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Training on installing solar water pump for resident of singkar 1 wareng wonosari gunungkidul yogyakarta indonesia

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ABSTRACT

Singkar 1 Hamlet, Wareng Village, Wonosari, Gunungkidul, Yogyakarta is a mountainous area that often experiences a shortage of clean water and does not yet have the technology to empower efficient irrigation. During the dry season, residents have to buy water from the Village Drinking Water Manager for daily needs and other needs such as watering plants. Geographical conditions that depend on seasonal changes are an obstacle in the availability of water irrigation facilities, but Dusun Singkar 1 Wareng has the potential to be developed because it has a large area of land and there are wells that have not been utilized for plant cultivation. The irrigation system works by draining water from residents' wells using a solar-powered DC water pump to irrigate land that has not been used optimally by residents. This system is able to increase the independence of residents in cultivating plants because residents can use water without having to buy it from the local village drinking water manager.

KEYWORDS
Water Pump;
Solar Panel;
Solar Water Pump;
Training;
Community Service

1. Introduction

Indonesia is a developing country that is still unable to meet the needs of clean water. The World Water Assessment Program (WWAP) formed by the United Nation Educational Scientific and Cultural Organization (UNESCO) emphasized that in 2012 as the Indonesian Institute of Sciences (LIPI) noted, Indonesia was ranked the worst and it was predicted that 321 million people would have difficulty getting clean and proper water. consumed throughout Southeast Asia. The proportion of water crisis areas will increase from 6.0% in 2000 to 9.6% in 2045. Water quality is also expected to decline significantly. The development of water quality and quantity is one of the environmental infrastructure developments that needs attention, because water is one of the vital resources that need sustainable management [1][2][3][4].

Singkar 1 Hamlet is one of the hamlets located in Wareng Village, Wonosari, Gunungkidul, Yogyakarta, Indonesia. The hamlet is located at Jl. Wonosari-Paliyan KM.04, Singkar 1, Wareng, Wonosari, Gunungkidul, Yogyakarta, Indonesia. The hamlet has a population of approximately 60 families. The population in Singkar 1 Hamlet is 1089 people, with details of 534 being male and 555 females. The hamlet has a large yard but has not been effectively utilized, and there are several wells as a source of water that have not been utilized properly. This is because electricity costs are needed to pump well water that has a depth of more than 15 meters during the dry season. Therefore, a solution is needed to pump the water at a low cost. In addition, residents also have to pay to buy water from the Village Drinking Water Manager.

Wareng Village is known as a mountainous area that often experiences a shortage of clean water and there is no integrated technology for efficient irrigation empowerment. Geographical conditions, depending on seasonal changes, are an obstacle in the availability of irrigation facilities for plant cultivation. Singkar 1 Village has the potential to be developed in the future because it has a large yard area and many wells as a source of water. The hamlet 1 community can be empowered to manage their unused yards and wells so that they become suitable land, such as planting aloe vera, empon-empon, and others. The use of a large yard for planting media can be an alternative for additional income for residents

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in addition to farming activities. Therefore, this service program aims to empower people who were initially not economically/socially productive in managing their yards to become more productive in terms of empowering residents to manage water sources and plant cultivation. The results of plant cultivation can be used for the needs of residents or sold in general or distributed to producers. The form of community empowerment is to provide counseling and training so that it can improve the knowledge and skills of residents. The active role of residents in Singkar 1 Village, Wareng Village, Gunungkidul is needed in developing the potential for plant cultivation and producing them into products that have more selling value than just whole plants.

Based on these problems, this service program proposes the application of solar-powered water pump technology to help residents meet their clean water needs. The solar-powered water pump will be installed in residents' wells to pump water and flow it to their homes and yards. In addition to assistance for the installation of water pumps, this service will also provide counseling and training on the operation of solar water pumps. The counseling can provide knowledge to residents about renewable energy technology derived from solar energy and the process of making solar water pumps so that residents have the skills to make solar pumps in other water sources.

Solar water pumps have been widely developed in agricultural irrigation systems [5][6], farm [7][8], small garden [9] and housing [10]. This system has the advantages of being environmentally friendly [11] because it produces no emissions compared to conventional pumps such as fossil-powered pumps [12][13]. This type of pump also does not require electricity from the electricity company because it uses electricity supplied from solar energy [14][15]. In addition, solar energy is suitable to be applied in a place that is far from electrical energy [16]. Therefore, this solution is expected to be able to overcome the problem of the availability of clean water and the expenditure of purchasing electrical energy which costs money [17][18].

The contribution to this service is to apply solar water pump technology to plant and household irrigation systems. Another contribution is to provide knowledge to residents regarding the process of making solar pumps, operating solar pumps and providing knowledge about renewable energy in the form of solar energy (solar power). This service is divided into several parts, namely introduction, method, results and discussion, and conclusion. The Introduction section discusses the background of community service and service. The method section discusses the method of implementing service. The results and discussion sections contain the results of the implementation of service and the impact of community service. The last section contains the conclusion of the implementation of service.

2. Method

2.1. Community Service Flow Diagram

The method of implementing community service programs in Singkar 1 Village, Wareng, Gunungkidul, Yogyakarta is carried out in several stages, namely preparation, implementation, and evaluation. The method of implementing the program can be seen in Fig. 1. The first is the preparation stage, which consists of a site survey, communicating with partners, namely villagers, and preparing tools and materials. The second is the implementation stage, in the implementation stage starting from September-October 2020 with the installation of a solar DC water pump, training on equipment operation, and assistance in irrigation governance. The final stage is evaluation and continued with ongoing assistance.

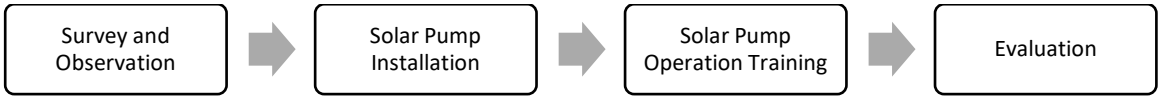

Fig. 1. Community service flow diagram

In general, the description of this service activity is divided into 4 stages, namely the problem identification process, finding the ideal solution to solve the problem, making indicators of service success, and making a number of output targets from this service activity. For more details, it can be seen in Fig. 2. In the problem identification process, it was found that the water condition was running low during the dry season and the high cost of providing water. This problem was given a solution by installing a solar DC water pump and training for residents in operating the water pump. This training serves to increase the knowledge of residents about renewable energy (solar electricity) and the use of solar water pumps. The indicators of success that have been set are that a solar water pump has been installed and the availability of clean water at a low cost. Some of the outputs of this service program are publication of service in national journals and mass media, video documentation published on social media (youtube), increasing citizen knowledge and intellectual property rights in the form of patents, copyrights or industrial designs.

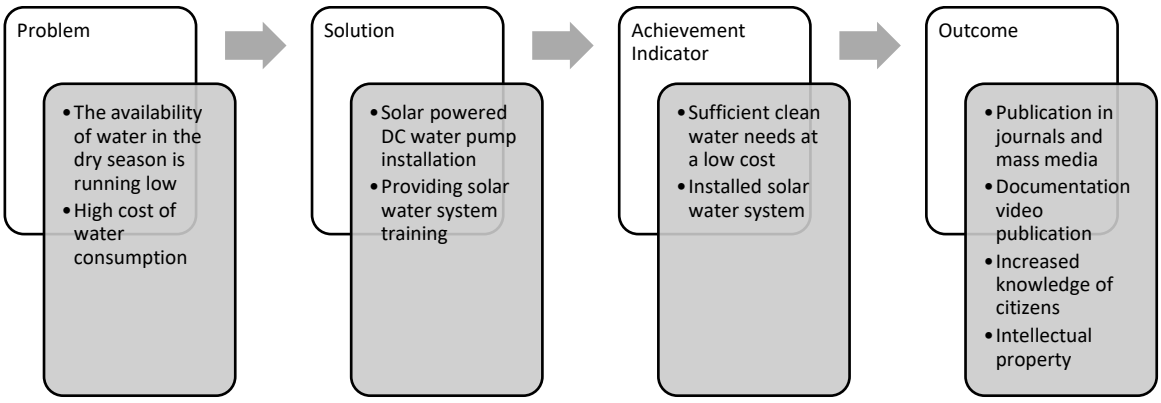

Fig. 2. Community service overview

2.2. DC Solar Water Pump

The solar water pump system is a water irrigation system that uses solar energy to turn on the pump [19]. The type of electricity that can be used in this system can use AC (Using Inverter) [20][21] or DC [22] electricity. In this service, the water pump uses DC electricity with the consideration that there is no energy conversion from solar panels to water pumps. The working system of a solar-powered water pump can be seen in Fig. 3. The function of the solar panel is to convert sunlight energy into DC electrical energy [23]. The solar panel have some applications such as water pumping system [24], driving energy [25], power generation [26], water heater [27][28][29] and heat pump dryer [30]. Solar Charge Controller (SCC) functions to regulate and charge electrical energy in the battery [31]. The SCC used is of the PWM type which has a cheaper price compared to the Maximum Power Point Tracker (MPPT) type [32][33]. The water pump is used to pump water from the ground to the surface [34][35]. The water tank functions as a water reservoir. The battery is used to store electrical energy to power the pump [36][37]. In addition to pump systems that use batteries, there are also solar pump systems without using batteries [37].

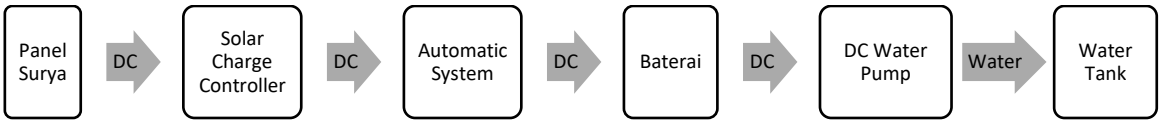

Fig. 3. Solar water pump diagram

In Fig. 3, the solar panel used has a power of 100Wp with an output voltage of up to 17.8 volts with a load and 21.8 vols without a load. There are two solar panels used. The battery used has a voltage of 12 volts and a current of 30A. The Automatic System consists of a water level sensor in the tank, Low Voltage Discharge (LVD) and a relay. The water tank has a water storage specification of 570 liters. The water level sensor connected to the relay functions to turn off the water pump when the water tank is full. The LVD connected to the relay functions to turn off the water pump when the battery voltage is less than 11

volts. DC Water Pump has a voltage of 12Volt and a power of 250Watt which is capable of pumping water up to a height of 30 meters. The type of water pump used is a submersible water pump with DC electricity.

3. Results and Discussion

In the survey results, the problems faced by partners are the lack of maximum empowerment of both Natural Resources (SDA), namely unused wells and large yards, as well as Human Resources (HR) of villagers. Partners need irrigation equipment such as solar DC water pumps to optimize natural resources and human resources so that their yards can be used appropriately and produce a more productive community. Partners also need assistance in managing irrigation distribution, plant cultivation, and processing good plant cultivation so that they can produce abundant and measurable harvests. The partners hope that this program can have a positive impact on the village in optimizing the program towards an independent village. Fig. 4 shows a discussion of the integrated irrigation system service program with residents of Singkar 1, Wareng, Gunungkidul, Yogyakarta.

Fig. 4. Discussion of service programs with residents

Residents have problems related to constraints on the need for inadequate water sources to increase the productivity of plant cultivation. Through the implementation of the manufacture of scheduled automatic irrigation equipment that is integrated with water reservoirs, it can be a solution for residents for routine irrigation distribution needs. Optimization of a large yard as shown in Fig. 5 (left) for planting media by residents is very useful for increasing harmony and productivity of the residents of Singkar 1 hamlet. This yard is used effectively and becomes an alternative for additional income for residents in addition to farming activities. This is supported by the presence of a nearby untapped water source that can be seen in Fig. 5 (right), so that the installation of a solar DC water pump helps residents overcome water limitations. Plant cultivation by providing an integrated irrigation system can increase time and energy efficiency because this system has been automated so that it can work automatically to irrigate plants in people's yards. Then the villagers are given training on food product processing by inviting experts who are experts in the field so that the villagers can process the results of plant cultivation independently.

Fig. 5. Plant field

The technology applied is in the form of irrigation equipment that is integrated with water reservoirs. Water comes from abandoned wells located close to the yard and then pumped for use. The tool is equipped with an automation system that can determine the irrigation schedule, this effort is made so that water distribution can be monitored in a structured manner. In the yard, a water pipe system will be installed to support the distribution of clean water and watering plants. In addition, water distribution will also be distributed to residents' homes for watering plants and meeting the needs of clean water.

The service process begins with the preparation of tools and materials shown in Fig. 6. Next is the installation of solar panels shown in Fig. 7 which are placed on the roof of the mosque near the location of the well. Then the process of installing the box panel is shown in Fig. 8 with the results of the installation of box panel 1 and panel 2 shown in Fig. 9. Box panel 1 consists of a battery charging system and an automatic water pump system. The filling system is SCC and the automatic system is LVD, water level sensor in the water tank and relay. In Fig. 9, the orange water storage tank is above the well at a height of 3 meters above ground level. The installation process is carried out simultaneously and integrated as part of the service program. All service activities are collaborations between village residents and students, laboratory assistants and lecturers of the electrical engineering study program, Ahmad Dahlan University as part of the university's mission and vision.

Fig. 6. Preparation of tools and materials

Fig. 7. Solar panel

Fig. 8. Box panel

Fig. 9. Result of solar water pump

The process of transferring and providing increased knowledge of residents is carried out during the process of installing solar power pumps by discussing and asking questions. The process is shown in Fig. 10. Residents seemed enthusiastic to listen to explanations and discuss related to solar pump technology. In addition, residents are also involved in the process of installing solar power pumps so that they can understand the process of making solar pumps.

Fig. 10. Knowledge transfer process with discussion and question and answer

4. Conclusion

This service program consists of installation, counseling, training on the operation of a solar powered water pump for residents of Singkar 1 Hamlet, Wareng Village, Gunungkidul, Yogyakarta, Indonesia. In general, community service activities can run well and smoothly. Participants are very enthusiastic and can work well together. It is hoped that with this service activity, residents can increase their independence

and have good knowledge about solar-powered irrigation systems. The most visible impact of this service program is the cost savings for the irrigation system because it uses free solar energy.

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Thank you to Ahmad Dahlan University for funding this activity and the residents of Singkar 1 Hamlet, Wareng Village, Wonosari, Gunungkidul, Yogyakarta, Indonesia who have participated in this activity. Thanks also to the Community Service Team of the Electrical Engineering Study Program which consists of lecturers, laboratory assistants and students.

Author Contribution

The method of implementing community service programs in Singkar 1 Village, Wareng, Gunungkidul, Yogyakarta is carried out in several stages, namely preparation, implementation, and evaluation.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Y. A. Fatimah, K. Govindan, R. Murniningsih, and A. Setiawan, "Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia," *Journal of Cleaner Production*, vol. 269, p. 122263, Oct. 2020, doi: 10.1016/J.JCLEPRO.2020.122263.

[2] C. Tortajada and A. K. Biswas, "Achieving universal access to clean water and sanitation in an era of water scarcity: strengthening contributions from academia," *Current Opinion in Environmental Sustainability*, vol. 34, pp. 21–25, Oct. 2018, doi: 10.1016/J.COSUST.2018.08.001.

[3] A. Suriadikusumah, O. Mulyani, R. Sudirja, E. T. Sofyan, M. H. R. Maulana, and A. Mulyono, "Analysis of the water quality at Cipeusing river, Indonesia using the pollution index method," *Acta Ecologica Sinica*, vol. 41, no. 3, pp. 177–182, Jun. 2021, doi: 10.1016/J.CHNAES.2020.08.001.

[4] A. Purwanto, J. Sušnik, F. X. Suryadi, and C. de Fraiture, "Quantitative simulation of the water-energy-food (WEF) security nexus in a local planning context in indonesia," *Sustainable Production and Consumption*, vol. 25, pp. 198–216, Jan. 2021, doi: 10.1016/J.SPC.2020.08.009.

[5] A. Nikzad, M. Chahartaghi, and M. H. Ahmadi, "Technical, economic, and environmental modeling of solar water pump for irrigation of rice in Mazandaran province in Iran: A case study," *Journal of Cleaner Production*, vol. 239, p. 118007, Dec. 2019, doi: 10.1016/J.JCLEPRO.2019.118007.

[6] P. K. S. Rathore, S. S. Das, and D. S. Chauhan, "Perspectives of solar photovoltaic water pumping for irrigation in India," *Energy Strategy Reviews*, vol. 22, pp. 385–395, Nov. 2018, doi: 10.1016/J.ESR.2018.10.009.

[7] M. A. Eltawil, H. A. Alhashem, and A. O. Alghannam, "Design of a solar PV powered variable frequency drive for a bubbler irrigation system in palm trees fields," *Process Safety and Environmental Protection*, vol. 152, pp. 140–153, Aug. 2021, doi: 10.1016/J.PSEP.2021.05.038.

[8] S. M. Wazed, B. R. Hughes, D. O'Connor, and J. K. Calautit, "Solar Driven Irrigation Systems for Remote Rural Farms," *Energy Procedia*, vol. 142, pp. 184–191, Dec. 2017, doi: 10.1016/J.EGYPRO.2017.12.030.

[9] R. C. A. K. . Parmar, "Performance Analysis of Cost Effective Portable Solar Photovoltaic Water Pumping System," *Current Photovoltaic Research*, vol. 9, no. 2, pp. 51–58, 2021, doi: 10.21218/CPR.2021.9.2.051. [Online]. Available: https://doi.org/10.21218/CPR.2021.9.2.051. [Accessed: 21-Aug-2021]

[10] B. A. Bhayo, H. H. Al-Kayiem, and S. I. Gilani, "Assessment of standalone solar PV-Battery system for electricity

generation and utilization of excess power for water pumping," *Solar Energy*, vol. 194, pp. 766–776, Dec. 2019, doi: 10.1016/J.SOLENER.2019.11.026.

[11] O. V. Shepovalov, A. T. Belenov, and S. V. Chirkov, "Review of photovoltaic water pumping system research," *Energy Reports*, vol. 6, pp. 306–324, Nov. 2020, doi: 10.1016/J.EGYR.2020.08.053.

[12] K. Yadav, A. Kumar, O. S. Sastry, and R. Wandhare, "Solar photovoltaics pumps operating head selection for the optimum efficiency," *Renewable Energy*, vol. 134, pp. 169–177, Apr. 2019, doi: 10.1016/J.RENENE.2018.11.013.

[13] B. Ali, "Comparative assessment of the feasibility for solar irrigation pumps in Sudan," *Renewable and Sustainable Energy Reviews*, vol. 81, pp. 413–420, Jan. 2018, doi: 10.1016/J.RSER.2017.08.008.

[14] P. Abhilash, R. N. Kumar, and R. P. Kumar, "Solar powered water pump with single axis tracking system for irrigation purpose," *Materials Today: Proceedings*, vol. 39, pp. 553–557, Jan. 2021, doi: 10.1016/J.MATPR.2020.08.336.

[15] M. Aliyu, G. Hassan, S. A. Said, M. U. Siddiqui, A. T. Alawami, and I. M. Elamin, "A review of solar-powered water pumping systems," *Renewable and Sustainable Energy Reviews*, vol. 87, pp. 61–76, May 2018, doi: 10.1016/J.RSER.2018.02.010.

[16] Renu, B. Bora, B. Prasad, O. S. Sastry, A. Kumar, and M. Bangar, "Optimum sizing and performance modeling of Solar Photovoltaic (SPV) water pumps for different climatic conditions," *Solar Energy*, vol. 155, pp. 1326–1338, Oct. 2017, doi: 10.1016/J.SOLENER.2017.07.058.

[17] S. Gualteros and D. R. Rousse, "Solar water pumping systems: A tool to assist in sizing and optimization," *Solar Energy*, vol. 225, pp. 382–398, Sep. 2021, doi: 10.1016/J.SOLENER.2021.06.053.

[18] R. Amaral Lopes, R. Grønborg Junker, J. Martins, J. Murta-Pina, G. Reynders, and H. Madsen, "Characterisation and use of energy flexibility in water pumping and storage systems," *Applied Energy*, vol. 277, p. 115587, Nov. 2020, doi: 10.1016/J.APENERGY.2020.115587.

[19] M. Chahartaghi and A. Nikzad, "Exergy, environmental, and performance evaluations of a solar water pump system," *Sustainable Energy Technologies and Assessments*, vol. 43, p. 100933, Feb. 2021, doi: 10.1016/J.SETA.2020.100933.

[20] M. Errouha, A. Derouich, B. Nahid-Mobarakeh, S. Motahhir, and A. El Ghzizal, "Improvement control of photovoltaic based water pumping system without energy storage," *Solar Energy*, vol. 190, pp. 319–328, Sep. 2019, doi: 10.1016/J.SOLENER.2019.08.024.

[21] R. Nisha and K. Gnana Sheela, "Review of PV fed water pumping systems using BLDC Motor," *Materials Today: Proceedings*, vol. 24, pp. 1874–1881, Jan. 2020, doi: 10.1016/J.MATPR.2020.03.612.

[22] T. Poompavai and M. Kowsalya, "Control and energy management strategies applied for solar photovoltaic and wind energy fed water pumping system: A review," *Renewable and Sustainable Energy Reviews*, vol. 107, pp. 108–122, Jun. 2019, doi: 10.1016/J.RSER.2019.02.023.

[23] S. Senthil Kumar, C. Bibin, K. Akash, K. Aravindan, M. Kishore, and G. Magesh, "Solar powered water pumping systems for irrigation: A comprehensive review on developments and prospects towards a green energy approach," *Materials Today: Proceedings*, vol. 33, pp. 303–307, Jan. 2020, doi: 10.1016/J.MATPR.2020.04.092.

[24] T. Vezin *et al.*, "Borehole water level model for photovoltaic water pumping systems," *Applied Energy*, vol. 258, p. 114080, Jan. 2020, doi: 10.1016/J.APENERGY.2019.114080.

[25] B. S. Pali and S. Vadhera, "A novel approach for hydropower generation using photovoltaic electricity as driving energy," *Applied Energy*, vol. 302, p. 117513, Nov. 2021, doi: 10.1016/J.APENERGY.2021.117513. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S0306261921008953. [Accessed: 21-Aug-2021]

[26] B. S. Pali and S. Vadhera, "Uninterrupted sustainable power generation at constant voltage using solar photovoltaic with pumped storage," *Sustainable Energy Technologies and Assessments*, vol. 42, p. 100890, Dec. 2020, doi: 10.1016/J.SETA.2020.100890.

[27] A. Shafieian and M. Khiadani, "Integration of heat pipe solar water heating systems with different residential households: An energy, environmental, and economic evaluation," *Case Studies in Thermal Engineering*, vol. 21, p. 100662, Oct. 2020, doi: 10.1016/J.CSITE.2020.100662.

[28] H. Fu, G. Li, and F. Li, "Performance comparison of photovoltaic/thermal solar water heating systems with direct-coupled photovoltaic pump, traditional pump and natural circulation," *Renewable Energy*, vol. 136, pp. 463–472, Jun. 2019, doi: 10.1016/J.RENENE.2019.01.028.

[29] S. Mandal and S. K. Ghosh, "Experimental investigation of the performance of a double pass solar water heater with reflector," *Renewable Energy*, vol. 149, pp. 631–640, Apr. 2020, doi: 10.1016/J.RENENE.2019.11.160.

[30] A. Singh, J. Sarkar, and R. Rekha Sahoo, "Experimentation on solar-assisted heat pump dryer: Thermodynamic,

economic and exergoeconomic assessments," *Solar Energy*, vol. 208, pp. 150–159, Sep. 2020, doi: 10.1016/J.SOLENER.2020.07.081.

[31] A. R. Al-Ali, A. Al Nabulsi, S. Mukhopadhyay, M. S. Awal, S. Fernandes, and K. Ailabouni, "IoT-solar energy powered smart farm irrigation system," *Journal of Electronic Science and Technology*, vol. 17, no. 4, p. 100017, Dec. 2019, doi: 10.1016/J.JNLEST.2020.100017.

[32] M. Fawzy El-Khatib, S. Shaaban, and M. I. Abu El-Sebah, "A proposed advanced maximum power point tracking control for a photovoltaic-solar pump system," *Solar Energy*, vol. 158, pp. 321–331, Dec. 2017, doi: 10.1016/J.SOLENER.2017.09.051.

[33] M. Benghanem, K. O. Daffallah, and A. Almohammedi, "Estimation of daily flow rate of photovoltaic water pumping systems using solar radiation data," *Results in Physics*, vol. 8, pp. 949–954, Mar. 2018, doi: 10.1016/J.RINP.2018.01.022.

[34] S. Verma *et al.*, "Solar PV powered water pumping system – A review," *Materials Today: Proceedings*, vol. 46, pp. 5601–5606, Jan. 2021, doi: 10.1016/J.MATPR.2020.09.434.

[35] H. Rezk, M. A. Abdelkareem, and C. Ghenai, "Performance evaluation and optimal design of stand-alone solar PV-battery system for irrigation in isolated regions: A case study in Al Minya (Egypt)," *Sustainable Energy Technologies and Assessments*, vol. 36, p. 100556, Dec. 2019, doi: 10.1016/J.SETA.2019.100556.

[36] M. Das and R. Mandal, "A comparative performance analysis of direct, with battery, supercapacitor, and battery-supercapacitor enabled photovoltaic water pumping systems using centrifugal pump," *Solar Energy*, vol. 171, pp. 302–309, Sep. 2018, doi: 10.1016/J.SOLENER.2018.06.069.

[37] V. Zavala, R. López-Luque, J. Reca, J. Martínez, and M. T. Lao, "Optimal management of a multisector standalone direct pumping photovoltaic irrigation system," *Applied Energy*, vol. 260, p. 114261, Feb. 2020, doi: 10.1016/J.APENERGY.2019.114261.