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Feasibility Study of SPV Water Pumping System at Village Malo Bheel, Tharparker

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***Abstract*— Water being basic need of human being has become global issue especially in developing countries where fresh water doesn't meet the demand. As per reports by WHO and UNICEF 11% global population that makes 768 million consume unsafe water sources which may cause serious health issues. Scarcity of Water in Tharparker has never been a new issue. One important problem that needs to be addressed is access to potable water in Tharparker. As per study carried by TRDP (Thardeep rural development program) out of 2350 villages, In tharparker the population that has access of drinking water is 47% whereas majority of population stands for hours for their turn to fetch water, whereas 76% women has to travel about 3 km to fetch water. People pay around 30PKR for 2 buckets of water. Tharparker being one of important district of Sindh and largest district of sindh by area having households of 301625 as per recent population census, this water scarcity problem should be resolved by proposing cost effective model and design. In this paper feasibility study is carried for SPV pumping system for village Malo Bheel in Tharparker. The aim is to predict performance of system and to economically evaluate the system using simulation software PVSYST. The location of Malo Bheel has been chosen considering few factors such as no access to grid station, and having no access to clean water.**

***Index Terms*—SPV, PVSYST, water pumping**

I. INTRODUCTION

According to report of PCRWR (Pakistan Council of Research in Water Resources), 44% of total population of Pakistan is deprived of safe drinking water whereas 90% of population in rural areas don't have facility of potable water. One of report submitted by The Institute for Social Justice to Sustainable Human Development Section, Special Procedures Division, UNOG-OHCHR tells that situation has been worsen due to non-availability of clean water that causes death of 97900 in Pakistan, whereas number of children under age of 5 dies due to diarrhea and sanitation services are 54,000. Renewable energy technologies are best solution for increasing access of clean water especially in developing countries such as Pakistan considering Price hike of fuels. There are many advantages in solar water pumping system such as no fuel cost, system is highly reliable and require low. There has been lot of interest shown by countries on investing on SPV Pumping System but mostly this has been implemented in developed nations like japan, USA and Europe due to certain reasons like upfront cost and awareness being the major issue. It is need of time that as rural population in Pakistan need clean water so SPV Pumping is most reliable way to provide them with clean water. Village Malo Bheel in Tharparker is among those villages having no access to electricity and also to clean water. Village consists of mud huts and 1 school. There are two objectives of this paper. First to know technical specifications of SPV Pump and secondly to do economic evaluation of SPV Pumping System.

II. LOCATION

Solar Radiation obviously is most important parameter for SPV system. All the data of Climatic Conditions, Geographical locations, of village Malo Bheel is taken from NASA-SSE Satellite Data using PVSYST Software. Location having latitudes 24.7°N , longitudes 70.2°E and annual solar radiation per day for this location is 5.20 kwh/m^2

III. METHODLOGY

We have used PVSYST 6.4.3 to simulate a solar photovoltaic water pumping system. Simulation Procedures are described below.

A. PRE-SIZING TOOL

It is obvious that pumping system is bit complex and it involves many variables especially when it comes to solar photovoltaic where there are different operating conditions. Through this simulation software, for a given location of village Malo Bheel, we have specified few parameters like the requirement of water in volume as per population of village, the level at which water should be pumped and also autonomy duration which we have specified as 2 days. As village is small and less populated the water requirement is simulated as 5 m^3/day for specified number of hours as shown in Table I.
Specifying our needs program will determine PV array, tank volume and pump size required for water pumping. After Predicting the performance program will also economically evaluate the project.

For Our Proposed model the main design parameters of SPV system are shown in Table 1

TABLE I
SPV SYSTEM INPUT PARAMETERS

User Need	House Hold
Water Requirement	5 m3/day, 2 days autonomy
Hours of Operation	3-18hours
Autonomy	2 days
Plane tilt	27
Array Power	610 wp
Specification of Panel:	305Wp 31V (1 string of 2 series modules)
Maximum Power Current	8.3A
Model Manufacturer Module Type	TDB156X156-72-P 305W (Sun Earth Solar Power Co Ltd) Si-mono

B. General Performance Parameters.

The general performance parameters like pump efficiency, system losses, effective energy at pump, unused energy, system efficiency were determined through this simulation and also meteo model is used in order to determine irradiance of given location. Different results were obtained such as monthly need of water, missing water and excessive PV energy when tank is full. The simulated

Proposed SPV System's balanced energy has been shown in Fig. 1 System is designed based on annual needs we have excessive water available for all months and this can be used for other purpose too.

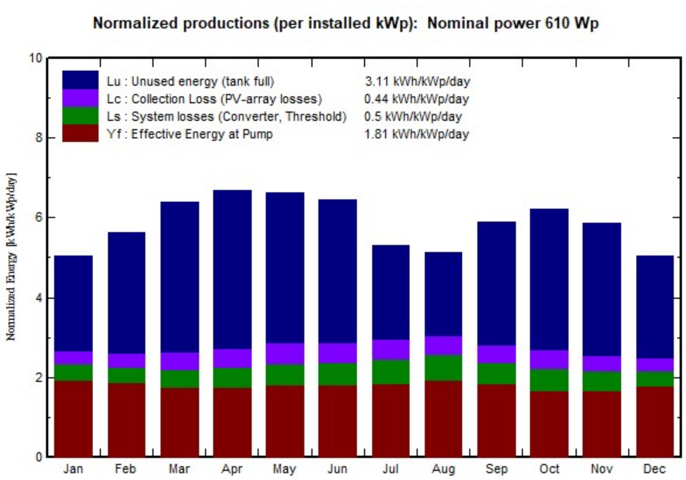

Fig. 1. Normalized Production

IV. SYSTEM DESIGN

Deep well configuration is used in this design. A submersible Centrifugal Multistage pump is placed in bottom of borehole. The diameter for bore hole selected is 18cm. Fig. 2(a) and Fig. 2(b) shows the architectural plan of design. The system configuration is mentioned in Table II.

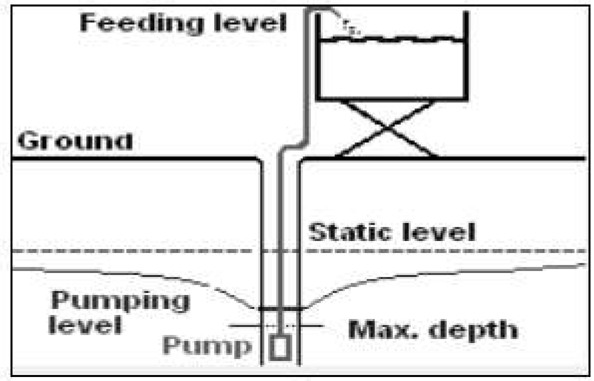

Fig. 2(a). Flow rate Function of Pump Power.

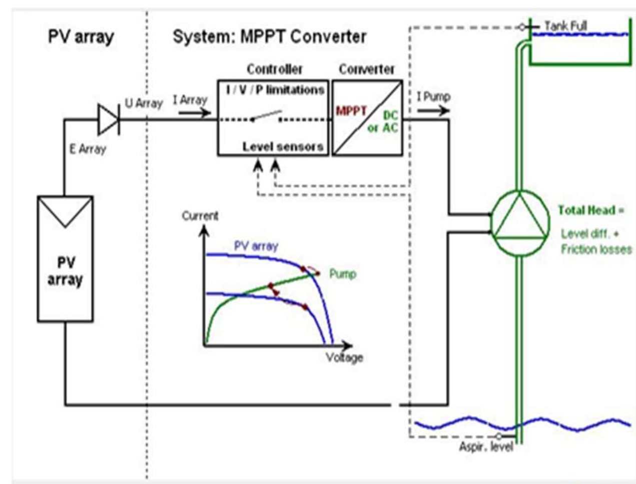

Fig. 2(b). Flow rate Function of Irradiance.

TABLE II
SYSTEM CONFIGURATION

System Type	Deep Well Configuration
Static Level Depth	32m
Maximum Pumping Depth	38m
Spec Drawdown	1.00 m / m³/h
Borehole Diameter	18cm

A. Storage Tank

Storage tank is included in design because solar energy isn't constant. As seen in Fig. 2(b) we will build storage tank in a way such that sufficient static pressure is exerted for distributing water by gravity. All parameters are defined in software such as tank diameter, storage volume, water height, alimentation mode. Table III shows the storage parameters

TABLE III
STORAGE TANK CHARACTERISTICS

Storage Tank	20 m^3
Diameter	3.5m
Feeding Altitude	6.0m
Height (Full Level)	2.1m

B. Piping Circuit

One of important consideration while choosing piping circuit is friction head losses. These losses occur when fluid flows through pipe and these loses depend on various factors such as material of pipe, if pipe is rougher from inner side, it will cause friction losses. Another factor is velocity of liquid through pipe. If velocity of fluid is higher it will cause greater friction losses. And another important factor to be considered is pipe length Longer the pipe more is friction losses. So considering all these factors we have specified pipe type, piping length in order to ensure good performance of circuit as mentioned in Table IV.

TABLE IV
SPECIFICATION FO PIPING CIRCUITS

System Type	Deep Well Storage
Piping Length	70m
Pipe Type	DN100

C. Pump Motor Technology

We have used asynchronous AC motor, monophase in our design as it is highly reliable and most commonly used pump in villages. The pump specifications are given in Table V

D. Pump Specification

TABLE V
PUMP SPECIFICATION

Manufacturer	Lowara
Pump Model	2GS03
Pump Technology	Centrifugal Multistage
Required Power	Head Min : 389w Head Nom: 358w Head Max : 305w
Maximum Pumping Depth	38m
Corresponding Maximum Flow rate	Head Min : 3 m3 Head Nom: 2.04 m3 Head Max : 1.20 m3

E. Operating System

Power Conditioning Unit used in this design is MPPT- AC inverter in order to maximize the power extraction from solar array . The operating conditions are specified in Table VI.

TABLE V
OPERATING CONDITIONS

Minimum MPP Voltage	83V
Maximum MPP Voltage	87V
Maximum Array Voltage	130V
Nominal power:	348W
Power Threshold	17W
Maximum Efficiency	96%
Euro efficiency	94%

V. Economic Evaluation

During Simulation Economic Evaluation of this design has also been observed. The cost after simulated results are given below:

Cost of PV module (305Wp): 325$/Unit, Overall Cost of 2 unit 650$

Pump Cost: 675$

Power Conditioning Cost: 350$

Setting, Wiring and support integration: 1500$

Running Cost (this also includes maintenance charges, annual taxes, insurance, and pump replacement over 8 years): 486$/year

Net Investment: 4916$ (this includes gross investment which was calculated as 4275, taxes on investment)

Based on this information the overall cost of water was calculated as 0.27$/$m^3$ which is economical considering the location where there is no access to electricity and provision of potable water. And this can be proved as cost effective solution compare to other sources such as diesel. As O&M charges for diesel are relatively high whereas maintenance and running charges of SPV water pumping is lesser compare to that of diesel.

VI. Conclusion

System for given location has been designed and analyzed by using PVSYST. 6.0 . Although lot of expertise is required to properly design a SPV pumping system. This simulated system of 610w, centrifugal pumps will be able to provide 99% of water to community. As water need at given location is 1825m^3 whereas with this design results shows 1833m^3 of water can be pumped. Main issue with design is cost of PV modules. If cost of PV module is decreased, the implementation cost of solar system become more economical and specially in area where there is desperate need of clean water. In order to ensure long term sustainability, it is important that villagers must realize ownership of system because mostly water pumping system in rural areas fail due to lack of responsibility shown by villagers. To ensure sustainability it is important that village committee must be formed to ensure proper maintenance and use of water pumps.

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