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Cost benefit analysis of adopting solar energy pumps for jalswarajya schemes in Sangli district: A case study.

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Abstract— The work undertaken to assess, Jalswarajya schemes in Sangli district resulted with reasons of scheme failures, one of the reason for failure was high electrical charges for pumping water. This study was undertaken to provide an alternative solution to the same, one alternative we thought off was solar pumps instead of electrical. This paper highlights the benefits and cost analysis of using solar pumps, with case study details of application and calculations are leistered in this paper.

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1 INTRODUCTION

OUR world is full of energy. We can save money and help to reduce air pollution using renewable energy sources such as solar or wind power, for our home or irrigation (drip) or for live stock water wells. Wind and solar energy can be excellent options in remote areas where the cost of extending transmission lines are high or the cost of electricity charge is on higher side as well as there is cut off of electricity for more than 10 hours a day. It is also important to consider the cost of buying and using a pumping system, which includes initial cost, energy cost and maintenance cost.

Where utility power is not readily available solar systems are often the most economical option ,factoring in all costs, such as installation, fuel, maintenance and water pumping are often less expensive than generators, windmills and running electrical lines. With solar water pumping system a customer has an accurate forecast of the cost to run and maintain them, as they have paid their energy cost up front. There may be tax credits and incentives that lower investment costs.

2. COMPARISON OF SOLAR SYSTEM WITH WINDMILL –

Both the initial and lifetime costs of solar powered system are far less than windmills due to lower shipping, installation and maintenance costs.

Solar pumps operate anywhere the sun shines, while windmills work where there is steady, constant wind supply.

Wind mills are stationary while solar systems can be more easily moved to meet seasonal or variable location needs.

Depending on the application, a solar pumping system may use water storage tank which acts like a "water battery" during cloudy weather but for wind mills there is no option.

Against this backdrop, renewable energy comes as the perfect answer derived from natural processes. That is replenished constantly and is sustainable in the sense that they can never run out. Moreover, solar energy the mother of all renewable energies is the ideal solution. It is perfect combination of 3 Es

2.1 Energy – Solar energy is plentiful and virtually inexhaustible. Studies shows that the energy needs of our entire planet can be addressed by the power of the Sun alone.

2.2 Ecology- Solar energy is clean, silent and generates no waste. Thus it does not contribute to global warming or create any environmental hazard. It allows compliance under the Kyoto Protocol and where required, enables users to quality for carbon credits with reduced carbon footprints.

2.3 Economy: - Being free of cost solar energy always has an attractive payback from the perspective of life cycle cost. At best, it is fixed cost that is insulated against increasing energy cost.

3. SOLAR PUMPING SYSTEM:-

3.1 Advantages:-

- Full day automatic operation Switch on and Off automatically in the morning and evening respectively.
- Free and renewable source of energy.
- Saving in electricity Bills.
- Durable and reliable.
- Minimal maintenance required.
- Handy and easy to operate.

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- Can replace conventional pumps where there is electric grid.
- Pollution free and environmental friendly.

3.2 Features of solar inverter -

Battery less operation:-

Variable frequency drive incorporated for smooth operation even during minimum sun light. Transformer less design makes the product 'cost effective' and smaller in size.MPPT incorporated to track maximum power and gives 35% more energy from the panel. Maximum torque at minimum sunlight

3.3 Site requirements –

1. Space to mount panels.
2) Technically designed panel- Mounting structure.
3) Pump House to house inverter.

3.4 Product Performance Range:-

Parameters	Solar Bore well Submersible	Solar surface	Solar Open well submersible
Water output @65Kw hr./Sqm/day	2,500 to 7,50,000 Lit/day	5000 to 12,00,000	35000 to 6,00,000
Total dynamic pump head	5 to 200 m.	10 to 150 m	8 to 40 m
Solar modules Wattage	500 to 30,000 Wat up	500 to 28000 up	500 to 10000 up

3.5 Prices of submersible/Surface solar water pumping system for AC Pumps-

Battery less based solar water pumping system (Without pump)

Sr.No.	Type	Complete unit price including inverters and Panel
1.	3 KW water pumping system with PV panel, MPPT Charger, inverter (for 3 H.P. Pumps)	3.5 Lakhs
2.	4 KW ---- do ---- (4 HP)	4.5 Lakhs
3.	5 KW ---do--- (5 HP)	5.00 Lakhs
4.	7.5 KW –do-- (7.5 HP)	7.00 Lakhs
5.	10 KW --- do ---- (10 HP)	9.00 Lakhs
6.	15 KW --- do ---- (15 HP)	14.5 Lakhs

Standard Pumping system consist of

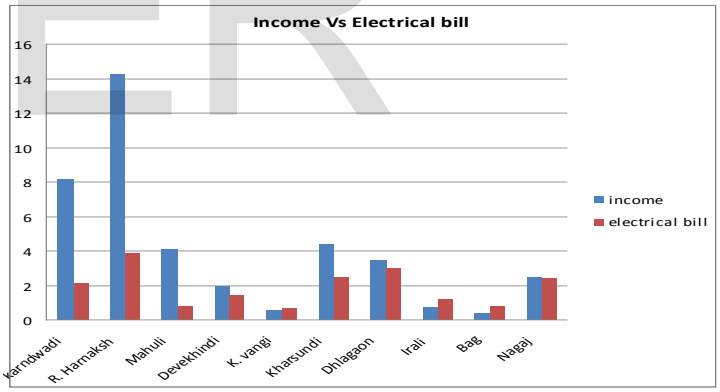
a) PV Array (Solar modules)
b) Pump.
c) Pump Controller
d) Safety disconnects and
e) Flushing.

The gap between supply and demand of electricity is not only huge but widening by the day. Add to this, the grim facts that power and fuel prices are inexorably climbing and power supply when available is also very erratic.

4. CASE STUDY :- DATA COLLECTION

Through the survey done in ten different villages from various tahasils, consumption of electricity for the Jalswarajya Scheme is one of the most important points for successful running of Jalswarajya Scheme. Increase in unit rate of electricity increases the bill amount; this higher cost is one factor resulting in scheme failure. Table 1.1 below shows these charges compared with income through water charges. Figure 1 shows the graphical representation of the same.

Sr. No.	Village	Elect. Charge (annual)	Income (annual)
1	Karandwadi (Walwa)	2,16,000	19000
2	R. Harnakshi (Walwa)	3,90,000	1425000
3	Mahuli (Khanapur)	84,000	4,11,66
4	Devekhindi (Khanapur)	1,42,708	1,97,550
5	Kherade Wangi (Kadegaon)	72,000	61,600
6	Kharsundi (Atpadi)	2,50,000	4,40,000
7	Dhalgaon (K.mahankal)	3,00,000	3,46,900
8	Irali (K.Mahankal)	1,20,000	73,000
9	Baj (Jat)	84,000	36,000
10	Nagaj (K. Mahankal)	2,40,000	2,46600



Looking at the income and electricity bills maximum share of income goes towards paying electricity bills, the share goes to @ 60% for many villages. Higher electricity charges are due to higher distance between source to ESR (more than 5 Km) and the depth of well (Water) (15 M)

4.1 Using Solar Pump system to Village- Rethare Harnaksh, Tahasil. Walwa.

The Jalswarajya Scheme – Successful.

1) Source : River Krishna
2) Population : 8133
3) Scheme Design : 40 Lpcd
4) Electricity Bill : 3,90,000/- yearly
5) Total Income by water charges :14,25,600/-

6) As per 40 Lpcd water require : 3,25,320 Lit.

7) ESR Capacity : 1,50,000 Lit.

4.2 Pump Capacity Calculation:-

Village- Rethare Harnaksha (Walwa)
Population - 8133
Per day demand – 40 Locd.
Water required /day = 8133 x 40 = 325320 Lit. = 325.32 M3
Assume- Average 5 Hrs. sun energy will be available
Water require per hour= 3, 25,320/5 = 65064 Lit/hr.
Water required per minute 65064/60 = 1084 L/M

Say = 286.50 L/pm

Total lift for water

Well = 15 m.

raising main 5 m. } Total Head = 30 M.

ESR Height = 10 m

HP = Q x H /3.960

Where Q = Pump capacity

H = Total Lift. (3.785 Lit.= 1 G.)

Q= gallon = 1084/3.785 = 286.50 Gallon PM

H = Feet = 30 x 3.281 = 98.43 feet

H = 286.50 x 98.43 / 3960

H = 7.12 Say 7.5 H.P.

Converting HP to Watt

Watt = HP x 746 Watt

= 7.5 x 746 = 5595 Watt.

Next to adjust the wattage to take in to consideration the loss of electricity in the cable and controls during transmission and in converting electricity to the mechanical movements of the pump. the average efficiency rate of these pumps is about 85%. To adjust for this inefficiency we must recalculate our power input.
Wattage needed = 3730/0.65 = 5595/0.85

6582.35 = Say 7 Kw

As per the company the Battery less based solar water pumping system (without pump costs).
5 KW water pumping system with PV panel mppt charger inverters
for 5 HP pumps - 5,00,000.00

Pump Unit - 18,000.00

Total Cost Rs. 5,18,000.00
Average life of the PV system = 20 years.

4.3 Panel and Pump design:-

Water required/day as 40 Lpcd

7.5 HP pump discharge = 1000 Lpm for 30 m Head.

Total discharge in 5 hours

1000 x 60 = 60,000 Lit.

In 5 Hrs.= 60,000 x 5 = 3,00,000 Lit.

Pump Specification:-

Pump HP = 7.5 HP

Discharge = 1000 Lpm

Head = 30 m

Rate of pump = 30,000/-

Panel Design –

1m x 2m Panel = 0.25 KW.

1 m x 2 m panel x 4 no. – 1 KW

For 7 KW

Panel required = 4 x 7 = 28 (1x 2)

Area required for Panel fitting

1 x 2 x 28 = 56 m^2

Add 100% more space for gap between the panel and area around it

Say = 56 m^2 x 2 = 112 m^2 = 1200 Sqft.

Arrangement of solar panels for solar system.

4.4 Stay required for Panel :-

Angle frame = 50 x 50 x 6 mm

7m x 2 +2 m x 2 = 18 m + 2 support (2 x 2 m) = 22 m.

Stay required -

U/S 1.65 + 0.60 in ground = 2.25 m

C/C distance = 7′-00″ Stay required 4 No.

L/S 0.75 m + 0.60 in ground = 1.35 m

Stays required = 4 No.

Total length of stays

2.25 x 4 + 1.35 x 4 = 14.40 m

For stays = 2″ pipe For One stand.

Angle 50 x 50 x 6 = 18 m + (2X2) = 22 m

Pipe 50 x 6 = 14.4 m

Rate = Angle 42.50 = 124 Kg pipe- 12 Kg. 52 Kg.

Excavation & Concrete = 8 pits = 0.6 x 0.3x 0.3

8 x 100/Pits = 800 Rs.

Concrete 0.054 m3 x 8 = 0.432 m3 (1:4:8)

0.432 x 4000/m3 = 1728 Rs.

Angle= 42.50 /Kg x 88 Kg = 3740-00

Pipe = 520/Kg x 30 Kg = 1560-00

Labor, Fabrication and coloring = 1000.No.

Total for 1 Frame = 8828 Say Rs. 9000/-

A) For Four stands 9000 x 4 Rs.= 36,000-00

B) Rate for 7.5 Kw Panel = 5, 00,000-00

C) Inverter / Converter = 2, 00,000-00

D) Wiring connection and other Expenses = 30,000-00

Total 7, 66,000-00

Pump and Accessories 35,000-00

Total expenditure for 7.5 HP Pump and Solar inverter Rs. 8, 01,000-00

5. PAY BACK PERIOD:

Amount	Year	Elect.bill	Interest Rate 12%	Amount
8,00,000	1	3,00,000 - 50,000 2,50,000	12%	8,96,000 6,46,000
6,46,000	2	25,000	12%	7,23,520 4,73,520
4,73,520	3	2,50,000	12%	5,30,343 2,80,343
2,80,343	4	25,000		30,342 33,984
33,984	5	25,000		21,617

Total Loan recovery = 10, 33,983-00
Against the loan of Rs. 8, 00,000-00
Total payback period is 5 years.

As we consider the life of solar system is 20 years.

The Electric bill saving for 15 years

15 years x 2, 50,000 = 37, 50,000-00

6. CONCLUSION

In our country day by day the availability of electricity by conventional methods is decreasing so the cost of electricity is going on increasing which increases the load of expenditure on the Jalswarajya schemes in the dry area of Sangli district, which is one of the most important reasons behind the failure of schemes. The solar pump system is most economical remedy for the scheme. Solar pumping decreases the electric charges and save an amount up to 80%.which can be used for further improvement of Jalswarajya schemes. Also the pumps and equipment's having low maintenance cost and zero running cost which will decrease the operation and maintenance cost of the scheme up to 50%.Further it is ecofriendly.

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