SOLAR PUMPS: A BOON FOR SALT FARMERS

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ABSTRACT

The increasing demand for energy, the continuous reduction in existing sources of fossil fuels and the growing concern regarding environment pollution, have pushed mankind to explore new technologies for the production of electrical energy using clean, renewable sources, such as solar energy, wind energy, etc. A large number of people in developing countries such as India still live in rural and remote areas, where electricity grid is yet unavailable or not ***envisaged*** *by the people. Pumps are critical to irrigation and community water supply systems in rural economies. According to the United Nations, agriculture accounts for 70 percent of global freshwater withdrawals—a harsh reality when considering the amount and consistency of power needed to obtain this water. There are an estimated 21 million irrigation pumps in India out of which over 9 million are run on diesel and 12 million depend on the electricity grid. Electricity consumption by irrigation pumps accounts for 10–15 percent of India's total electricity consumption.*

Keywords: Rural Economics, Irrigation pumps, Fossil Fuels ,Renewable Sources etc.

I. INTRODUCTION

India is the third largest salt producing country in the world, next to the US and China. The major salt producing states of India are Gujarat, Tamil Nadu, and Rajasthan. More than 20,000 salt pan workers in Gujarat and Rajasthan currently rely on diesel pumps to earn a living. Salt farming process is an extremely taxing manual process but the only mechanized phase of salt processing is brine pumping. Pumping is done since early days by diesel pump accounting for 70 percent of the total expense of salt production. This creates high indebtedness continuously during the farming season because farmers have to buy diesel through credit money, hence the efficiency of salt production goes way into negative. Diesel systems are independent of natural cycles. Diesel generators cause noise, environmental pollution, and are costly to operate—especially as water demand rises during the growing season and fuel prices spike.

Pic.1: The Process of Salt Production ^

The salt farming process is not hi-tech farming. It is primarily a manual process involving building of embankments, preparing the salt pans, 'sowing' the salt seeds, daily 'ploughing' of the pans, and the final harvesting—all done by the salt farmers themselves. The pumping of brine has to be carried out continuously during the farming season, for which farmers spend a fortune on diesel. The diesel required per engine per day is 8–10 litres.

Pic.2: Solar Pump Installed in Gujrat ^

Pic.3: A Salt Farmer Carrying Salt ^

II. HIGHLIGHTS OF YEARLY CYCLE

A survey was conducted for salt farmers living in Little Rann Kutch (LRK) Gujarat, India. Each Agariya (salt farmers are called by this name in Gujarat) family has an average of 10 acres of land. Mostly farmers use 3hp diesel pump with 10–12 hours daily operation. They avoid using larger size pumps because the pumps need to be replaced every two years due to the corrosive nature of brine water. They start seeding for salt in the month of October. Farmers borrow money for diesel and household expenses against each 'pata' of salt amounting to almost N70,000–80,000 by the end of the season. In between March–April, the salt production comes to an end and each salt pan produces on an average 700 tonnes of salt. Monthly expenditure and yearly income of salt farmers is described in Table 1 and Table 2, respectively.

Table 1: Monthly expenses per Pata (considering 3 hp diesel pumps)

Details	**Amount (Rs.)***
Petrol expenses for daily up and down for food, water, etc. Average 50 per day per pata(assuming family owns three patas)	500
Cost of diesel per month including procuring cost (9 litres per day, @ 50 (47 Diesel prices + 2.5 for transportation of fuel) per litre	13,500
Total monthly expenses per pata	14,000

**amount may vary from area to area*

Table 2: Net revenue per Pata per season (considering 3 hp diesel pumps)

Details	**Amount (Rs.)***
Total expected revenue per pata(230 per tonne, for 700 tonnes)	1,61,000
Monthly production expenses for 7 months (14,000 × 7 months)	98,000
Monthly household expenses	1,000
Maintenance of diesel cost	10,000
Initial labour expenses	3,000
Total accrued credit per season per pata	112,000
Net expected revenue per pata	49,000
Labour and transport expenses for salt pick-up	36,000
Net actual payment made against per pata	13,000

**amount may vary from area to area*

Only 8 percent of the Agariya's total revenues are converted into savings. Out of the rest of the revenues spent, the direct and indirect costs of using diesel consist of over 70 percent. Renewable energy technologies promoted

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in the country are regarded as a means of satisfying rural energy needs of the country for operating different rural end-uses. The aim of this study is to prove the case of solar energy for pumping with its optimal utilization, as an alternate to one of the most widely used non-renewable resource—diesel. Both DC-operated- and AC-operated pumps are widely available in Indian market at almost the same price. But, if we study about the prices of each component, DC pump is 5–6 times costlier than AC pump. In the salt area, where there is need to pump brine water, it is always recommended to use pumps that are efficient as well as low cost. AC pumps are well known to the farmers and they can easily replace it at any time in comparison to DC pumps. In this investigation, a study is carried out to compare the alternatives on the basis of the economic parameters, i.e., net present value and payback period. The solar water pumping system for irrigation is shown in Picture 1.

III. COMPONENTS INVOLVED IN THE SYSTEM

*Solar PV array: The solar PV array is a set of photovoltaic modules connected in series and parallel combination. The output of solar array passes through pump controller for conditioning.

*Pump controller: A pump controller is an electronic device that boosts the linear current. It is equipped with a maximum power point tracking (MPPT) controller and an inverter. The MPPT controls the pump as a function of solar radiation and the inverter converts DC power to AC power with suitable frequency. Farmers can be benefitted from the maximum amount of pump output during the day.

*Pump set: Pump sets generally comprise the motor, which drives the operation and the actual pump which moves the water under pressure.

IV. OPERATION OF SOLAR WATER PUMPING SYSTEM

A solar photovoltaic array directly generates electricity from the sunlight with no moving or wearing parts. Here solar radiations are converted into direct current (DC electricity) which later on is converted into AC power and this generated electricity is used to pump water through groundwater source. The wide power and voltage range enables operators to use solar pump controller for a longer time. The size of the pump is designed based on the total requirement of water and total dynamic head. The size of the solar array is designed considering availability of yearly solar radiations on location and hydraulic energy required per day to pump the required amount of water. Solar pumping systems are a practical solution to pump the brine in electricity scarce areas. Meanwhile, solar pumping systems can also be used in community water supply, fish farming and agriculture, forestry, and wastewater treatment engineering. The systems are also becoming more popular for use in municipal engineering, city parks, tourist sites, resorts, and even landscapes and fountains in residential areas. Solar pumping delivers several benefits over diesel:

*Better return on investment and low maintenance;

*No periodic tariff increases;

*No dependency on often unreliable grid power;

*No environmental pollution; and

*Carbon credits savings.

V. NET PRESENT VALUE FOR SOLAR VERSUS DIESEL

Net present value (NPV) at 10 per cent discount factor for 3hp water pump operating with diesel and solar energy is shown in Table 3 and Table 4, respectively. The project analysis is done for 15 years project period. The project cost is the sum of capital cost and operating cost of diesel engine-operated pump and solar pump. The cash inflow or earning of the project comes from custom hire of irrigation service to the farmers. The hire rate is equal for both diesel pump and solar pump.

$$NPV= - IC +\{AS-AM\}\left[\{1+i\}^{n}-1 / i^{n} \{1+i\} \right]$$

Where, IC is initial cost, AS is annual savings, and AM is annual maintenance.

Table 3: Net present value (NPV) of diesel operated pump (in Rs.)

Year	Initial cost (Rs)	Maintenance cost (Rs)	Operating cost (Rs)	Replacement cost (Rs)	Cash flow (Rs)	Yearly revenues (Rs)	Present value (Rs)
0	40,000						
1		3,000	94,500		97,50 0	161,000	57,727.27
2		3,000	94,500		97,500	161,000	52,479.34
3		3,000	94,500		97,50 0	161,000	47,708 .49
4		3,000	94,500	40,000	1,37,500	161,000	16,050.82
5		3000	94,500		97,500	161,000	39,428.50
6		3,000	94,500		97,500	161,000	35,844.09
7		3,000	94,500	40,000	1,37,500	161,000	12,059.22
8		3,000	94,500		97,500	161,000	29,623.22
9		3,000	94,500		97,500	161,000	26,930.2
10		3,000	94,500	40,000	1,37,500	161,000	9,060.27
11		3,000	94,500		97,500	161,000	22,256.36
12		3,000	94,500		97,500	161,000	20,233.66
13		3,000	94,500	40,000	137500	161,000	6 ,807.11
14		3,000	94,500		97,500	161,000	16,721.53
15		3,000	94,500		97, 500	161,000	15,201.4

NPV = 368,130.88

Table 4: Net present value (NPV) of solar operated pump (in Rs.)

Year	Initial cost (Rs)	Maintenance cost (Rs)	Operating cost (Rs)	Replacement cost (Rs)	Cash flow (Rs)	Yearly revenues (Rs)	Present value (Rs)
0	224,000						--224000
1		3,000			3,000	161,000	143636.36
2		3,000		15,000	18000	161,000	118181.82
3		3,000			3,000	161,000	118707.74
4		3,000		15,000	18000	161,000	97,670.92
5		3,000			3,000	161,000	8,105.57
6		3,000		15,000	18000	161,000	80,719.77
7		3,000			3,000	161,000	81,078.98

8	3,000	15,000	18000	161,000	66,710.56
9	3,000		3,000	161,000	67,0 07.42
10	3,000	15,000	18000	161,000	55,132.69
11	3,000		3,000	161,000	55,378.04
12	3,000	15,000	18000	161,000	45,564.21
13	3,000		3,000	161,000	45,766.97
14	3,000	15,000	18000	161,000	37,656.37
15	3,000		3,000	161,000	37,823.94

NPV= 925,141.36

NPV of solar pump is higher than diesel engine-operated pump which indicates that investment on solar pump is more profitable than diesel pump. Investment on solar pump is more risk free with higher discount rate than diesel engine-operated irrigation pump. Payback period of solar water pumps comes to 2 years 6 months and 11 days (Table 5).

Table 5: Payback period calculation for solar pumping system compared to diesel pump set

Year	Total annual costs of diesel (Rs.)	Total annual costs of diesel (Rs.)	Savings due to solar (Rs.)	Replacement cost of solar (Rs.)
0	--	--	--	224,000
1	97, 500	3,000	94,500	--
2	97, 500	18,000	79,500	--
3	97, 500	3,000	94,500	--
4	1,37,500	18,000	119,500	--
5	97, 500	3,000	94,500	--
6	97, 500	18,000	79,500	
7	1,37,500	3,000	1,34,500	--
8	97, 500	18,000	79,500	--
9	97, 500	3,000	94,500	--
10	1 37,500	18,000	1,19,500	--
11	97, 500	3,000	94,500	--
12	97,500	18,000	79,500	--
13	1,37,500	3,000	1,34,500	--
14	97,500	18,000	79,500	--
15	97,500	3,000	94,500	--

Payback period= 2 years, 6 months, and 11 days

VI. FEATURES FOR SAFE FUTURE

Efficiency is one of the greatest challenges when designing a solar pumping system. The electronics of controller should be so strong that it starts the pump's motor and keeps it running even at low sun energy input. This includes starting at sunrise or during cloudy days. MPPT provides uninterrupted flow, even during drastic changes in radiation. When equipment is installed at remote sites—where maintenance is infrequent—the tracking system provides remote monitoring that eliminates the need for site visits. The controller's fault resets and other features should all be automatic. The controller should automatically shut down to prevent equipment damage if the pump runs dry. Sensor equipped flow measurement device gives a direct indication of performance, allowing the end user to measure system performance on flow rather than electrical parameters.

VII. CONCLUSION

SPV pumping systems can easily meet the irrigation requirements for land holdings for small and marginal farmers. Due to lack of grid power electricity, a large number of diesel pump sets are being deployed every year in the country. This study cleared the idea about economics of solar water pumping system against diesel pumps. It will obviate farmers from long distance travels to procure and transport diesel. From the technical perspective (reliability and easiness in operation) and economic evaluation of the technical alternatives, solar AC pumping system is found to be the most viable solution to pump brine in the salt farming areas.

REFRENCES

[1]. Kamat N. Reviving the salt industry in Goa. Navhind Times.2005.

[2]. Sonak S, Kazi S, Abraham M. Khazans in troubled waters. New Delhi: TERI Press; 2005. p. 54.

[3]. Kamat N. Seminar on History of agriculture in Goa. Goa University; 2004. History of Khazan land management in Goa: ecological, economic and political perspective.

[4]. Goa Government Budget Speech. http://www.goa.gov.in/pdf/speech12-13.pdf.

[5]. Rubinoff JA. Pink Gold: Transformation of Backwater Aquaculture on Goa's Khazan Lands. Economic and Political Weekly. 2001. pp. 1108–1114.

[6]. Kamat N. Santa Cruz: The Ecological Mysteries of a Goan Village. http://www.goa-world.com/goa/about_goa/santac.htm.

[7]. Fernandes TEC. Salt pan ecology and its impact on community structure of halophilic Archaea. PhD thesis. Goa University: Department of Microbiology; 2006.

[8]. Korovessis NA, Lekkas TD. Solar Saltworks' wetland function. Global NEST J. 2009;11:49–57.

[9]. Parrikar R. Salt of the Earth. http://www.parrikar.com/blog/2011/05/27/salt-of-the-earth/

[10]. Khedekar V. Salt of the land. Navhind Times. 2011.

[11]. Salgaonkar BB, Kabilan M, Nair A, Sowmya G, Braganca JM. Interspecific interactions among members of family halobacteriaceae from natural solar salterns. Probiotics Antimicrob Proteins. 2012;4(2):98–107. doi:

[12]. 10.1007/s12602-012-9097-8. [Cross Ref]

[13]. Raghavan TM, Furtado I. Occurrence of extremely halophilic archaea in sediments from the continental shelf of west coast of India. Curr Sci. 2004;86:1065–1067.