SOLAR ENERGY TECHNOLOGY

Solar Pump Components and Functionality

Gerrit Jacobs

14-18 June 2010

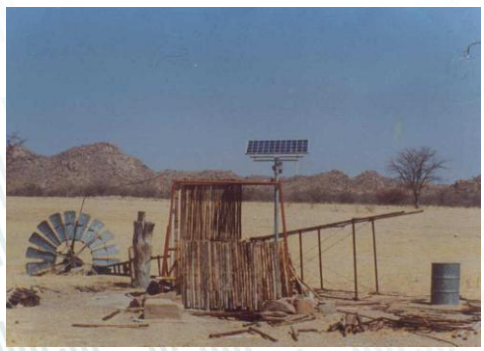
Jakarta
Indonesia

Structure of this Presentation

- PV pump applications
- Overview of pumping technologies
- Pump design
- Sizing
- Cost comparison between pumping technologies

The fall of the Dinosaur

(source: Solar Age Namibia)



PV Pumping Installation

Overview of Pumping Technologies

- Hand Pumps
- Animal Driven Pumps
- Hydraulic Pumps (rams)
- Wind Pumps
- Solar Pumps
- Diesel / petrol Pumps

PV Pump Applications

- Household water supply
- Village water supply
- Livestock and Game watering
- Irrigation

Water Requirements

Drinking water		Water for animals		Water for irrigation	
Liters per person and day		Liters per head and day		Cubic meters per hectare and day	
Minimum	10	Horses	50	Rice	100
Normal rural living conditions	40	Dairy cattle	40	Cereal / grain	45
		Camels, donkeys	20	Sugar cane	66
		Pigs	20	Cotton	55
		Sheep	5		
		Goats	5		
		Poultry	1		

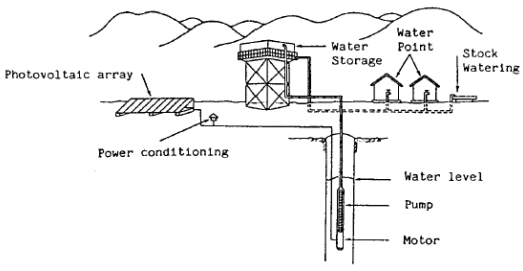
9

Village Water Supply

Livestock and Game Watering

10

Solar Water Supply System

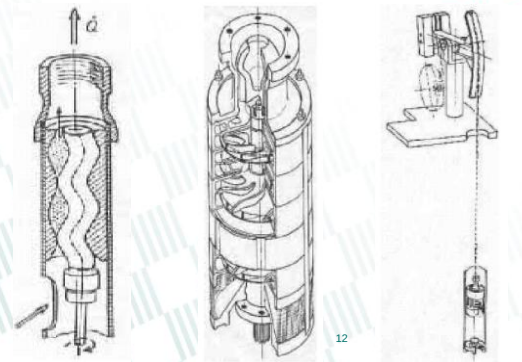


11

11

Pump Types

Helical Screw | Centrifugal | Reciprocating



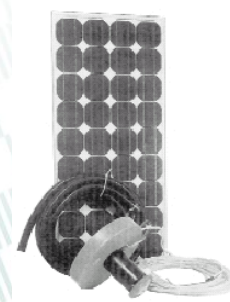
12

12

Helical Screw

Centrifugal

Pump Designs



14

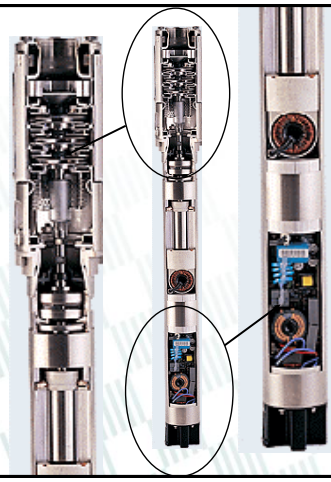
Examples of Grundfos Pumps

15

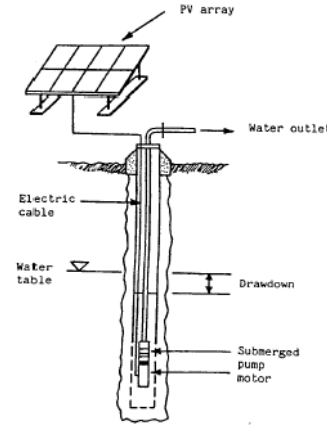
Inside the Pump (1)

16

Inside the Pump (2)

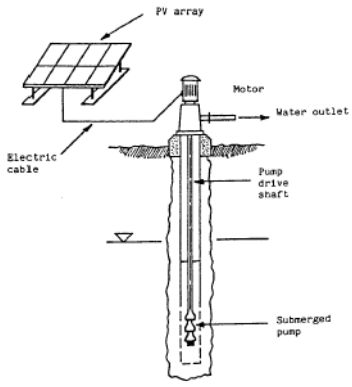


Submersed Multistage Centrifugal Pump



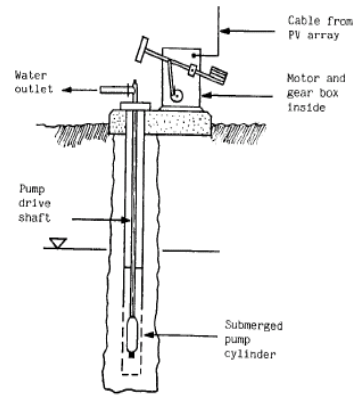
18

Submersed Surface Mounted Pump



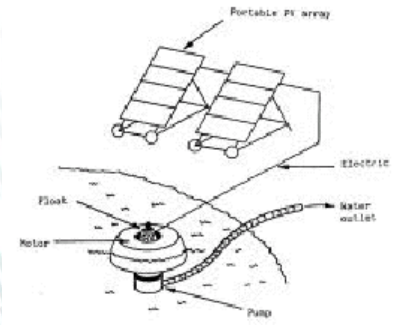
19

Reciprocating (Jack) Pump

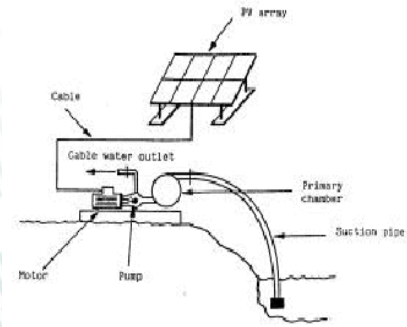


20

Floating Motor Pump



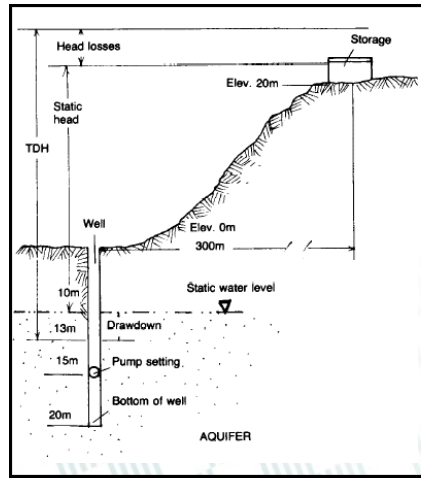
Surface Suction Pump



Typical System Specifications

Motor pump/ Configuration	Output (m³.day) @ 5kWhr day insolation	Head (m)	Solar Array (Wp)
Submerged borehole motor pump	40 25	20 20	1200 800
Surface motor/ submerged pump	60	7	840
Reciprocating positive displacement pump	6	100	1200
Floating motor/pumpset	100 10	3 3	530 85
Surface suction pump	40	4	350

Determining Pumping Head



Empirical Formula

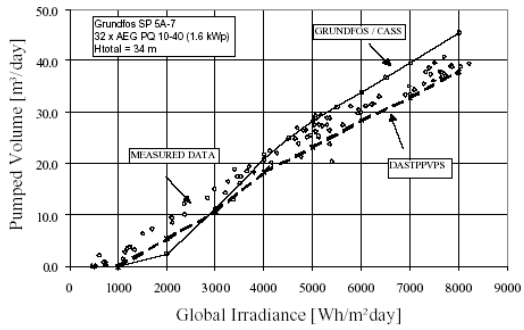
$$P_{SP} = (12 * H * V_d) / G_d$$

- Psp is Power of Solar Panels in Wp
- H is Head in metres
- Vd is Volume of water in m3 / day
- Gd is Global irradiance in kWh / m2 day

Sizing Table Grundfos SQFlex

Zone	Solar radiation	Required head [m]												No. of solar modules GF 43	Power [Wp]
		5	10	20	30	40	50	60	70 (A)	80	90	100	110	120	
		Required flow [m³/day]													
Zone K - tilt angle 30°	7.3 kWh/m² per day	22.3	12.1	8.5	4.5	3.1	2.7	2.4	2.1	1.9	1.6	1.4	1.1	0.8	4	172
		SQF 5A-3	SQF 2.5-2			SQF 1.2-2	SQF 0.6-2									
		52.8	25.7	17.5	12.1	8.5	6.4	5.5	4.7 (B)	4.1	3.8	3.5	3.2	2.8	8 (D)	344 (E)
		SQF 14A-3	SQF 5A-3	SQF 2.5-2			SQF 1.2-2 (C)		SQF 0.6-2							
		78.8	40.2	21.5	17.9	14.1	11.1	8.8	7.4	6.7	5.8	5.1	4.3	4.0	12	516
		SQF 14A-3	SQF 5A-3	SQF 2.5-2					SQF 1.2-2					SQF 0.6-2		
		98.8	59.1	29.1	20.4	17.6	15.2	12.7	9.7	9.2	7.5	6.9	6.3	5.7	16	688
		SQF 14A-3		SQF 5A-6	SQF 2.5-2				SQF 1.2-2							
		115	75.0	37.6	22.2	19.5	17.4	15.4	12.9	10.6	8.4	7.9	7.3	6.8	20	860
		SQF 14A-3		SQF 5A-6	SQF 2.5-2				SQF 1.2-2							

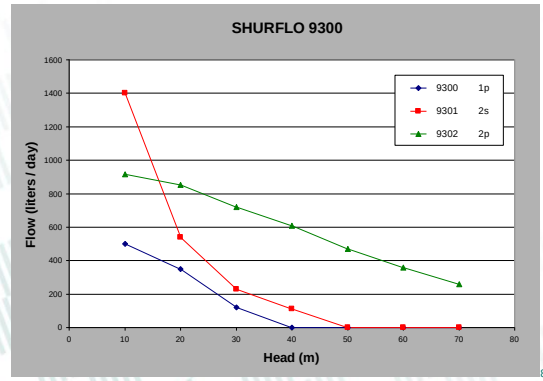
Verifying Data



27

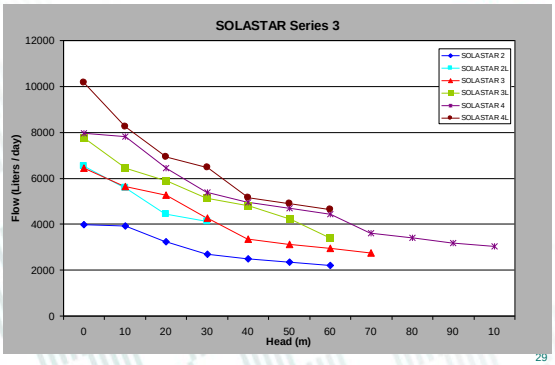
27

Test Data SHURFLO 9300



28

Test Data SOLASTAR



29

Causes of Limited Output

External causes

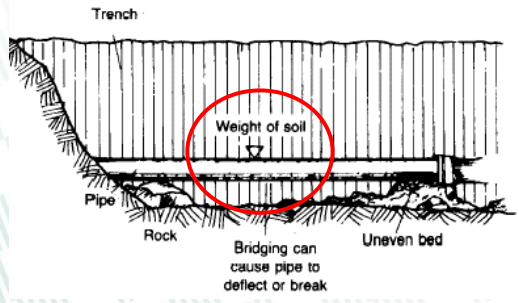
- inadequate planning data (e.g., pumping head)
- dirt-plugged pumps, pipes and valves
- shading of the PV generator
- underestimated temperature effects
- premature wear of system components due to corrosive substances in the water
- irregular use of water

System-specific causes

- output limitation imposed by the inverter on an oversized PV generator
- inverter mismatch losses, e.g., due to inaccurate control of the maximum power point
- PV-generator mismatch losses, e.g., due to a false combination of modules
- power reduction caused by defective system components

30

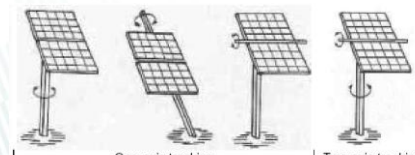
Burial of Pipes



31

31

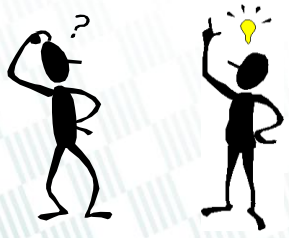
Tracking Systems



Tracking increases water output with 20% -30%

32

QUESTIONS ?



Gerrit Jacobs
ETC Energy

winter@etcnl.nl
PO Box 64
3830 AB Leusden
the Netherlands
T: +31 33 432 6025
F: +31 33 494 0791

33