

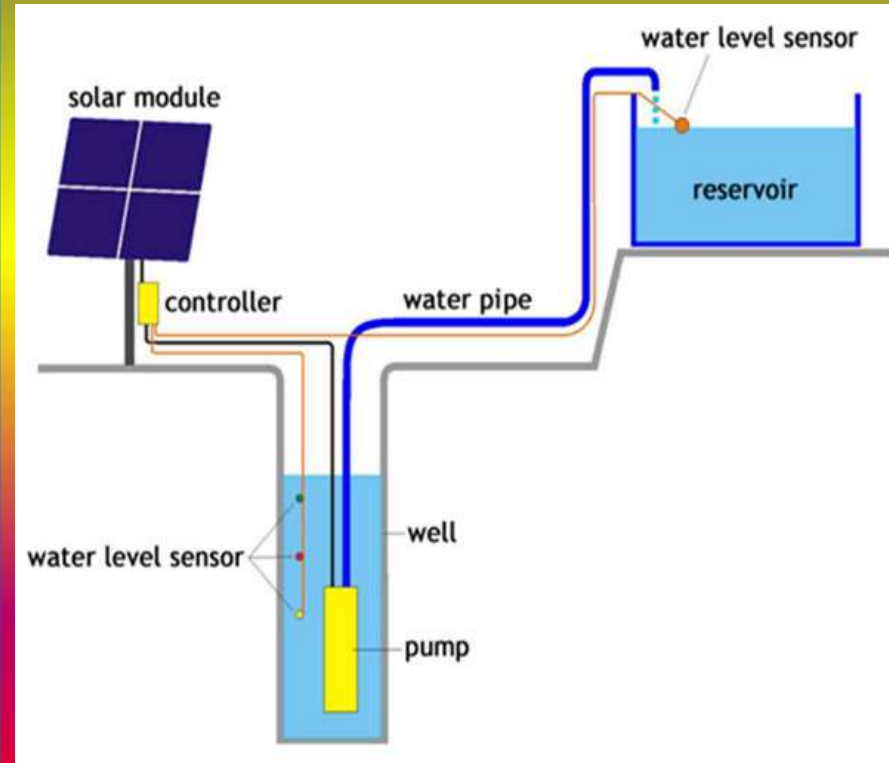
# **SPV Water Pumping Systems**

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# SPV Pumping: Principle

- **Sunlight - electricity power – motor – pump**
- **Online or storage**
- **Varying power input - varying water output**
- **Reliable stand-alone systems**
- **Requires no fuel and very little attention**



# Applications

- **Water supply**
  - Villages, schools, hospitals, homes
  - Resorts, hotels and farmhouses
  - Animal farms and poultries
  - Housing societies and apartments
- **Irrigation**
  - Farms, fields and greenhouses
  - Govt. forest departments
  - Corporate/ industry parks
  - Sprinklers and drip irrigation
- **Decorative**
  - Fountains
  - Water parks
  - Swimming pool recirculation
  - Watering of golf courses

# Components: Typical solar pump system

- **Pump and motor set**
- **Solar power conditioning unit (SPCU)**
- **Solar PV modules**
- **Support structure**
- **Pipes and cables**
- **Foundation**
- **Earthing kit**

# Advantages

- **Low operating cost:**
  - No fuel required e.g. electricity or diesel
  - Operating cost is minimal
- **Low maintenance:**
  - A well-designed solar system requires little maintenance
  - Just cleaning of the panels once a week
  - Spares easily available
- **Harmonious with nature:**
  - Maximum water – when most needed - hot and dry months
  - Slow solar pumping allows us to utilize low-yield water sources
- **Flexibility:**
  - Freedom regarding the placement of panels
  - Auto start and stop as per solar intensity with manual switch also
- **Additional source of power:**
  - Optional use as battery charger cum booster
  - Charge battery – a) morning & evening hours, b) when not running
  - Output can be used at night for CFLs, fans, TV etc

# Limitations

- **Low yield:**
  - Not suitable for high requirement
  - Smaller capacities
- **Variable yield:**
  - Out put uncertainty
  - Difficult planning irrigation
- **Dry operation:**
  - Surface pumps - very sensitive to dry run
  - 15 minutes or more can cause considerable damage
- **Water quality:**
  - Works best if the water is clean
  - Filter at immersed pipe end required
- **Theft:**
  - Theft of solar panels - a problem in some areas
  - Needs insurance theft as well as natural hazards

# MNRE Technical Specifications

- **PV array:**
  - 200 Watt to 5 KWp
  - Stable structure: facility of tracking the sun
  - Suitable for bore-well, open well, water reservoir, water stream
- **Motor Pump Set:**
  - Surface DC motor pump – with brush and brushless
  - Submersible DC motor pump – with brush and brushless
  - Surface AC induction motor pump – with electronic controller
  - Submersible AC induction motor pump - electronic controller
  - **Mono block: driving unit and impeller - on a common shaft**
- **Electronics:**
  - Solar power conditioning unit
  - Maximum Power Point Tracker (MPPT)
  - Controls and protections
- **Accessories:**
  - Interconnect Cables and “On-Off” switch
  - Water level sensor

# Types of Motor Pumps



Deep well submersible



Shallow well Submersible



Open well submersible



Shallow well surface pump



# SPV Modules

- **Mono/ multi crystalline silicon solar cells**
- **SPV array: Series and parallel combination of modules**
- **Each module: Minimum 74 Wp at STC**
- **Output: IEC 61215 certified**
- **Safety qualification: IEC 61730 Part I and II certified**
- **Minimum efficiency: 14%**
- **Minimum fill factor: 70%**
- **Output wattage Warranty:**
  - **Minimum 90% at the end of 12 years**
  - **Minimum 80% at the end of 25 years**

# **MOUNTING STRUCTURES/TRACKING SYSTEM**

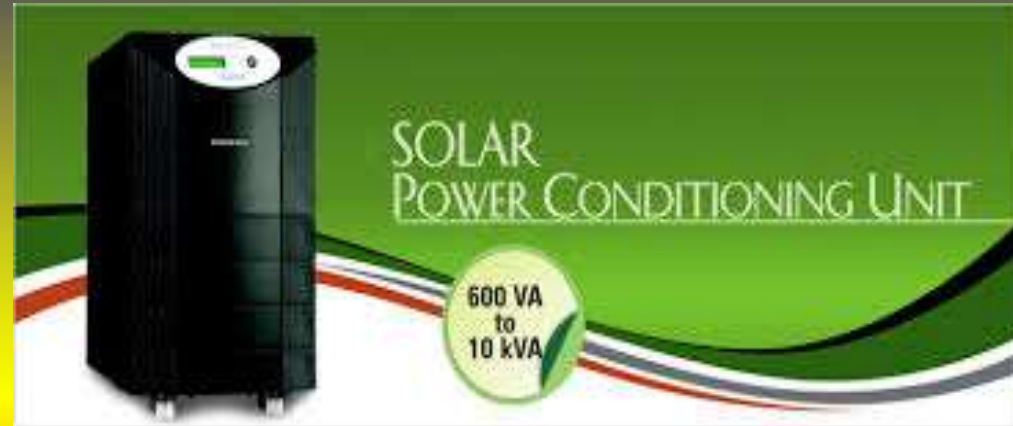
## **Mounted on metallic structure:**

- Angle iron: Minimum 50x50x5 mm**
- Mild steel, hot dipped galvanized (120 micron)**
- Withstand wind speed of 150 Km/hr**

## **Tracking system:**

- Auto tracking suggested**
- Manual tracking must:**
- Angle adjustment provision**
- 10 to 40 degrees - steps of 10 degree**
- Seasonal tilt angle adjustment**
- Three times manual tracking in a day**

# Electronic Controls and Protection



## Maximum Power Point Tracker

- The motor input power is instantaneously and automatically adjusted by varying the operating frequency to match the maximum output power available from the Solar PV panels at different sun intensities
- Efficiency: solar panel, pump and motor maximized

## Electronic Protections

- Dry run protection
- Under voltage and over voltage protection
- Reverse polarity protection
- Soft start for the ac induction motors
- Output short circuit protection
- Protection from lightning

# Water Discharge Norms

Type	Model I	Model II	Model III	
	PV-900W, TDH-12m	PV-1800W, TDH-15m	PV-2700W, TDH-25m	
Shallow Well DC	90,000 lpd at 10 m	1,80,000 lpd at 10 m	1,48,000 lpd at 20 m	
Shallow Well AC	81,000 lpd at 10 m	1,62,000 lpd at 10 m	1,35,000 lpd at 20 m	
	Model IV	Model V	Model VI	Model VII
	PV-1200W, TDH-45m	PV-1800W, TDH-45m	PV-3000W, TDH-70m	PV-4800W, TDH-70m
Deep Well DC	42,000 lpd at 30 m	63,000 lpd at 30 m	63,000 lpd at 50 m	1,00,000 lpd at 50 m
Deep Well AC	38,000 lpd at 30 m	57,000 lpd at 30 m	57,000 lpd at 50 m	91,000 lpd at 50 m

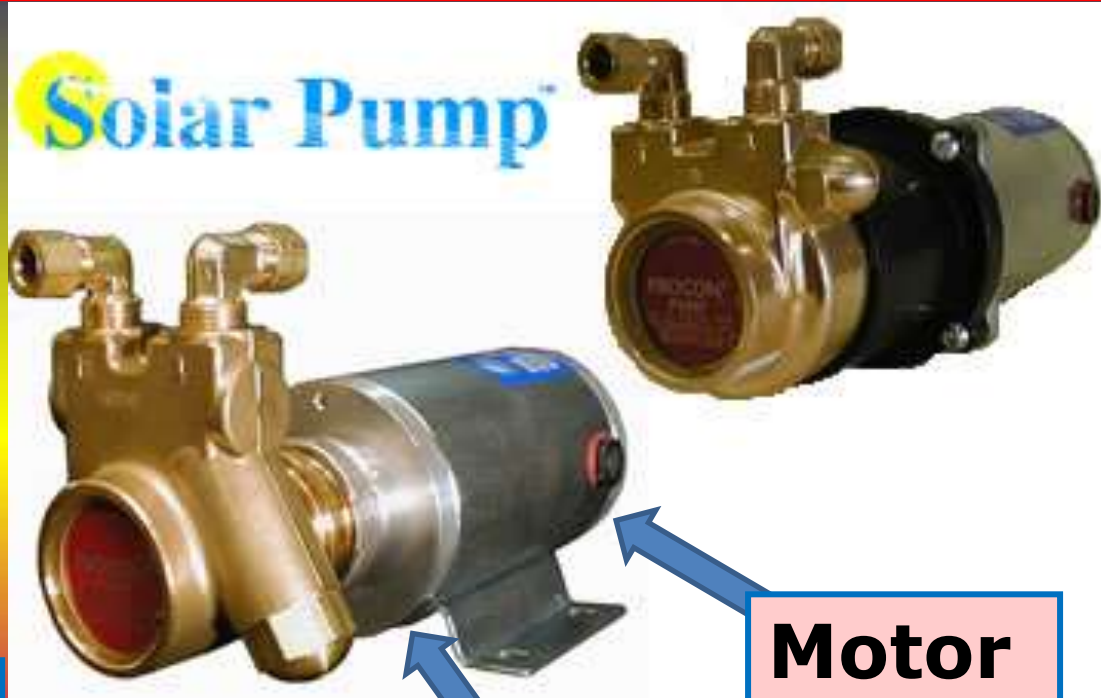
**\*Under the "Average Daily Solar Radiation" condition of 7.15 KWh/ sq.m.**

# Special Instructions

- **Whole system:**
  - 5 years warranty
  - Spares: provide with system
- **Prefer 'Surface Motor Pump sets" : 10m depth**
- **Pump must match total dynamic head requirement of the site**
- **Must meet water discharge norms**
- **Select appropriate model as per site requirement**

**Two big questions?**

# Motor and Pump Combination



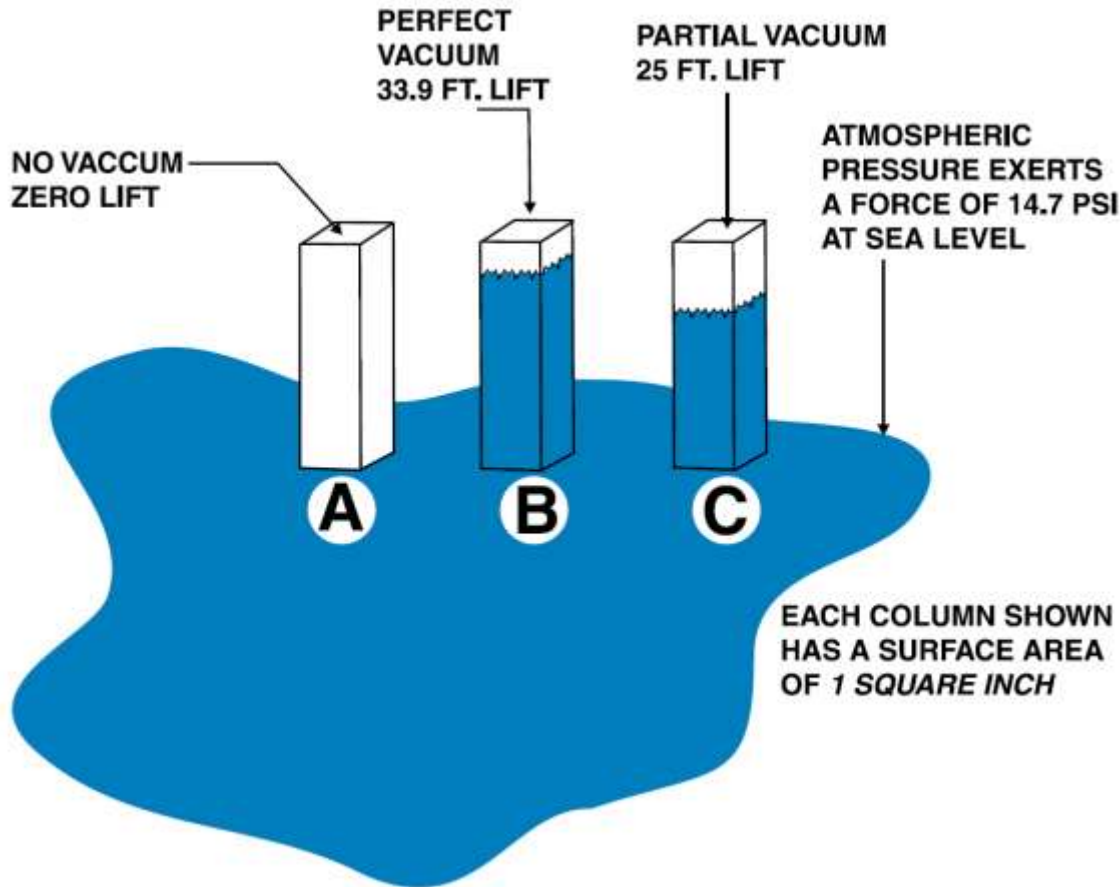
**Pump**

**Motor**

**Coaxial joint**

- **Motor provides spinning action**
- **Pump creates vacuum or pressure**
- **Proper combination is necessary**

# Basics of Pump



## Calculation of Theoretical Suction Lift:

- Atmospheric pressure at sea level: 14.7 (lb/in<sup>2</sup>)
- Density of water: .0361 (lb/in<sup>3</sup>)
- $14.7 \text{ (lb/in}^2\text{)} \div .0361 \text{ (lb/in}^3\text{)} = 407.28 \text{ (in)}$
- $407.28 \text{ (in)} \div (12 \text{ in/foot)} = 33.9 \text{ (ft)}$

- **33.9 ft (10.33m)** - maximum theoretical height water can be lifted under perfect conditions at sea level
- **25 ft(7.62m)** - practical suction lift, attainable for cold water (60°F) at sea level by creating a partial vacuum



# Centrifugal Pump

Impeller eye



Impeller

Volute

CENTRIFUGAL

TRASH

HIGH PRESSURE

IMPELLERS



A



B



C

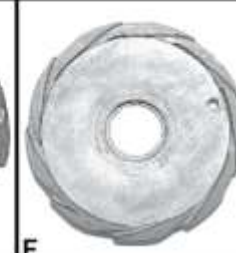
VOLUTES



D



E



F

## Pump capacity

- Impeller diameter
- Number of impellers
- Eye or inlet opening size,
- Speed of the shaft rotation
- Capacity 1psi = 2.31 ft

## •Impeller: Rotating disk

- Set of vanes coupled to motor shaft
- Produces centrifugal force

## •Volute: Stationary housing

- Impeller rotates in it
- Collects and re-circulates water

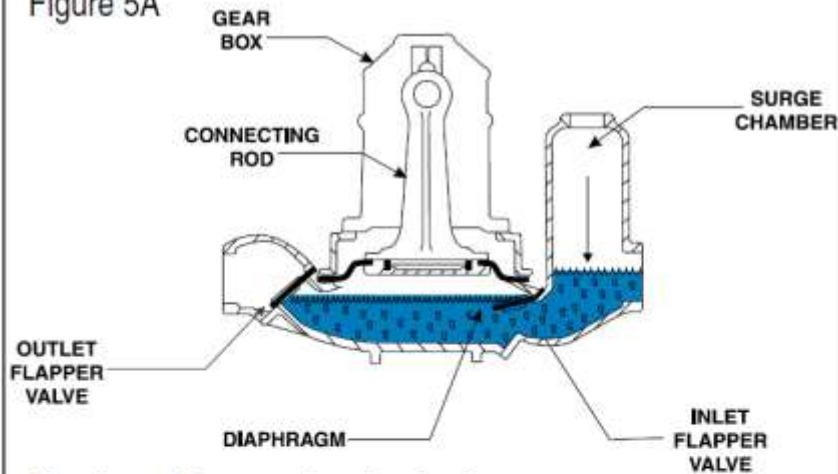
## •Vacuum/ pressure created

## •Water moved through casing



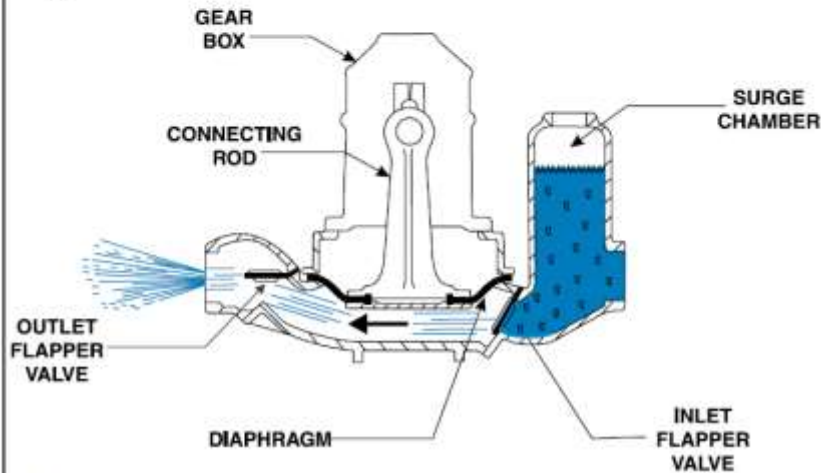
# Positive Displacement Pump

Figure 5A



*Diaphragm Pump — Suction Stroke*

Figure 5B



*Diaphragm Pump — Discharge Stroke*

- Uses piston or diaphragm
- Positive displacement design
- Pump specific amount of flow per stroke, revolution or cycle
- Motor shaft turns connecting rod
- Connecting rod alternately raises (expands) and lowers (contracts) the diaphragm
- Expansion-contraction pumps water
- Inlet and outlet valves used alternatively

# Submersible Pumps

- Centrifugal type
- multi-stage
- Motor joined/submerged in water
- Most energy: to push water rather
- Mounted on a single shaft
- Each impeller passes the water to the eye of the next impeller
- The pump and motor assembly lowered into the well
- Pump always filled with water (primed) and ready to pump



Impeller /  
Diffuser  
Stack

# Comparision

- **Piston and diaphragm type**
  - **Complex with lots of moving parts**
  - **Needs lubrication – pollution**
  - **Useful for shallow well**
- **Centrifugal pumps**
  - **Simple**
  - **Low maintenance**
  - **Can work with variable speed**
  - **Useful: both low and high water table**
  - **Useful for surface and submerged application**
- **MNRE Choice:**
  - **Mono block: driving unit and impeller - on a common shaft**
  - **Naturally centrifugal preferred**

# Motor Drive

Feature	Brushed	Brushless	AC induction
<b>Commutation</b>	Mechanical	Electronically	Electronically
<b>Maintenance</b>	High	Low	Low
<b>Electrical Noise</b>	High	Low	Low
<b>Life</b>	Shorter	Longer	Longer
<b>Speed/Torque Characteristics</b>	Moderately flat	Flat	Flat
<b>Efficiency</b>	Medium	High	Low
<b>Motor Size</b>	Larger	Smaller	Smaller
<b>Speed ranges</b>	Commutator limits speed	Can rotate high speeds	Can rotate high speeds
<b>Audible noise</b>	High at high speeds because of brushes	Low	Low
<b>Cost</b>	Less expensive	Expensive	Inexpensive
<b>Control Requirements</b>	No controller required for fixed speed	Controller required	Controller required

- **DC brushless: highly desirable**
- **AC induction: good compromise**

# Cost and Subsidy

## MNRE Benchmark cost:

- **DC Pump:**
  - Rs. 190/- per watt i.e. Rs. 1,90,000/- per kW
- **AC Pump:**
  - 15% less as compared to DC
  - Rs. 161.5/- per watt i.e. Rs. 1,61,500/- per kW
- **Subsidy:**
  - 30% of benchmark cost of actual whichever is less
- **Net cost:**
  - DC - Rs. 1,33,000/- per kW
  - AC - Rs. 1,13,050/- per kW

# Pump Terminology and Concepts

- **Static Suction Lift** — Water level to impeller axis
- **Dynamic Suction Head** — Static suction lift + pipe friction (Also known as *Total Suction Head*)
- **Static Discharge Head** — Pump outlet to water tank
- **Dynamic Discharge Head** — Static discharge head + friction in the discharge line (Also known as *Total Discharge Head*)
- **Total Dynamic Head** — The Dynamic Suction Head plus the Dynamic Discharge Head (Also known as *Total Head*)

**\* TDH important for pump selection**

# Designing

## Housing society water pumping system:

- **Number of flats: 20**
- **Number of persons per flat: 5**
- **Total occupancy: 100 persons**
- **Water requirement per person: 150 lpd**
- **Total water requirement: 15000 lpd**
- **Lower storage tank: Underground 3 m depth**
- **Motor position: 1 m above ground**
- **Storage Tank height: 12m**
- **Total static head: 16m**
- **Friction head loss (2" dia GI pipe): 0.15-0.20 ft per ft**
- **Add pipe friction head loss: 4m (approx.)**
- **Total Dynamic head: 20m**

# Designing

Water pumped (in '000 litres per day)

	150Wp	300Wp	600Wp	900Wp	1200Wp	1800Wp	2400Wp
10 m	7.5	18.7	37.1	54.5	70.9	87.5	94.6
30 m	3.6	7.8	15.1	26.5	35.6	50.9	57.8
50 m	2.3	5.0	9.6	14.2	21.1	34.1	45.6
60 m		4.3	8.0	12.3	16.6	27.0	38.1
80 m		3.1	5.9	8.7	12.3	18.5	21.2
100 m			4.4	5.4	8.6	14.7	18.3
120 m			3.0	4.8	5.2	10.5	15.1
150 m				2.9	3.9	5.0	9.2

- **Solar DC shallow well water pumping system**
- **900 Wp or 1hp pump preferred as safe option**
- **Extra capacity can be used to charge battery**



# THANK YOU

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