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Original Article

Performance and Economical Analysis of Solar Photovoltaic Pumping System in Village Malo Bheel, Tharparker

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Abstract - *It's so challenging situation for Pakistan to cope up with problems like providing clean water, especially in rural areas where health is a primary issue. Pakistan has been facing issues related to clean water as the majority of the population resides in rural areas. As a result, there is a lack of facilities for clean water that causes severe health issues. Water is a basic necessity for human beings, and the world has been facing severe issues. With a growing population, the demand for water has been increasing, especially in backward areas where water demand isn't met. According to reports from WHO and UNICEF, 68 million of the population doesn't have access to safe water, which is about 11% of the global population, and that surely is causing serious health issues. Water scarcity in that parker has been a serious issue for many decades. This issue has been discussed on various platforms, but fruitful results haven't been obtained. Tharparker being the largest district by area of Sindh faces the same issues. A study carried by Thardeep rural development program (TRDP) tells us that only 47% of the population has access to drinking water, the survey was carried out of 2350 villages, and from that population, many people have to stand in queue and wait for hours in order to fetch water. 6% po population has to travel about 3km in order to avail water. The report also tells that approx 30pkr is spent in order to get only 2 buckets of water. So there is a serious need to design an effective model as tharparker is one of the most important districts, and their livelihood depends on livestock. A feasibility study is carried in this research for solar photovoltaic pumping system for village MaloBheel in tharparker. Research work is purely conducted through simulations, and this proposed system for the modeling is simulated on PVSyst software. The aim of this research is not only to predict system performance but also to evaluate the solar photovoltaic system economically in village MaloBheel,tharparker using simulation software PVSYST.*

Keyword — *Agriculture, Water, Solar cell, Pump & Photovoltaic.*

I. INTRODUCTION

With emerging technologies, solar water pumping is the reason that has minimized the dependency on Coal based, Diesel, or gas-based electricity. These conventional systems have several disadvantages, such as creating air and noise pollution, and they are expensive too. Another point is diesel pumps require more maintenance and their operation and upfront cost is higher compare to solar photovoltaic pump. Millions of people live in rural areas, and they have inadequate access to water. In many areas, groundwater is taken out all the way through electric water pumps, and diesel is used to fuel their systems. Usage of these systems is not only expensive, regular servicing as well as it requires to purchase the fuel; they produce carbon dioxide that makes the atmosphere dirty. Solar Water Pumping, or photovoltaic water pumping (PVP), gives a substitute. After years of research as well as technological progress, it has been confirmed to be operationally, economically, as well as environmentally sustainable. The study carried by Thardeep rural development program (TRDP) tells us that only 47% of the population has access to drinking water, the survey was carried out of 2350 villages, and from that population, many people have to stand in queue and wait for hours in order to fetch water. 6% po population has to travel about 3km in order to avail water. A survey carried by SDNA Sindh Drought Needs Assessment Report also mentions that only 5% of the population have access to water within their home/compound; 52% of the population has to walk more than 30mins to fetch water. Lack of drinking water for livestock has also been reported as a critical issue. A Solar Photovoltaic Water pump looks like a normal pump with an electric motor. In order to produce the electricity that is required for the engine on-site, a photovoltaic solar panel

converts the sun's energy into a continuous electric current that can be stored in a solar battery park. Major advantages of solar pumping system are that this system requires low maintenance and they are environment friendly, and there is no fuel cost and transportation charges related to fuel. Especially in backward areas like Malo Bheel that have storage of clean water and shortage of grid electricity, Solar based pumping system is the most promising application of solar energy. “In such areas where deploying diesel engines require efforts and lot of money as it requires high in order to run power lines, one of attractive complementary energy source is Solar photovoltaic (PV) systems especially where there is remarkable irradiance considering meteorological data of that location.” There is no difference in technology. Both conventional pumping systems and solar-based pumping systems are the same, but their source of power is different. Like power source in solar-based pumping system is solar energy. In today’s era PV system has been gaining so much importance as prices of fuel has been increasing. The flow rate of power in PV based pumping system depends on incident radiation and the overall size of the Array. So it is so important that proper design should be made that can result in long-term sustainability and cost-saving of plant and proved to be more economical compare to the conventional pumping system.

Solar Photovoltaic pumping system consists of various segments. There is a photovoltaic array, as seen in fig. 1. The photovoltaic array converts solar energy into electricity. The selection of pumps depends on our requirement, and the electric motor will drive the pump. In order to get the best performance, all attributes need to be coordinated. Depending on the size of the pump, the motor unit will be selected based on factors like the speed of the motor. The selected motor can be ac or dc. If the motor is AC, an inverter will be required. In General, AC motors are broadly accessible. While selecting the unit, it is important to select an inverter that is electronically controlled that will, in turn, improve the coordination between panel and pump. Besides AC Motor, the effective motor used is a Permanent magnet motor in the SPV system. These days’ photovoltaic systems use silicon which is basically multi-crystalline or monocrystalline. But considering the economical and efficiency factor, different materials such as cadium teeluide, copper indium diselenide are also used. An array can change from maybe a couple of modules with a yield of low or less to an immeasurable bank of a few kilowatts or even megawatts.

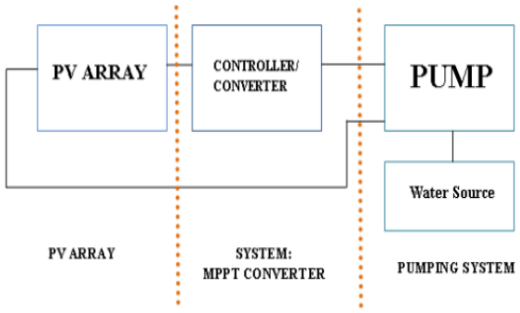

Fig. 1 Segments of solar system

Many SPV systems in the world are used and proved to be the ultimate solution for different applications in the village. Advancement and experimental studies have been carried in order to enhance the SPV Water System Performance. The Village MaloBheel in Tharparker has a lack of access to water and also electricity, and this village is among those villages which are deprived of other facilities like lack of access to clean water and electricity. Malobheel consists of 1 school and a mud hut. This research is conducted purely through computer simulations is carried out for the Solar Photo Voltaic pumping system for MaloBheel. The proposed system for modeling will be simulated on PVSYST software. The aim of this research is to predict the performance of the system, and we have also economically evaluated the Solar Photovoltaic System in village MALO BHEEL.

II. LITERATURE REVIEW

Pumping through a solar system is based on PV technology in which sunlight is directly converted to electricity in order to pump water. The arrangement of the array is such that the Panels are connected to a motor that converts electrical energy into mechanical energy, and the pump converts that mechanical energy into hydraulic energy. There are various functions that need to be considered in the pumping system. The capacity of any pumping system depends on 3 variables.

One of the factors while considering solar pump is pressure, how much pressure on the inlet and outlet of pressure should be this information will let us know the right selection of pump. It is important to know the flow rate in order to select the proper pump. The flow rate of the pump is measured in Gallon per minute. The higher the flow rate, the larger is the size required for the pump.

There are two basic purposes for using Distribution storage tanks, and one is to equalize storage, and the second is to use it for emergency storage. The Term Equalizing storage refers to the volume of water needed in order to

satisfy peak hourly demands in a specific location. The water demand is higher during days, so in order to satisfy the peak hours, the water flows out of the tank as per water needs. However, when the demand for water is lower, which is during early morning hours and late night, high-lift pumps are required to fill the tank resulting uniform flow rate at the pumping station. The amount of work that pump has to do is determined by the elevation difference between the source of water and the storage tank. Depend on the work, and the pump will draw power from the PV array.

According to Utkarsh Sharma, in his paper, smart sharing concepts have been proposed. The researcher has proposed a cost-effective solution in which SPV is grid interfaced for the pumping system. This aids advantage, such as it doesn't make use of batteries for storage of energy as there are few complications such as hazardous waste, low life, and acid leakage, but this is possible where grid supply is already available. The researcher has proposed a design control and implementation of the system. In our research, we have proposed a system for a site where there is no grid station. As the population is less in that area, it's not feasible to construct a grid station due to financial crises, so an alternative must be chosen for that.

According to Shahidul I. Khan, in his research, he has worked on the design, technical specifications, and economic analysis is carried for solar water pu8jmping system used for irrigation process. And in order to improve the efficiency of the pump, a buck converter is designed and constructed. As a particular site, the irradiance level is 400 w/m2 the power obtained is 450watts. 5 panels are connected in 2 rows, and two panels are connected in 1 row. This is done just to increase current. Shatadru Biswas, in the paper, has researched two energy storage systems. Firstly, the energy storage system using a battery bank, and secondly, the storage of water in the large water tank. Simulation is performed on MatLab, and the effectiveness of the system is checked and then compared with the diesel engine system. Badari Narayana Patel, in his paper, has proposed a design and researched the system to extract maximum power transferred to load. As high starting torqure is required for pumping so to extract maximum PWM and microcontrollers are used to implement MPPT in the boost converter. This will increase the efficiency of the pumping system.

III. WATER PUMPING

Photovoltaic is broadly utilized in irrigation and agricultural power generation and consumption. Pumping systems utilizing solar systems are most common. It has already helped different industries and is installed at various places. It is mandatory at many such places to meet the water demand. In the daytime, the solar directly give supply to the water pumping system, and while in off daytime or in the night time when the sun is not available to harvest energy and supply, so the option of storing water is used instead of storing the electrical energy which reduces the use of batteries and it reduces the cost of the overall system.

No doubt the capital cost is high and is a discouraging factor for its choice. At the same time, the cost estimation depicts that the overall cost of the system up to 10 years will yield the benefit and can provide a certain amount of subsidy to the concerned industry or entity. In overall research, it was found that solar is a better choice and economical as well. The systems installed require less maintenance and are more reliable. It cost more than other sources of producing energy but yields benefit after a certain amount of time.

IV. COMPONENTS SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEM

A. Solar Panels

Solar panels can generate electricity with lesser efficiency but are cleaner and sustainable than the other available sources. PV modules are used in this case to produce the required electrical energy to operate the pumping system. They are connected in series and in parallel to operate at a specified voltage level. The efficiency is up to 19 %, but for larger rated output, the number of plates will be increased.

B. Controller/ Solar Inverter

Here comes the role of a solar inverter or charge controller, which are used to streamline the charges that are coming from solar panels and make them suitable for required equipment operation. The inverter can serve an additive purpose of converting DC to AC when required. It is used as per the specific application.

C. Pump

A pump is used to suck the water or fluid from one place and throw it at another place, and the simple example is when water is stored in overhead tanks for domestic purposes. A pump is used to carry the water and raise it to the level of the tank where it is stored. Pumps can be reciprocating or rotary depending upon their applications. Pumps utilize electrical energy as a motor is connected with them to run them. The energy to the motor can be provided by any of the available sources, and this can be diesel, thermal, wind, solar, etc. In this case, solar energy will be used to operate them.

D. Battery

The battery is an electrical device that stores the energy in the form of chemical energy, and there is the presence of an electrolytic solution and electrodes. These electrodes are dipped in the solution, and they are supplied with a DC supply to store the energy. The plates get accumulated by no. of ions present in the solution and lead to storage of energy in the form of voltage. They can be connected in various combinations series or parallel and may increase the value of voltage up to the requirement.

E. Architecture View

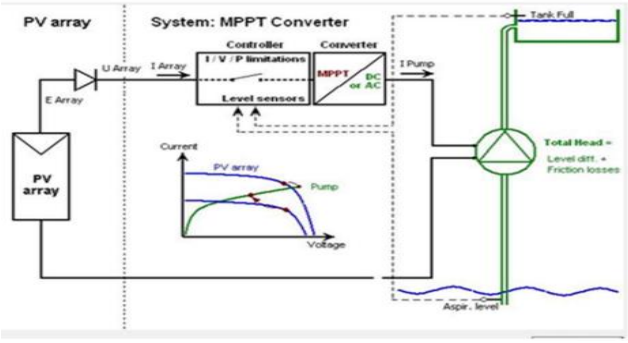

Fig. 2 Architecture View

V. SCOPE FOR FURTHER RESEARCH

This thesis has contributed to designing a facile grid-connected microgrid model for optimally tuned power controllers to get a stable and reliable microgrid system. Nonetheless, an extension to the current contribution is specified as follows:

- As future work, the proposed power controller can be extended to be employed in the presence of different types of DG units.
- The joint synergy for applying optimization techniques can be considered for optimal tuning of inner and outer loops of the proposed controller.
- The future study can include a different technique for generating reference signals in the inner loop of the controller.
- It is believed that the work presented in the dissertation does not end here. In the future, the proposed concept would find application in designing small/medium scale distribution networks incorporating the MG concept.

VI. CONCLUSION

The increasing demand for electricity, the depletion of fossil fuels, and the growing environmental problems are paving the way for power generation from renewable energy sources. Moreover, the line losses on long transmission lines and transmission system maintenance costs which are causing the power sector to transform into a new world of the modern power grid, are known as Microgrid. The activity which increases the load demand can be met by comprehensive power generating units called distributed generation units (DG). The ability of MG is that it can work in conjunction with the traditional network and support the network (online mode), or it can operate, or it can work independently without a network (island mode). The most important purpose is to provide affordable, consistent local energy security for urban and rural residents, but also an outlet for industrial and commercial consumers and federal governments. Reducing Greenhouse Gas (GHS) emissions and reducing stress on the existing transmission and distribution system are the additional benefits of a small grid power distribution system are the additional benefits of a small power system.

Therefore, in this study, the important properties of MG were investigated, and an improved control unit was proposed to control and regulate MG parameters (voltage, load). The MG system consists of a double feed induction generator to check the effectiveness of the proposed controller in MG operating modes. The proposed controller also confirms its utility in regulating MG parameters when the load demand changes while in operation with the network or independently.

Overall, this scan center effectively introduced an improved VSI based DG power controller in the MG framework. The proposed regulator used an SSO computation to set the ideal PI controller in order to achieve an ideal control output. During MG island activity, the proposed controller with SSO optimizes the control target, for example, voltage and load during process transition and when load demand changes. Whereas, during MG network connection mode, SSO-based power controller optimizes control parameter. The proposed mini-grid model is connected to the grid and proves the effectiveness of the SSO-based controller when the electricity demand increases in both MG operating modes. Ultimately, the simulation results obtained from the proposed controller meet the voltage and load limit specified in IEEE 1547-2203 standard. Therefore, the proposed control technology presents a better scenario for the MG system. Through this, the dependence on the conventional energy system will be reduced while increasing the use of renewable energy resources and reducing the cost of electric energy. Research Contribution

The contribution of the research is:

- The proposed modified model of grid-connected microgrid incorporating double fed induction generator because of its high-power efficiency and low running cost.
- Development of an enhanced power controller implementing modern meta-heuristic technique (Salp Swarm Optimization) the purpose of the intended controller is as follow:
- To regulate voltage and load and share the power between connected DG units when MG is operating in islanding mode.
- To share the demand of load between connected DG units and grid as per predefined condition given to controller.

- To regulate the flow of active and reactive power.
- With the application of the proposed controller in the MG scenario implementing optimization techniques for optimizing system parameters, an efficient and dynamic performance has been achieved in terms of reliable and stable power supply.
- The anticipated system also satisfied the condition mentioned in IEEE 1547-2003 standard.

APPENDIX A

Appendices, if present, must be marked A, B, C, and placed before the Acknowledgment section.

ACKNOWLEDGMENT

Place your acknowledgments before References. Do not mention the sponsors and/or financial support obtained in this section, as they must be included in an unnumbered footnote on the first page of the paper. You have to delete de footnote on the first page if there is no sponsorship information to add.

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