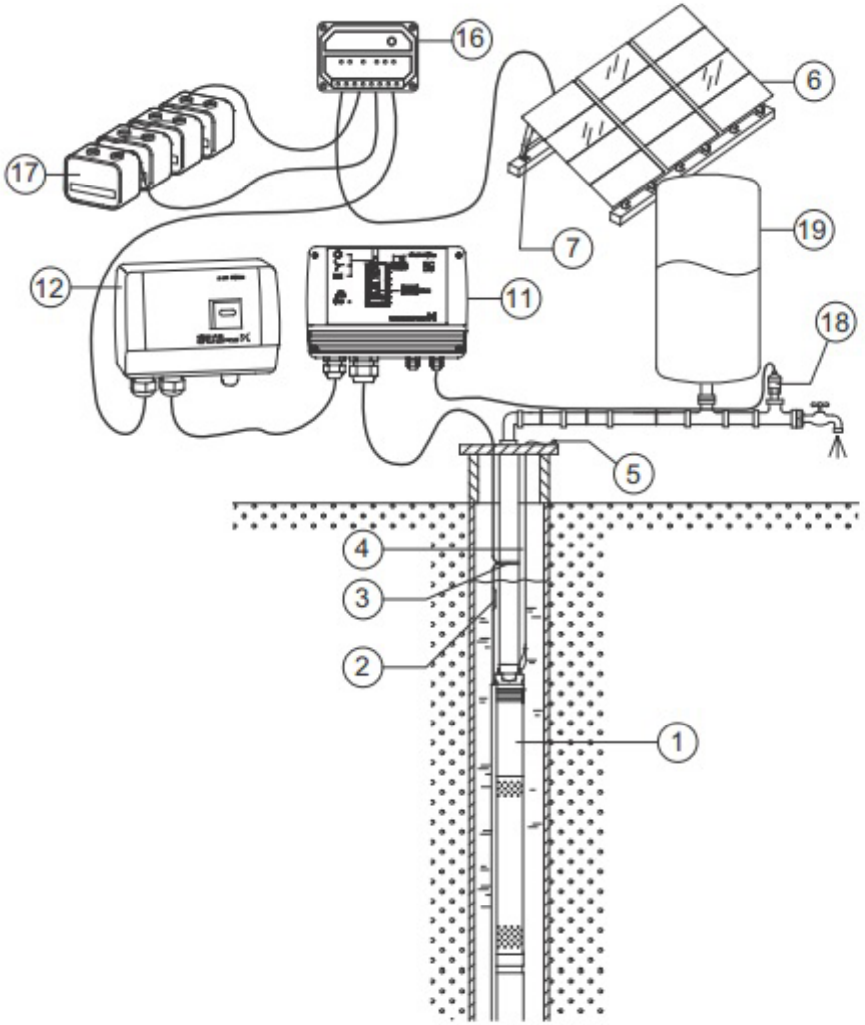
2. Integrated power inverter into internal pump



Solar PV with generator backup

Pos.	Description
1	SQF pump
2	Submersible drop cable
3	Cable clips
4	Straining wire
5	Wire clamps
6	Solar panels
7	Support structure
10	Diesel- or petrol-driven generator
13	IO 101 SQFlex switch box

2. Integrated power inverter into internal pump



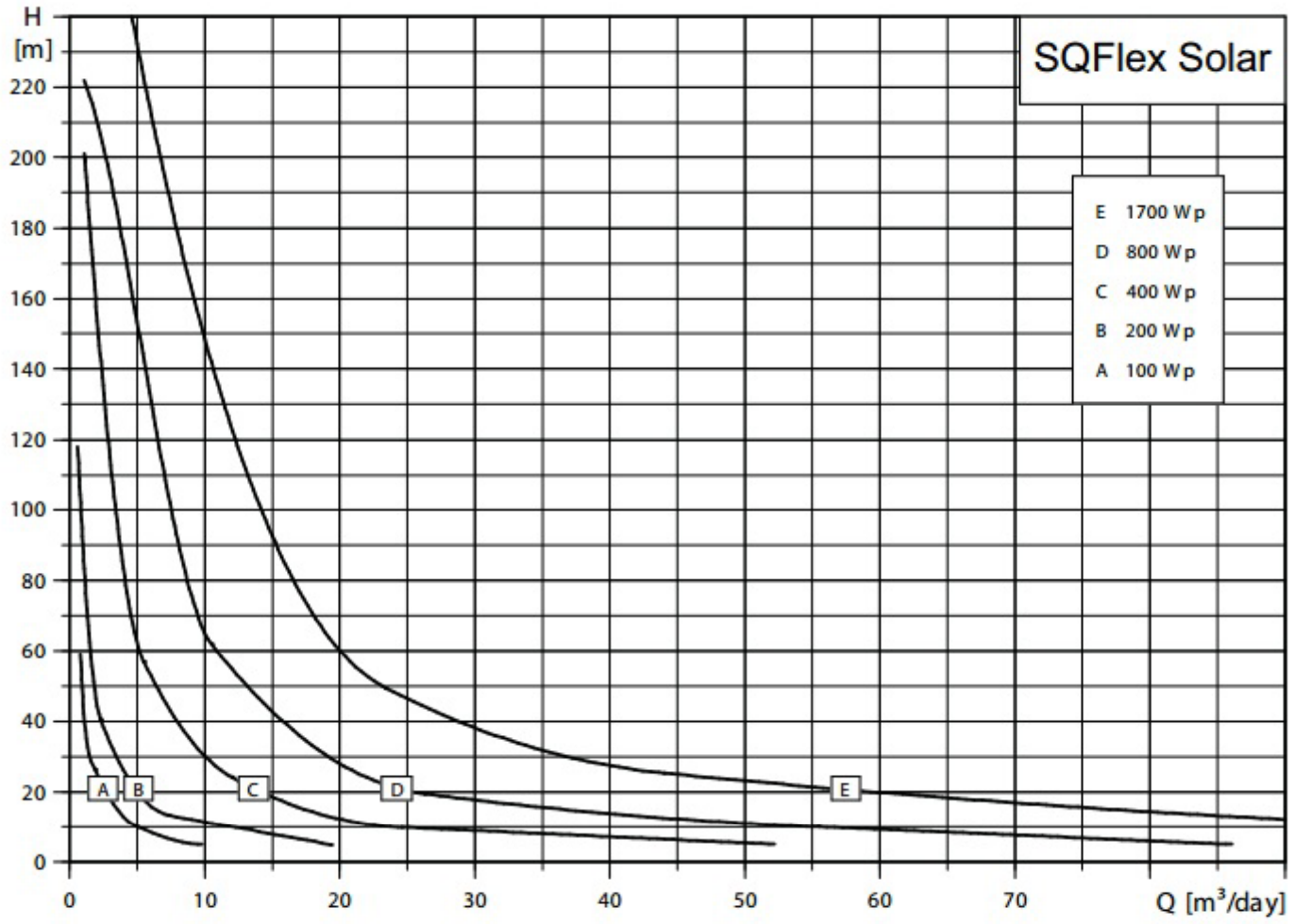
Solar PV with battery backup

Pos.	Description
1	SQF pump
2	Submersible drop cable
3	Cable clips
4	Straining wire
5	Wire clamps
6	Solar panels
7	Support structure
11	CU 200 SQFlex control unit
12	IO 101 SQFlex switch box (optional)
16	Charge controller
17	Batteries
18	Pressure switch
19	Pressure tank

How to select pump model?

1. Total water head 2. Flow rate

Performance range



Population technology of solar water pump system

1. Low AC voltage

2. Integrated power inverter into internal pump

3. Using Frefrency inverter

3. Using Frefrency inverter

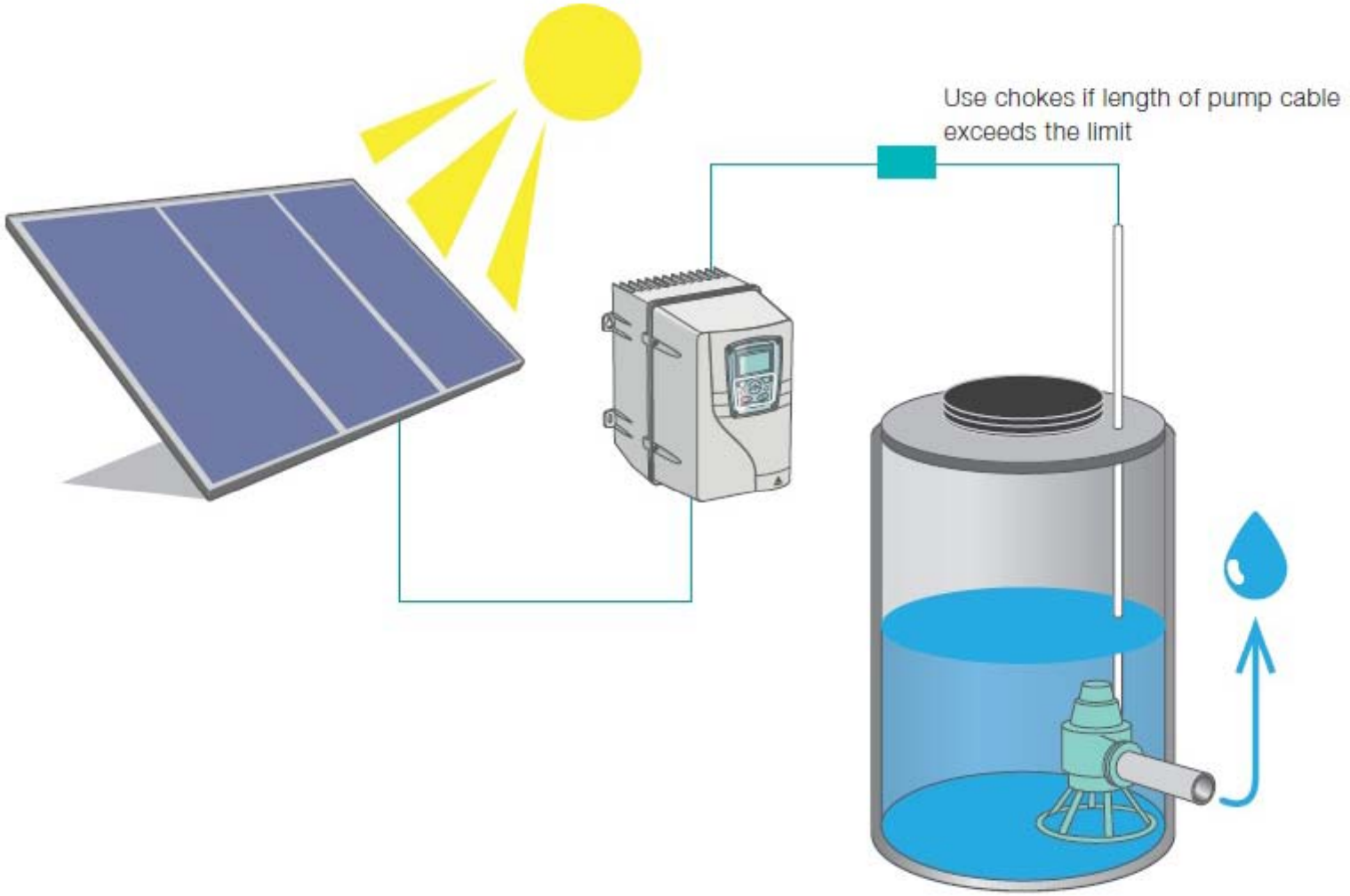
The normal water pump can be operated with solar PV by using Solar Frefrency inverter

Groundfos

ABB

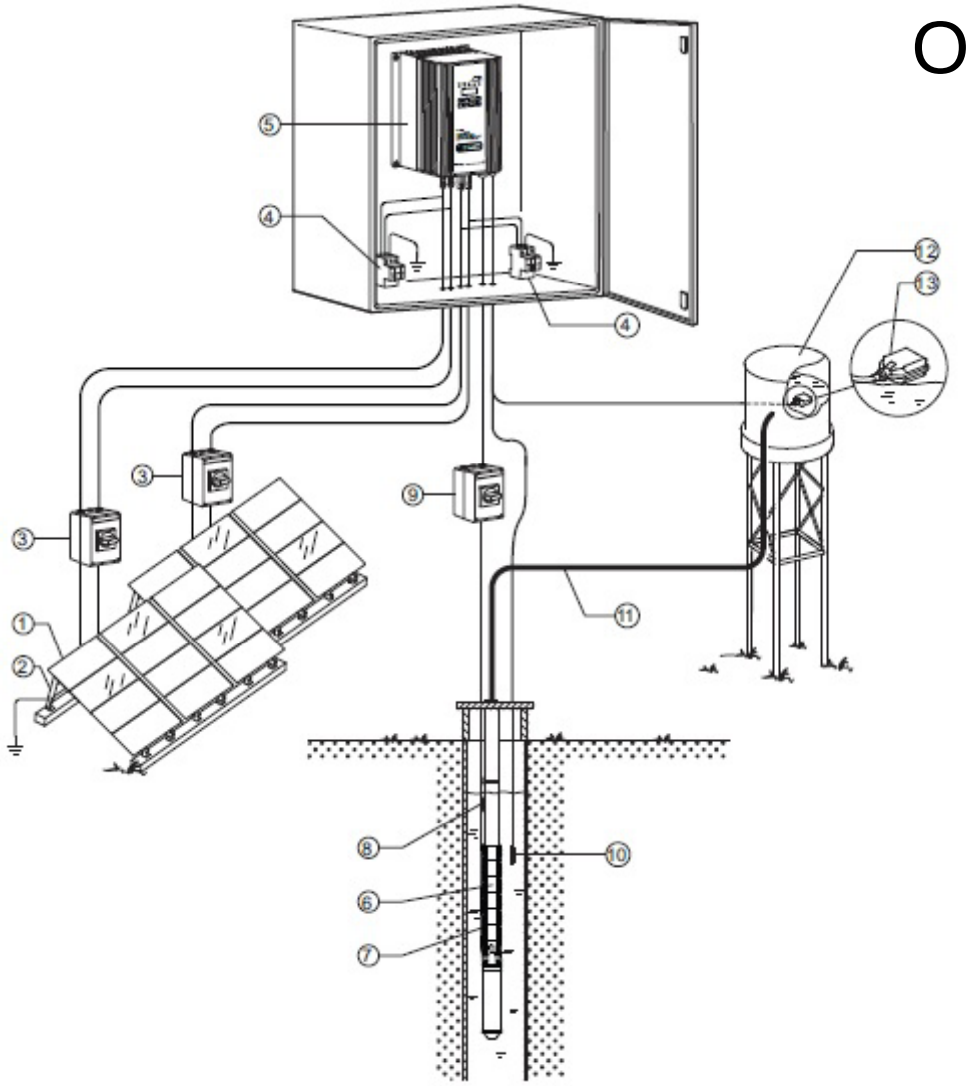
Schneider

3. Using Frefrency inverter



3. Using Frefrency inverter

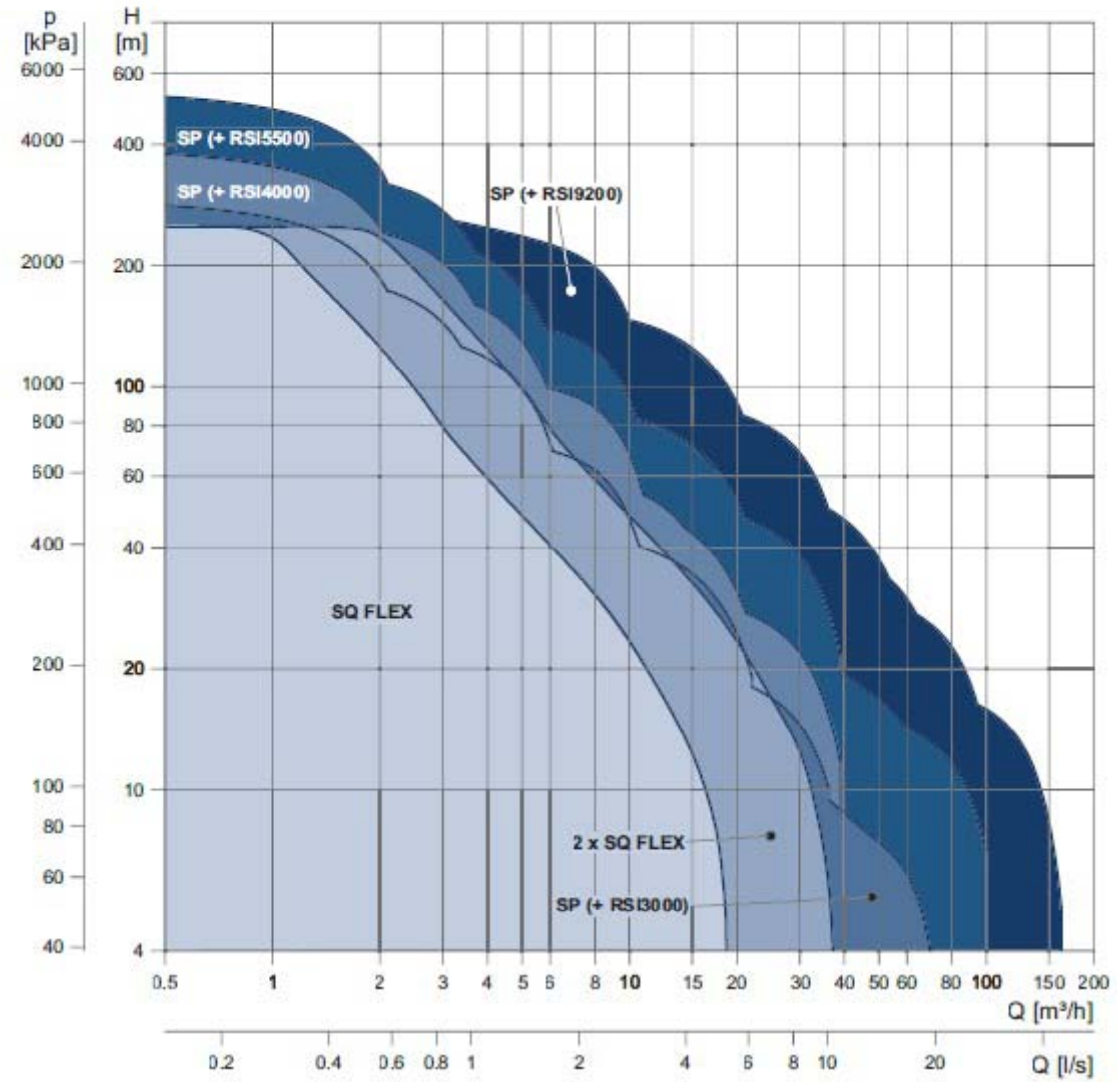
Operation diagram



① Solar panel
② Mounting structure
③ Circuit breaker DC
④ Surge protection DC *)
⑤ Renewable Solar Inverter
⑥ SP pump
⑦ Cable
⑧ Submersible drop cable
⑨ Circuit breaker AC
⑩ Dry running sensor
⑪ Pipe
⑫ Water tower/tank
⑬ Level switch

3. Using Frefrency inverter

Performance range



How to design ?

Drive selection in solar pump applications

- When pump and motor has been selected drive needs to be selected so that the required motor voltage, current and the power can be applied
  - Below an extract of the ACS355 solar pump drives available for 380…480V motors
  - P_N and I_{2N} need to be equal or bigger than the motor rated values

P_N (HP)	P_N (KW)	I_{2N} (A)		
250V to 800V DC or 380V to 480V 3-phase AC				
0.5	0.37	1.9	ACS355-03E-01A9-4	R0
0.75	0.55	2.4	ACS355-03E-02A4-4	R1
1.0	0.75	3.3	ACS355-03E-03A3-4	R1
1.5	1.1	4.1	ACS355-03E-04A1-4	R1
2.0	1.5	5.6	ACS355-03E-05A6-4	R1
3.0	2.2	7.3	ACS355-03E-07A3-4	R1
4.0	3.0	8.8	ACS355-03E-08A8-4	R1
5.0	4.0	12.5	ACS355-03E-12A5-4	R3
7.5	5.5	16.6	ACS355-03E-16A6-4	R3
10.0	7.5	23.1	ACS355-03E-23A1-4	R3
15.0	11.0	31.0	ACS355-03E-31A0-4	R4
20.0	15.0	38.0	ACS355-03E-38A0-4	R4
25.0	18.5	44.0	ACS355-03E-44A0-4	R4

- As an example we have a 5HP pump where motor is

4.0kW, 400V, 8,6A, 1440rpm, 90% efficiency

→ We select **ACS355-03E-12A5-4** drive

Solar panel dimensioning
Basics

- Important panel selection values from panel data sheet are
  - P_{max} = Maximum output power of the cell
  - V_{OC} = Open circuit voltage (max. voltage)
  - V_{mpp} = Voltage at maximum power point
  - I_{mpp} = Current at maximum power point
- Panels need to be set in series to match panel output voltage with drive rated DC voltage and needed motor voltage
  - DC nominal voltage = 1.35 x motor nominal voltage
- Panels need to be set in parallel to match panel output current with drive rated DC current
  - Drive rated DC current is 0,817 x $I_{2N\ (drive)}$
- Panel number in series multiplied with number of parallel arrays multiplied with Pmax needs to be higher than the required DC power
  - DC power = Pump power + motor losses + drive losses
  - Rule of thumb → Pump power in HP = DC power in kW

Solar panel dimensioning
Example – rule of thumb

- Values in our example system
  - 5HP pump → 5kW cell power required
  - DC voltage need is 400V x 1.35 = 540V
  - DC current need is 12,5A x 0,817 = 10,2A
  - Maximum DC voltage is 800V
- Below datas from three different panel models and their sub models:

PV panel offering of manufacturer X	Pmax	Voc	Vmpp	Isc	Impp
	170	28,5	23,7	7,9	7,4
	175	28,6	23,8	8,0	7,4
	180	28,8	24,0	8,1	7,5
	185	29,0	24,1	8,3	7,7
	190	29,2	24,4	8,4	7,8
	195	29,4	24,7	8,5	7,9
	150	43,4	36,3	4,5	4,2
	155	43,8	36,4	4,6	4,3
	160	44,1	36,9	4,7	4,3
	165	44,5	37,5	4,7	4,4
	190	42,7	35,5	5,8	5,4
	195	43,3	36,0	5,9	5,5
	200	43,3	36,2	5,9	5,5
	205	43,7	36,4	6,1	5,7

Solar panel dimensioning
Example – rule of thumb

- Calculate the needed panels in series based on voltage:
  - DC voltage need is 400V x 1.35 = 540V
  - Maximum DC voltage is 800V
  - V_{mpp} x n ≥ 540V → n > 540V / V_{mpp} (round up n)
- Check the open circuit voltage
  - V_{oc} x n < 800V

	Pmax	Voc	Vmpp	Isc	Impp	Number in series		Udc max
PV panel offering of manufacturer X	170	28,5	23,7	7,9	7,4	22,82	23	655
	175	28,6	23,8	8,0	7,4	22,69	23	658
	180	28,8	24,0	8,1	7,5	22,51	23	663
	185	29,0	24,1	8,3	7,7	22,37	23	668
	190	29,2	24,4	8,4	7,8	22,16	23	671
	195	29,4	24,7	8,5	7,9	21,85	22	646
	150	43,4	36,3	4,5	4,2	14,88	15	651
	155	43,8	36,4	4,6	4,3	14,83	15	657
	160	44,1	36,9	4,7	4,3	14,63	15	661
	165	44,5	37,5	4,7	4,4	14,40	15	668
	190	42,7	35,5	5,8	5,4	15,22	16	683
	195	43,3	36,0	5,9	5,5	15,00	16	692
	200	43,3	36,2	5,9	5,5	14,91	15	650
	205	43,7	36,4	6,1	5,7	14,86	15	655

Solar panel dimensioning
Example – rule of thumb

- Calculate the needed panels in parallel
  - DC current need is 12,5A x 0,817 = 10,2A
  - $I_{dc} = n \times I_{mpp} \rightarrow n = I_{dc} / I_{mmp}$ (round up n)
- Checking panel selection from the 1st line, there is 23 panels in series and 2 in parallel so the amoun of the panels in this setup would be 46 pcs

	Pmax	Voc	Vmpp	Isc	Impp	Number in series		Udc max	Parallel	Idc
PV panel offering of manufacturer X	170	28,5	23,7	7,9	7,4	22,82	23	655	2	14,7
	175	28,6	23,8	8,0	7,4	22,69	23	658	2	14,8
	180	28,8	24,0	8,1	7,5	22,51	23	663	2	15,0
	185	29,0	24,1	8,3	7,7	22,37	23	668	2	15,4
	190	29,2	24,4	8,4	7,8	22,16	23	671	2	15,7
	195	29,4	24,7	8,5	7,9	21,85	22	646	2	15,8
	150	43,4	36,3	4,5	4,2	14,88	15	651	3	12,5
	155	43,8	36,4	4,6	4,3	14,83	15	657	3	12,9
	160	44,1	36,9	4,7	4,3	14,63	15	661	3	13,0
	165	44,5	37,5	4,7	4,4	14,40	15	668	3	13,2
	190	42,7	35,5	5,8	5,4	15,22	16	683	2	10,7
	195	43,3	36,0	5,9	5,5	15,00	16	692	2	11,0
	200	43,3	36,2	5,9	5,5	14,91	15	650	2	11,1
	205	43,7	36,4	6,1	5,7	14,86	15	655	2	11,3

Solar panel dimensioning
Example – rule of thumb

- Verify that the output power of the modules is enough to power the system (P_{need} = 5kW)
  - P_{total} = amount of panels x P_{max}
- Select the setup where the current is nearest to the required and where the power is nearest to the required
- And select the most cost efficient setup

	Pmax	Voc	Vmpp	Isc	Impp	Number in series	Udc max	Parallel	Idc	Total power [kW]
/ panel offering of manufacturer X	170	28,5	23,7	7,9	7,4	22,82	23	655	2	14,7	7,82
	175	28,6	23,8	8,0	7,4	22,69	23	658	2	14,8	8,05
	180	28,8	24,0	8,1	7,5	22,51	23	663	2	15,0	8,28
	185	29,0	24,1	8,3	7,7	22,37	23	668	2	15,4	8,51
	190	29,2	24,4	8,4	7,8	22,16	23	671	2	15,7	8,74
	195	29,4	24,7	8,5	7,9	21,85	22	646	2	15,8	8,58
	150	43,4	36,3	4,5	4,2	14,88	15	651	3	12,5	6,75
	155	43,8	36,4	4,6	4,3	14,83	15	657	3	12,9	6,98
	160	44,1	36,9	4,7	4,3	14,63	15	661	3	13,0	7,20
	165	44,5	37,5	4,7	4,4	14,40	15	668	3	13,2	7,43
	190	42,7	35,5	5,8	5,4	15,22	16	683	2	10,7	6,08
	195	43,3	36,0	5,9	5,5	15,00	16	692	2	11,0	6,24
	200	43,3	36,2	5,9	5,5	14,91	15	650	2	11,1	6,00
	205	43,7	36,4	6,1	5,7	14,86	15	655	2	11,3	6,15

Example

Solar water pump system for agriculture

Solar water pump case of Lumpang province

Solar water pump

Solar water pump

Solar water pump

Solar water pump

Solar water pump

Solar water pump

Solar water pump

Solar water pump

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