

SOLAR ENERGY TECHNOLOGY

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Solar Pump Components and Functionality

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Indonesia

Training Course on Renewable Energy Part II - MEMR
CASINDO

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Structure of this Presentation

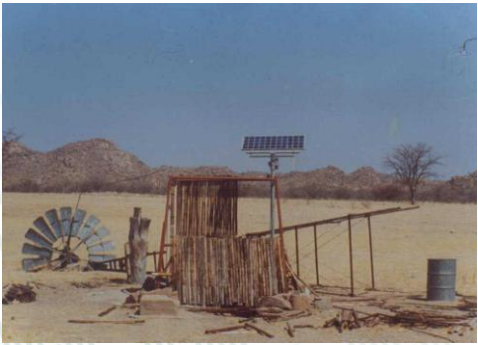
- PV pump applications
- Overview of pumping technologies
- Pump design
- Sizing
- Cost comparison between pumping technologies

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The fall of the Dinosaur


(source: Solar Age Namibia)



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PV Pumping Installation



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Overview of Pumping Technologies

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

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PV Pump Applications

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

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Water Requirements

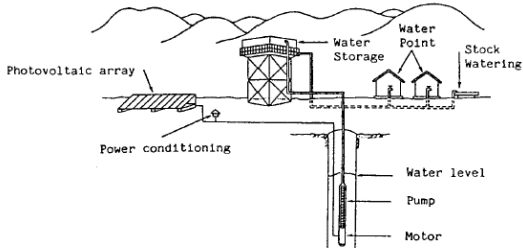
Drinking water		Water for animals		Water for irrigation	
Liters per person and day		Liters per head and day		Cubic meters per hectare and day	
Minimum	10	Horses	50	Rice	100
Normal	40	Dairy cattle	40	Cereal / grain	45
rural living conditions		Camels, donkeys	20	Sugar cane	66
		Pigs	20	Cotton	55
		Sheep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

Village Water Supply



Livestock and Game Watering

Solar Water Supply System

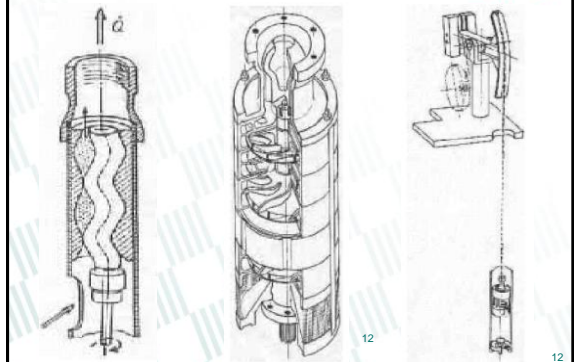


Pump Types

Helical Screw

Centrifugal

Reciprocating

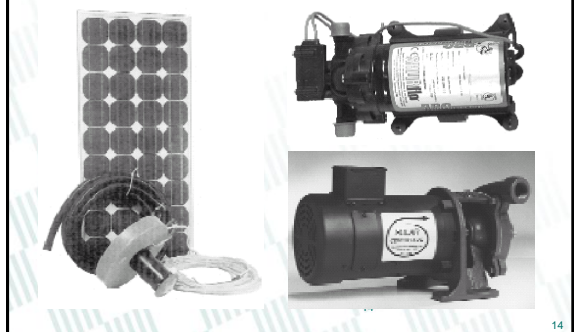


Helical Screw

Centrifugal



Pump Designs



Examples of Grundfos Pumps



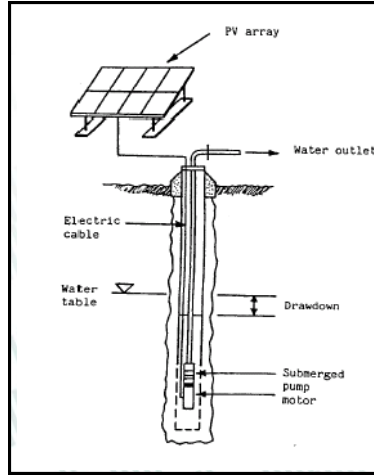
Inside the Pump (1)



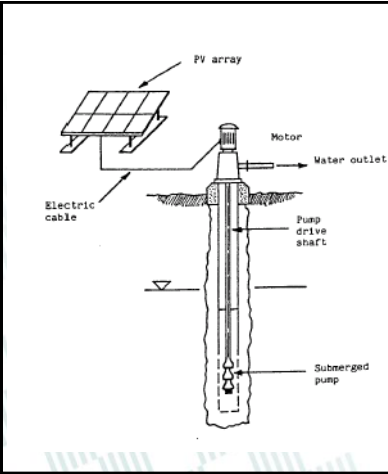
Inside the Pump (2)



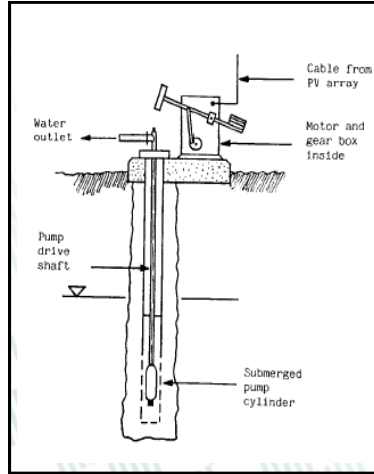
Submersed Multistage Centrifugal Pump

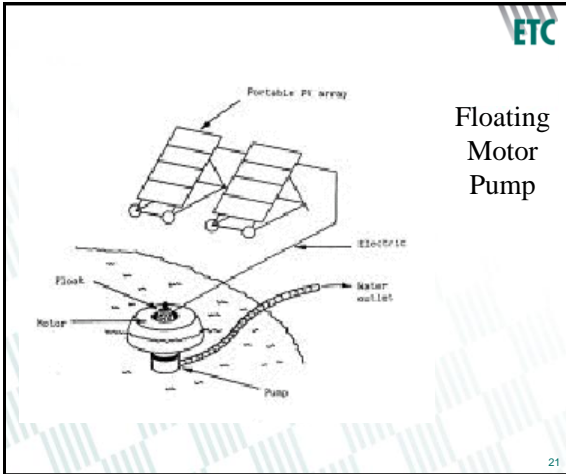


Submersed Surface Mounted Pump

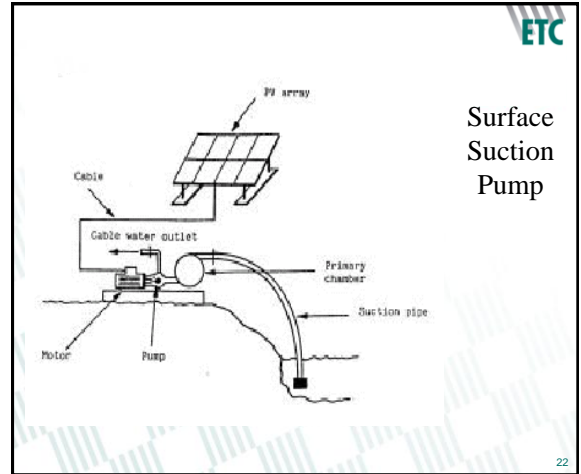


Reciprocating (Jack) Pump





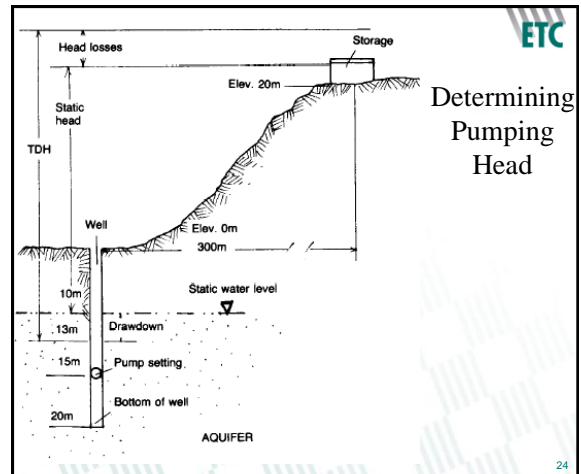
Floating Motor Pump



Surface Suction Pump

Typical System Specifications

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



Determining Pumping Head

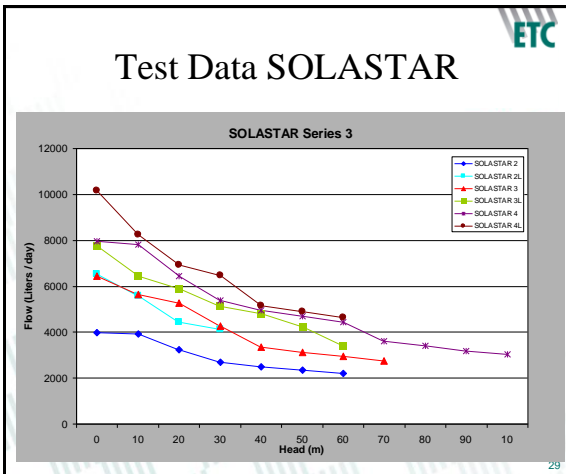
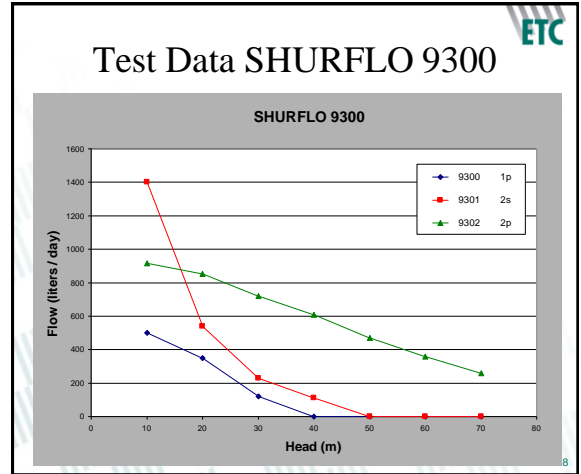
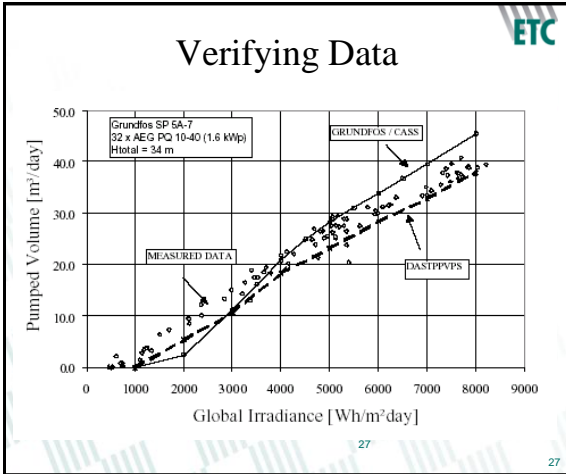
Empirical Formula

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

- P_{sp} is Power of Solar Panels in Wp
- H is Head in metres
- V_d is Volume of water in m³ / day
- G_d 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	80	90	100	110			120		
Zone K - tilt angle 30°	7.3 kWh/m ² per day	Required flow (m ³ /day)												4	172			
		SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2							
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2 (C)			SQF 0.6-2			8 (D)	344 (E)
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2				
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2			12	516
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2				
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2			16	688
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2				
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2			20	860
		SQF 14A-3			SQF 5A-3			SQF 2.5-2			SQF 1.2-2			SQF 0.6-2				



Causes of Limited Output

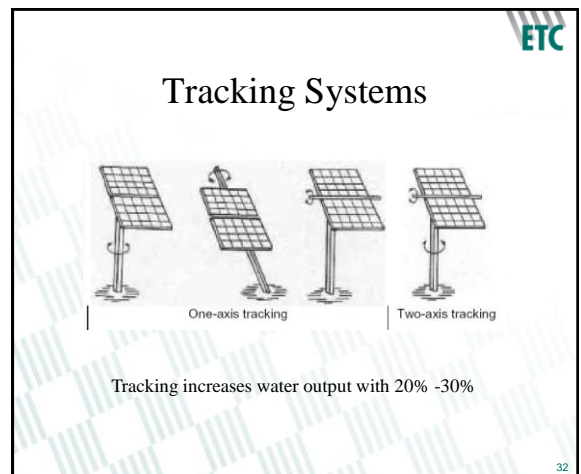
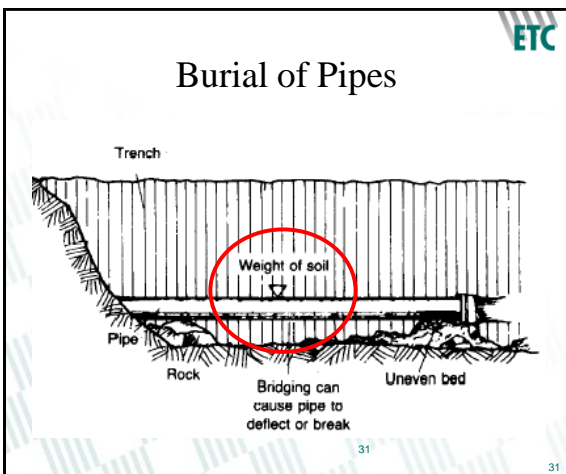
External causes

- 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

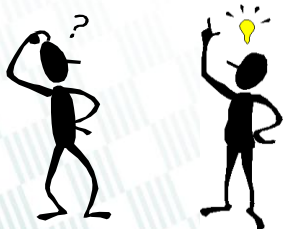
- output limitation imposed by the inverter on an oversized PV generator
- inverter mismatch losses, e.g., due to inaccurate control of the maximum power point
- PV-generator mismatch losses, e.g., due to a false combination of modules
- power reduction caused by defective system components

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QUESTIONS ?



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