



***Solar Pumping System under PM-
KUSUM Yojana
Evaluation Requirements
and Challenges
Case Studies***

R P Singh
ERDA Vadodara

Introduction



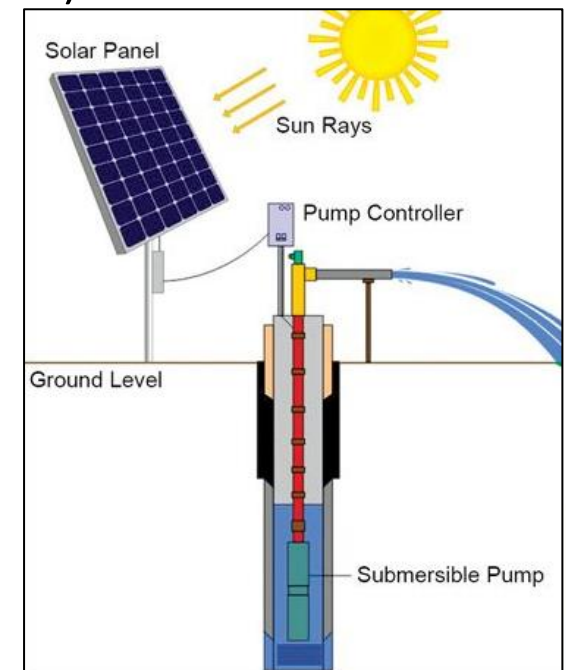
- There are many challenges for the evaluation of the performance of the solar PV powered pumping systems.
- MNRE has introduced the specification for solar pumping system.
- ERDA has the state of the art test facility for the testing of the Solar pumping system as per MNRE specification.
- ERDA has also design and development facility for Solar Pumps and Motors
- Facilities are MNRE, NABL and BIS approved.
- ERDA has also the facility for other balance of the system like Cable, DC/ AC Switches, Inverters, Lightning arresters, Earthings etc.

Components of Solar Pumping System



Below are the major components of the Solar Photovoltaic Pumping System

- a. Solar Photovoltaic Modules
- b. Inverter/Converter with MPP tracker
- c. Remote monitoring unit (internal or external)
- d. Motor & Pump set
- e. Balance of System like
 - a. Mounting Structure,
 - b. Earthing System and
 - c. Lightning Arresters
 - d. Sensors etc.



Requirements of Solar pumping systems



- Under PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) the Ministry of new and renewable energy (MNRE) provide financial subsidy to state utilities for installation of Solar pumping system.
- The new MNRE Specification has set requirements for the Solar pumping systems.
- This specification gives general requirements of various component of solar pumping system.
- It gives requirement of water output performance.
- It describes safety requirements
- It also gives requirement of materials.
- Warranty and guarantee is also defined in specification

Requirements and testing of SPV Modules



Modules must be certified as per IS 14286 or IEC 61215, IEC 61730-1 & IEC 61730-2 & IEC 61701, IEC TS 62804-1:2015-1

Efficiency $\geq 19\%$ and fill factor $\geq 75\%$.

Mismatch in array must be within $\pm 3\%$.

Array Power shall be more than minimum wattage requirements

Warranted output wattage $\geq 90\%$ power for 10 years and $\geq 80\%$ till 25 years.

Requirements...



- Modules must qualify to IEC TS 62804-1:2015 for the detection of **potential-induced degradation** - Part 1: Crystalline silicon (Mandatory in case the SPV array voltage is more than 600 V DC)
- In case the SPV water pumping systems are intended for use in coastal areas the solar modules must qualify to IEC TS 61701:2011 for salt mist corrosion test ,
- During testing, modules must be clean, connection must be tight, cable must be proper in size



Requirements of Motor-Pump Set

- **Type of Installation**
 - Surface mounted motor-pump set
 - Submersible motor-pump set
 - Floating motor-pump set
- **Type of operation**
 - AC Induction Motor.
 - DC Motor [PMSM/BLDC/SRM (with brush or brushless)]
- **Capacity**
 - It covers the capacity from 1 HP to 10 HP (Now Increased to 25 HP)
- **Material of construction:**
 - The pump and all external parts of motor used in **submersible pump** which are in contact with water, should be of stainless steel of **grade 304** or higher as required.
 - The motor-pump set should have a **5 years warranty**.
 - All cables used shall be as per IS 694 or IS 9968(Part 1).

Requirements of Controllers



Controllers must conform to the following requirements

Remote monitoring

Shall be integrated with GSM/GPRS Gateway with Geo tagging.

IP 65 .

Protection against:

Short Circuit,

Open Circuit,

Under voltage,

Dry run,

Reverse polarity,

Surge Current &

Lightening



IS/IEC: 60947-2 Certified DC switch

MPPT efficiency shall be 98% in 10% to 100% of power

Shall work without any resetting after initial setting

Requirements..



- **Module Mounting Structures and Tracking System**
- The PV modules should be mounted on metallic structures of adequate strength and appropriate design, which can withstand load of modules and high wind velocities up to 150 km per hour.
- The module mounting structure should be hot dip galvanized according to IS 4759. Zinc content in working area of the hot dip galvanizing bath should not be less than 99.5% by mass
- Seasonal tilt angle adjustment and three times manual tracking in a day should be provided.

Requirements of Solar pumping systems



Earthing

- Earthing of the motor shall be done as per IS 9283 in accordance with the relevant provisions of IS 3043. Separate earthing shall be provided for Controller, pump and SPV array

Lighting arresters

- A lightning arrestor shall be provided with every SPV Water Pumping System, it shall be as per IEC 62305 and IEC 63227

Use of indigenous components

- It will be mandatory to use indigenously manufactured solar modules with indigenous mono/ multi crystalline silicon solar cells. Further, the motor-pump-set, controller and balance of system should also be manufactured indigenously.
- The vendor has to declare the list of imported components used in the solar water pumping system.

Factors Affecting Performance



- Solar irradiance
- Cell temperature
- Tracking of solar modules
- Cloud /shadowing
- Motor technology
- Pump technology
- Static Suction Lift of surface pumps



Challenges for industry

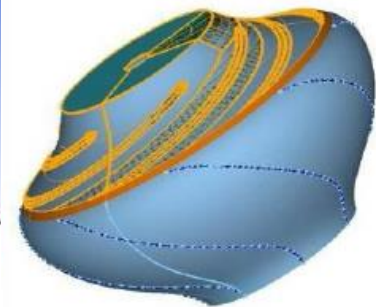
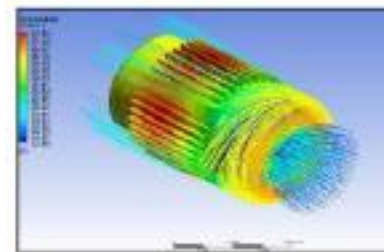
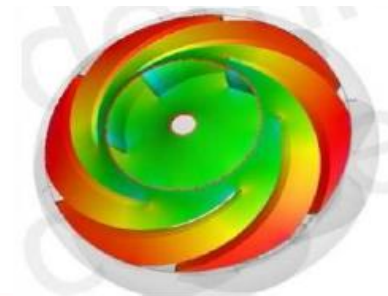
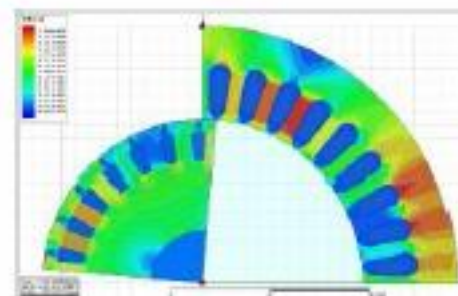
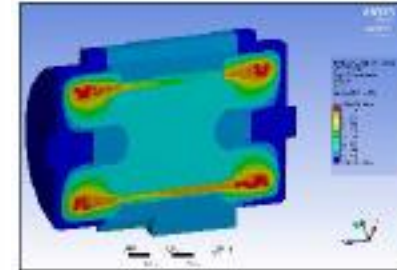
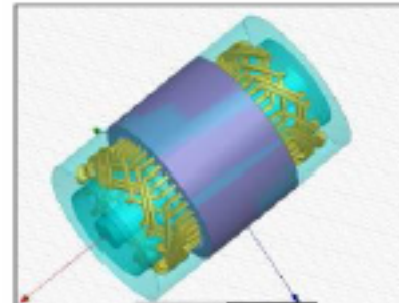


- Efficient Motor design and manufacturing
- Efficient Stainless steel Pump design and manufacturing
- Controller with high Conversion and MPPT efficiency
- Controller IP 65 protection
- Controller Remote Monitoring facility
- Testing of Prototype and final product (Completer Solar Pumping System)

Challenges for industry



- ERDA has state of art facility to design motors and Pumps and controllers as per requirements of the MNRE specification
- ERDA Has following software packages
- Ansoft RmXpert
 - Design of Motors
 - Performance evaluation
 - Optimization
- Ansoft Maxwell 2D/3D
 - Finite Element analysis
 - Electromagnetic analysis
 - Electrostatic Analysis
 - Thermal Analysis
 - Coupled Analysis
- CF Turbo & Simerics
 - Submersible pump design using CFD Analysis
 - Performance optimization of Pumps
 - Validation through testing

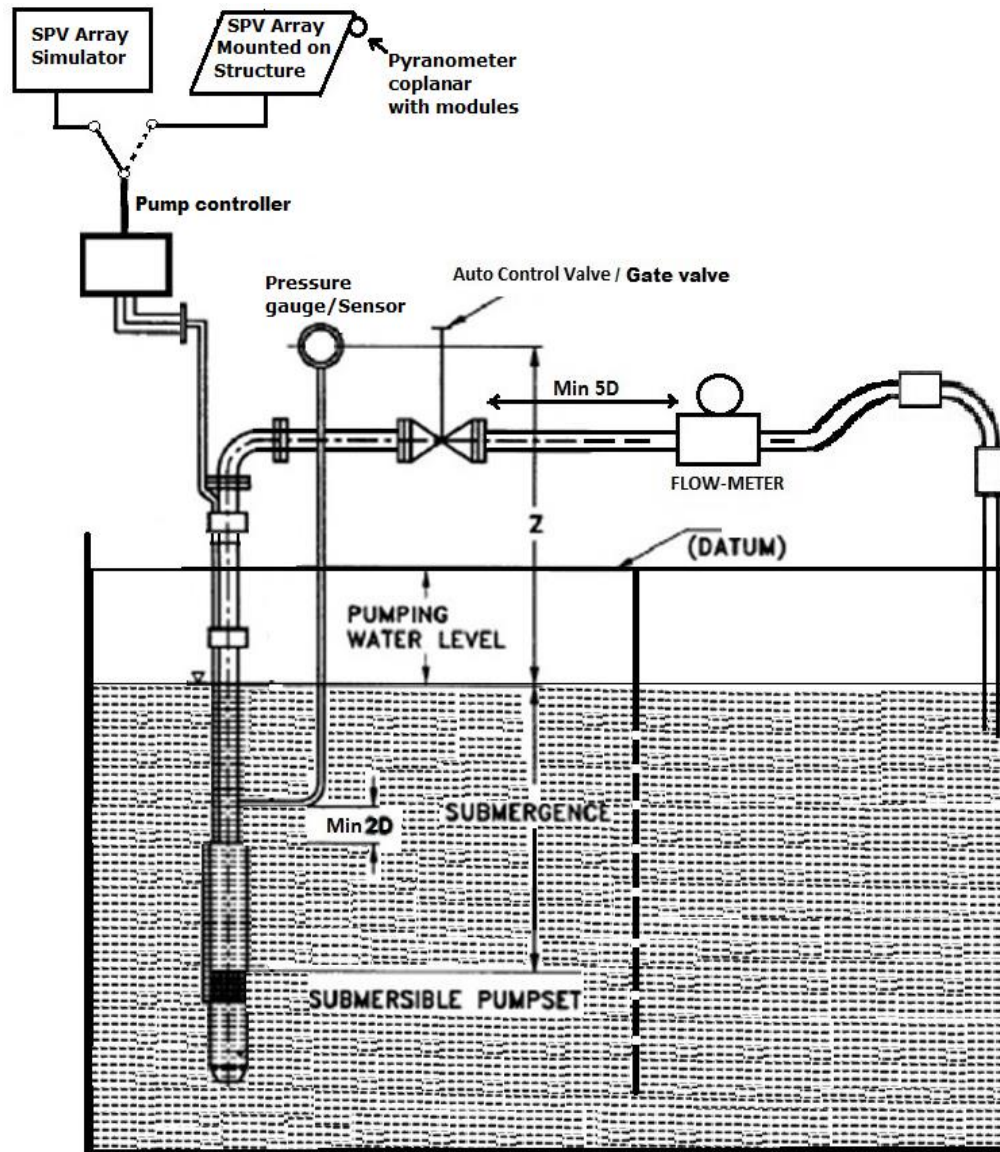


Testing of Solar Pumps Requirements



1. Module maximum power determination at STC (Standard test Condition)
2. IP 65 test of controller /controller housing.
3. Controller protection test
4. Remote monitoring facility verification
5. System performance test
 - a) Test at Hot profile of irradiance and temperature
 - b) Test at Cold profile of irradiance and temperature
 - c) Test at Realistic (outdoor) condition using modules from sunrise to sunset.

Test Setup – Submersible pumps

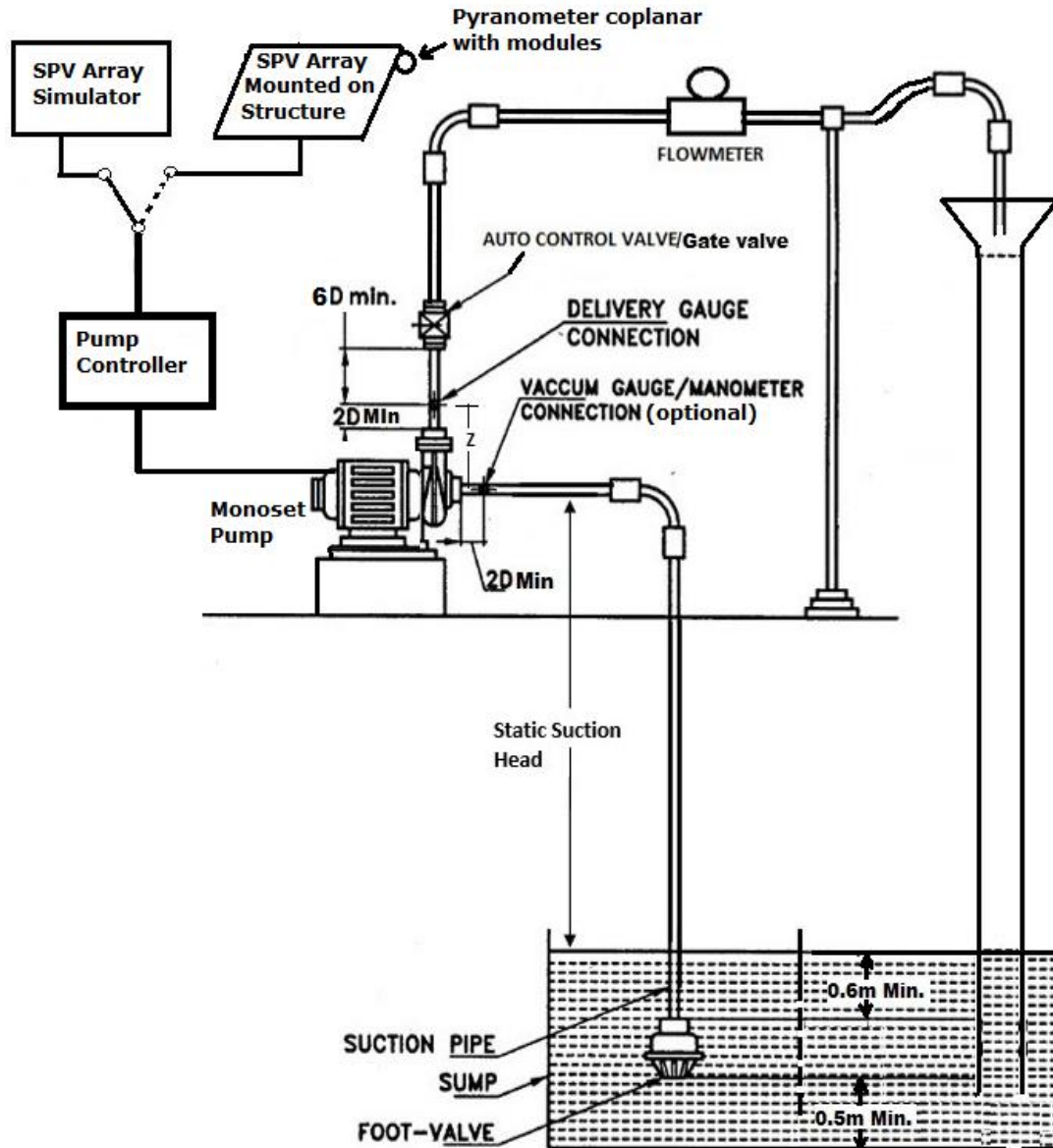


Minimum requirements of test setup given in figure must be fulfilled to minimize the error in testing.

All reading must be recorded, continuously in an interval of 1 minutes or less



Test Setup - surface pumpset



Here **static suction lift** must be maintained during testing as per minimum requirements

Minimum requirement given in figure must be maintained.

Test Setup – Measuring Instruments



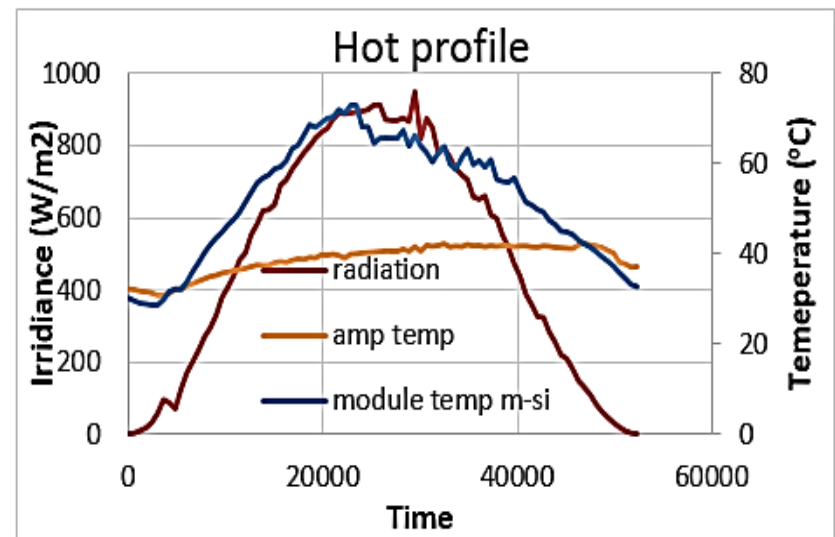
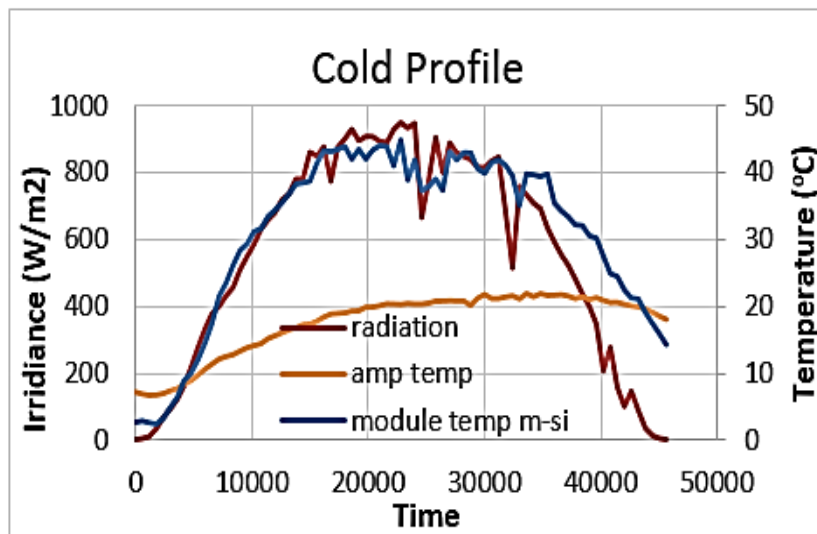
- Measuring instruments such as pressure transmitters, flow transmitters, Pyranometers etc must be precise.
- Data logging must be frequent at least 10 second or less.
- Head controlling valves must control head as per required head band.



Testing on Simulation Profiles



- Both profile are equally significant in view of comprehensive performance of the pumping system.
- Generally hot profile gives less water flow and cold profile gives higher water flow.
- STC data entry in simulator should be correct.



Testing in Outdoor Condition



Testing in outdoor condition is mandatory.

Because it gives overall performance of each and every components of SPV water pumping system

Here sunrise to sunset irradiance shall be measured for flow calculation

Clear Sunny day should be there for testing

Case Study -1



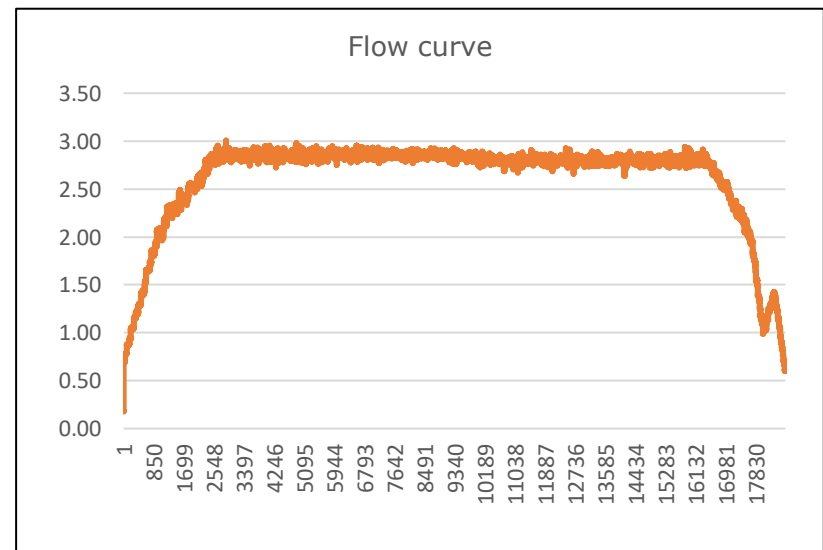
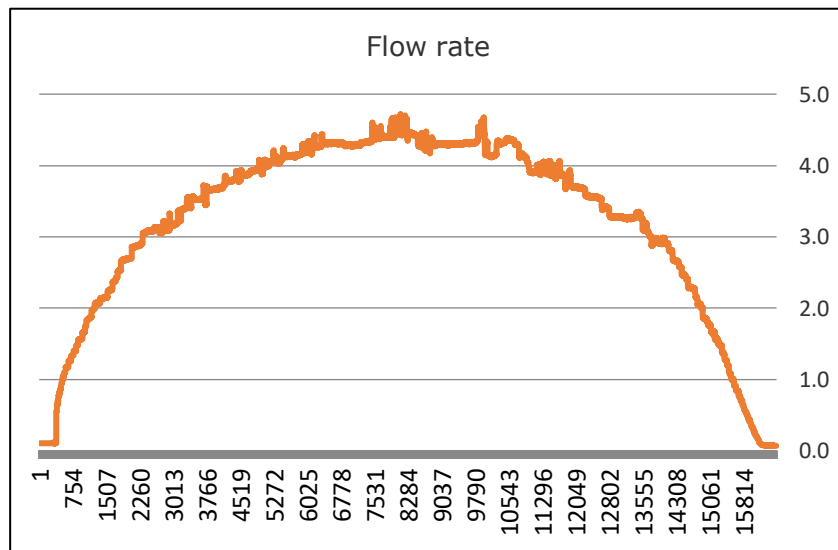
MPPT not working properly:

- Maximum power point tracking (MPPT) efficiency of controller is very important for the satisfactory performance of complete solar pumping system.
- In general the water output in cold profile is always more (5%-10%) as compared to Hot Profile. Due to negative temperature coefficient.
- But here in case study it is found that the water flow in cold profile is even less than the hot profile.
- Though the solar power available from the simulator is more in cold profile but output flow was low.
- MPPT is working in a certain voltage range and beyond that range MPPT efficiency become low.

Case Study -1



- Here per day water flow in cold profile was 97542 liters however in hot profile it was 99548 liters.
- Flow rate pattern must follow irradiance profile but here it become flat above a certain level of irradiance, hence water output is less.



Case Study -2





Performance comparison of centrifugal and screw pumps in 1HP and below rating

- Solar pumping system with screw pumps are performing better in 1 HP and below ratings with comparison to centrifugal pumps.
- Both technology has its own advantage and disadvantage however for the clear water the screw pump is the best performer especially in lower rating. Only issue with screw pump is that, its reliability reduces if sand is present in water.

Case Study -2



- Performance comparison of centrifugal and screw pumps in 1HP and below rating
- The per day water output is higher than centrifugal based pumps

Model	Screw Pump	Centrifugal Pump
		
1 HP, 60 m	21395 litre	11071 litre
1 HP, 90 m	12154 litre	6234 litre

Conclusion



- Solar pumping system is the major component which can really help to Indian farmers who are using diesel/petrol driven pumping system.
- More Solar pumping system need to be deployed in agriculture field.
- The product quality control needs to be assured by taking field samples and testing of these SPV water pumping system should be carried out at an accredited laboratory.

Thanks

Any Question ?

