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# INSTALLATION OF SOLAR PANELS FOR FILTRATION SYSTEMS ON KOI FISH CULTIVATION IN SUMBERINGIN KIDUL VILLAGE, TULUNGAGUNG REGENCY

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**Abstract**

The large electricity bill for aerators and filter pumps in Koi fish farming ponds is a problem for PPM (Community Service) partners. In addition, long-term power outages can cause fish death. This koi fish farming located in Tulungagung district has an area of about 2000 $m^2$ which is divided into several pond plots. The decline in the quality of Koi fish is also caused by poor filtration. The purpose of this activity is to install a micro-scale Solar power plant. This micro Solar Power Plant is used as a power source for filter pumps and pond aerators. The installed 600 Wp Solar Power Plant system consists of 4 solar panels with a capacity of 150 Wp each, an 850 VA hybrid inverter, and a 100 Ah VRLA battery. Electrical energy from Solar Power Plant can power a 75 W pump with a capacity of 26000 L/h. The installation of solar panels in this pool can produce an average of 2.5 kWh of electrical energy/day. So that the electricity savings from PLN can reach IDR. 108,352.5 per month.

**Keywords:** Solar Panel, Micro Solar Power System, Koi Pond, Filter Pump, Aerator

## INTRODUCTION

In the last five years, the development of solar panel technology has been extraordinary (Zou et al., 2016). So that the positive impact is that the community can find solar-based technology equipment circulating in the market easily and cheaply (Lestari et al., 2021). This is also supported by government policies in the new renewable energy development program, especially solar energy (EBTKE, 2021). The application of solar panels can be used for PV mini-grid, street lighting, and ultraviolet repellent lamp technology to electric vehicle charging stations (Parastiwi et al., 2018).

So that in recent years, many PPMs have been carried out taking topics based on the application of solar cell technology to solutions for electrical energy needs in the community (Hidayah et al., 2019; Putri et al., 2020; Tambunan et al., 2020; Asrori et al., 2021; Gumono et al., 2021).

The target audience/objects of this Community Service (PPM) are IKM (Small and Medium Industries) in the field of ornamental fish cultivation, namely Koi fish. The ornamental fish cultivation business by this partner has been carried out for the last 10 years. Previously, artificial ponds (cement ponds) owned by partners were used for the cultivation of


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gouramy. The pool, which is located in an area of 2000 m2, is divided into several plots with their respective functions. The location of this pool is in the village of Sumberingin Kidul, Kec. Ngunut, Kab. Tulungagung. Figure 1 shows the location of the Koi fish farming pond.


Figure 1. Location of PPM activities

The partner's main problem is the use of large amounts of electricity to support pool equipment, namely pool pumps, filter pumps, and aerators. In addition, there are several partner problems, namely:

1). The problem of pool water treatment (water treatment). The cultivation system is carried out in an artificial pond (cement pond) with the condition of the pond water being still so that it tends to be dirty & cloudy. Water conditions and quality (temperature and pH) greatly affect the growth of fish. Especially ornamental fish (Koi), the quality of fish is characterized by good growth and color patterns (Rizky et al., 2015). So far, the pool has only installed 3 water pumps with a power of 150 W each for filling pool water and not for circulation or filtration pumps.

2). PLN often goes out for a long time. So far, for the supply of oxygen in the pond, 3 units of aerators with a capacity of 60 W work for 24 hours. The aeration installation carried out by partners is also very simple, namely using a branched hose. When there is a long power outage (more than 5 hours) and the oxygen supply aerator does not work, as a result, many koi are found floating and some of them die (Figure 2).

Figure 2. Koi die due to a lack of oxygen supply

Meanwhile, the use of solar panels as a source of electricity in aquaculture areas, both to increase the productivity of aquaculture or save energy, has begun to be carried out by many

researchers. Drive power requirement

Large pool circulation pumps are the main topic, to find a solution (Anjarsasri, et al., 2017; Dwiyaniti et al., 2020; Nurhadi, et al., 2021). The system and support for pool water filtration equipment also did not escape the attention of researchers and PPM activities. Filter media, water treatment, pump circulation methods to the addition of automatic control equipment, can affect the growth and health of aquaculture (Permatasari et al., 2017; Firmansyah et al., 2021; Fakhriza et al., 2021).

Community empowerment through the use of appropriate technology and analysis of environmental potential is the focus of every Community Service activity (Gunawan, et al., 2020). The potential area for the PPM location is in the village of Sumberingin Kidul, which is 15 km east of the city of Tulungagung. Tulungagung Regency is famous for its potential for freshwater fish cultivation (consumption and ornamental). The locations of these ponds are scattered in almost all areas of the Tulungagung district (Dewi, 2019; Zaman et al., 2021).

From the on-site survey and interviews with partners, it was found that several problems needed to be solved, and solutions were found. However, the problems and challenges faced by partners are also complex. Therefore, the PPM implementation activities are focused on the problem of water treatment and the installation of solar panels as a source of electrical energy to drive pumps for the filtration of Koi aquaculture ponds.

## IMPLEMENTATION METHOD

The Community Partnership PPM was conducted in Ds. Sumberingin Kidul, Kec. Ngunut, Kab. Tulungagung, East Java. The location point for installing solar panels for the supply of electrical energy for this Koi pond filter pump is around the coordinates: 8.1249 °LS; 112.004 °E (Figure 1). In general, the flow of the PPM implementation is shown in Figure 3. This activity was carried out by the PPM Team of Lecturers and Students of the State Polytechnic of Malang, from June – July 2022.

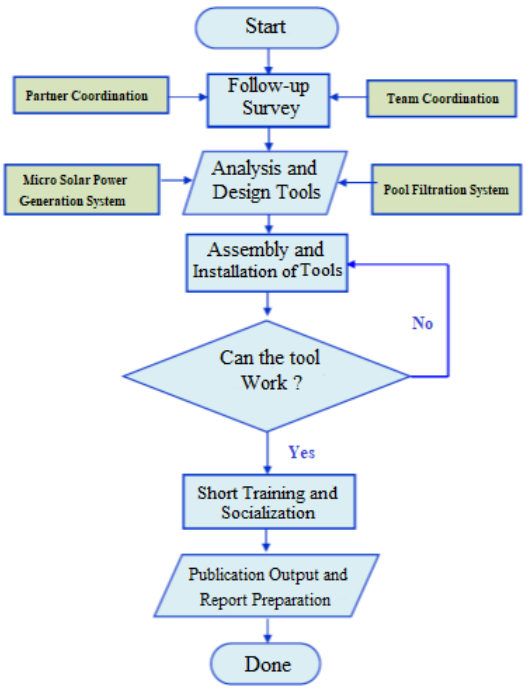


Figure 3. PPM implementation flowchart

The success of the PPM implementation certainly cannot be separated from the appropriate, effective, efficient and effective and sustainable method. Therefore, the PPM implementation method/strategy is divided into several stages, namely:

A. Design Planning Stage

Appropriate Technology that is applied at the partner locations broadly consists of two main parts, namely: a). Solar power generation system. The main components of this equipment are solar panels, solar charger controllers, inverters, and batteries. b). The water treatment system in the fish pond, in which there is a process of filtration, aeration, and disinfection to the process of maintain the water temperature. The main equipment for this water treatment system consists of; a chamber filter unit, filter media (silica sand, activated carbon, bio ball, japmat, filter cotton), water pump, and UV light. The design of the filtration system is shown in Figure 4. This filter body consists of; a) settling basin, b) settling tank, c) mechanical filter, d) biological filter and e) chemical filter. While the water circulation system in the filter will be driven by a submersible pump. In addition, chemical filtration equipment will be equipped with UV lamp installation. Of course, pumps and lamps will require electricity. Then this power source will be supplied by the installed micro Solar Power Plant.

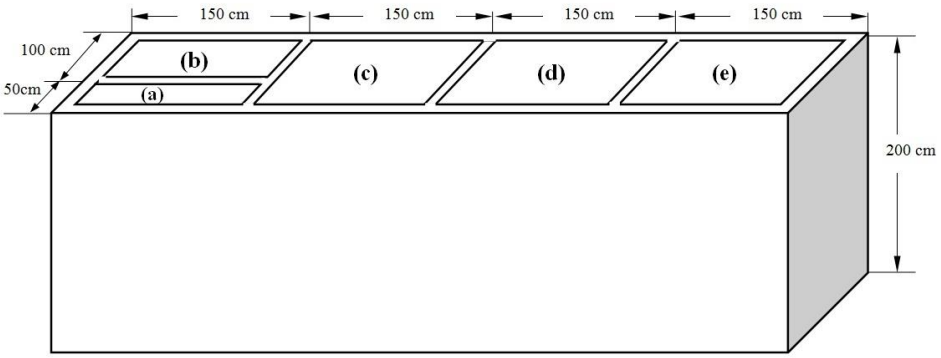


Figure 4. The design of the chamber-type filtration system (bulk bulkhead)

The Solar Power Plant system used as a source of electrical energy in the Koi fish culture pond filter system is shown in the illustration in Figure 5. The working principle of this system is that the water in the pond will be circulated through the filter chamber using a submersible pump. kill bacteria using a UV lamp (UV Clarifier). The AC power source for both pieces of equipment is supplied from the installed Solar Power Plant. This small/micro Solar Power Plant system is planned to have a capacity of 600 Wp. The solar panels through the solar charger controller will control the charging current in the battery. The inverter functions to change the DC voltage of the battery into AC voltage, to turn on the pool filter pump.

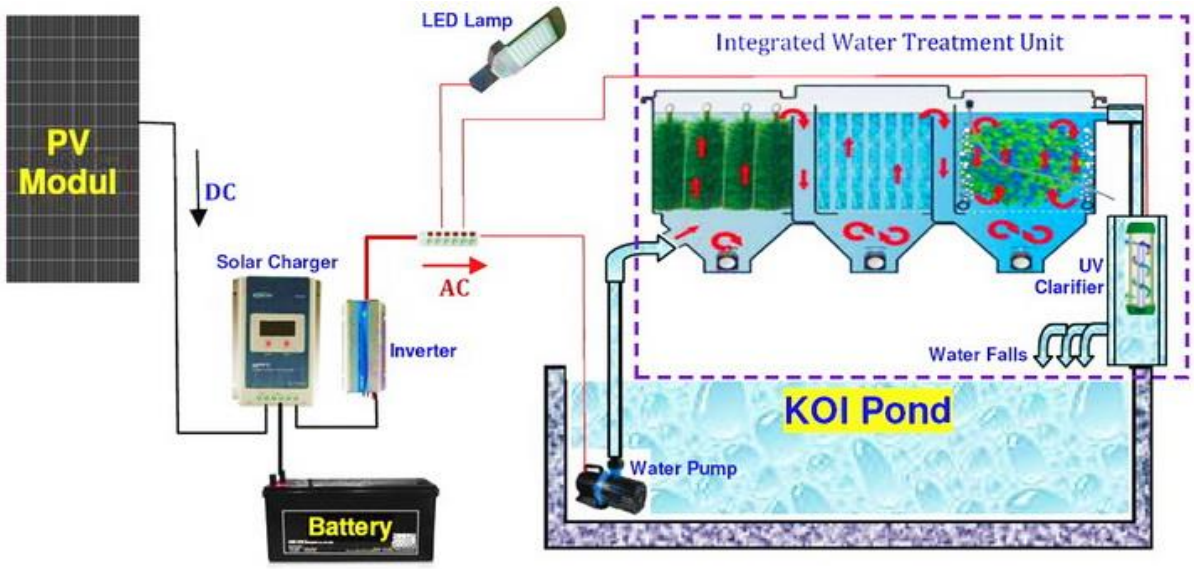


Figure 5. A solar power generation system for Koi. pond filtration system

B. Preparation Stage

The stages of preparation carried out in this PPM are 1). Coordinate the internal team (lecturers, staff & students). This is done to strengthen the structure of the program that has been designed so that the activities to be carried out become more organized and directed. This stage includes all matters of a technical, managerial, and time schedule for the implementation of the Partnership PPM. 2). Coordinate with partners regarding plans for making or installing Micro Solar Power Plant installations for pond filtration systems. 3). Conduct a review of the pool location and ensure a strategic location point for the placement of equipment to be installed. 4). Purchasing tools and materials for solar pool filtration systems under pre-designed specifications. The main components consist of solar panels, battery controllers, batteries, water pumps, UV light, and supporting materials for pool filtration (building materials, filtration media, pipes, etc.). 5). Coordinate workshop or handyman personnel around the site.

C. Implementation Stage

The implementation of PPM carried out at this stage is the creation of a chamber filter pool which is civil work. This work is carried out by builders who are in the vicinity of the site. Furthermore, after the civil works are completed, the Solar Power Plant system assembly is carried out to supply electricity needs from the filtration technology applied in the Koi pond.


Figure 6. Location of the filter basin and installation of solar panels

D. Evaluation and Monitoring Phase

Monitoring is carried out intensively by the implementing team for each activity that takes place. This is to ensure the implementation of this PPM goes according to plan. Evaluation is carried out at each stage of the activity based on the PPM implementation flow chart (Figure 3). The implementing team and partners are expected to have an agreement in terms of determining criteria, indicators for achieving goals, and benchmarks that can be used to declare the success of these activities. Diversification of Appropriate Technology through PPM activities is very important. So it's not just making and submitting it, but the most important evaluation is the knowledge up-grade and respect of partners for the technology applied to their fish ponds.

## RESULTS AND DISCUSSION

This Community Service (PPM) begins with determining the point of making the filter basin and the location of the solar panel installation. Figure 6 shows the location of the filter basin and the installation of solar panels. The physical work carried out in this Community Service (PPM) activity consists of two activities, namely:

A. Making the Filter Chamber

The main materials used for the filter tank are brick, sand, and cement. While the supporting material is PVC pipe. The process of building this filter basin is shown in Figure 7. The filter for this koi pond is made with a water circulation system that passes through 5 filter chambers. The chamber system is made in such a way that water can pass through each chamber bottom-up. This model is expected to be able to make clear the Koi pond so that its growth can be maximized. Figure 8 shows a model of a filter basin made for a koi pond culture filtration system. This main filter system generally consists of 4 main parts, namely; 1) mechanical filtration system (Mechanical filtration). This filtration physically functions to filter out particulate waste and material debris in the pond. Commonly used materials for mechanical filtration are sand, brush, matt filter, lint, and sponge foam. The material can filter out suspended materials in pond water, such as leaves, twigs, fish droppings, etc. The mechanical filter stage in this design is made in two stages, namely in the settling basin and the settling basin. Where in the settling basin there is a drain, where the bottom of this tub is made sloping. This drain is installed with PVC pipes which are installed vertically and can be removed when cleaning dirt/sediment.

Figure 7. The process of installing bricks for the manufacture of pond filter tanks


Figure 8. The shape of the tub (chamber) in the Koi. pond filtration system

2). Biological filtration system (Biological filtration). This filtration stage uses natural biological processes to convert hazardous waste released by koi or as a result of decaying plant matter in ponds into hazardous compounds. Koi release ammonia, which is lethal to the koi themselves in large doses. Certain anaerobic bacteria (without oxygen) can convert ammonia to nitrite and are also toxic to koi. Bio-filter material can use porous rocks.

3). Chemical filtration system (Chemical Filtration). This filtration step is needed to break down and convert compounds that can cause death in fish, such as ammonia and nitrite. Both of these compounds in certain amounts can inhibit or cause death in koi fish. Chemical filters utilize activated carbon as a filtration medium which helps absorb chemicals.

4). UV (Ultraviolet Light) Sterilization System. This UV (UltraViolet) light is used to kill pathogens because UV-C rays can reduce nucleic acids in parasites and bacteria so they are unable to reproduce.

The water circulation system is driven by a submersible pump. The specifications of the pump used are; model: LP-26000, voltage: 220V, frequency: 50Hz, power: 75W, $Q_{max}$: 26000 L/h, $H_{max}$: 3.8 m, size: 200 (diameter) x 360 (height) mm, Outlet diameter: 110mm. The technology applied in this PPM is the design of an integrated water treatment system (Integrated Water Treatment). With a filtration system (biological, mechanical, chemical), coupled with the addition of a UV lamp as a disinfectant medium in the pool water, it can optimize the process of filtering and purifying water.

B. Solar power plant assembly

The installed Solar Power Plant has a capacity of 600 Wp. The installation consists of 4 units of 150 $W_p$ solar panels. Figure 9 shows the installation of solar panels. The technical specifications of solar panels are; type: monocrystalline, $I_{mp}$: 8.33 A, $V_{mp}$: 18 V, $V_{oc}$: 22.6 V, $I_{sc}$: 9.07 A, $E_{ff}$: 20.7%. This solar panel electrical energy conversion is managed by a device that is a combination of a solar charger and an inverter called a hybrid-smart inverter. Figure 10 shows the process of setting up the inverter, battery, and fuse equipment in a wooden panel. The assembly process for the 600 Wp micro PV mini-grid installation also involves partners (Figure 11). This is important to do so that the sustainability of the installed equipment can last a long time because partners already have the correct knowledge of OM (operation & maintenance).

Figure 9. Solar Panel Installation

The inverter used in this PPM, to receive 600 Wp solar panels is the Luminous Inverter Solar Hybrid 850VA/12V. This type of inverter is capable of producing pure Sine Wave (PSW) frequencies, so this system can be connected to the PLN (On Grid) network. The PWM-type solar charger in this tool can charge a battery with a capacity of 12V/100 Ah.

Figure 10. The process of setting the smart inverter and battery on the panel box

The installation of a micro Solar Power Plant with a capacity of 600 Wp can be calculated for its energy productivity. If the effective hours of sunlight, it is assumed for 5 hours and the efficiency of the system is 0.85%. So this solar panel is predicted to produce energy of 2.5 kWh/day. The basic electricity tariff for the R-1/TR class with 1300 VA power as of July 2022 is Rp 1,444.70/kWh (Anwar, 2022). Thus, the savings that can be made by partners is Rp. 108,352.5 per month. The main advantage of installing this solar panel is that it guarantees the continuity of the filtration system working for 24 hours because it is not affected by a PLN power outage. The installation of a solar-powered filtration system in this PPM activity is expected to provide a strengthened science and technology, and the use of renewable energy in the field of fish farming, especially Koi fish. So that the results of the PPM program carried out can be a trigger for fish farmers/breeders in the area, which in turn becomes an industrial sector that can be oriented to national and even global markets.

Figure 11. Partner involvement in the installation of 600 Wp Surya solar panels

## CONCLUSION

The conclusions of the PPM Partnership activities carried out by the team of lecturers and students of Polinema are:

The pool water filtration and circulation system use a 75 W submersible pump with a capacity of 26000 L/hour. The dimensions of the filter chamber are $w \times l \times h$ = 6 x 1.5 x 2 m. The filtration stage goes through the mechanical, biological, and chemical filtration stages.

The installed micro Solar Power Plant system consists of 4 units of monocrystalline solar panels with a capacity of 150 Wp, a PWM/PSW hybrid inverter 850 VA, and a 100 Ah VRLA battery. The installation of this 600 Wp solar panel can save electricity bills of Rp. 108.352.5/month.

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## REFERENCES

Anjarsasri, D. P., Safitri, H. K., & AI, B. (2017). Pemanfaatan Sistem On-Grid Pada Kontrol Kecepatan Pompa Sirkulasi Berdasarkan Kekeruhan Kolam Ikan Menggunakan Fuzzy Logic Control. *JURNAL ELKOLIND, 4* (2), 28-34. doi: http://dx.doi.org/10.33795/elk.v4i2.112

Anwar, M. C. (2022, August 10). *Kompas.com*. Retrieved from https://money.kompas.com/read/2022/07/03/130130526/daftar-harga-listrik-per-kwh-2022-untuk-golongan-tarif-non-subsidi?page=all.

Asrori, A., Harijono, A., Faizin, A., Dani, A., & Kriswitono, K. (2021). Aplikasi Home Solar System sebagai Penerangan untuk TPQ-Al Murtadho di Kota Malang. *Jurnal Penelitian dan Pengabdian Kepada Masyarakat UNSIQ, 08* (01), 99-106. doi: https://doi.org/10.32699/ppkm.v8i1.1499

Dewi, E. (2019). Analisis Kelayakan Usaha Budidaya Ikan Air Tawar dengan Sistem Kolam Terpal di Kecamatan Kedungwaru Kabupaten Tulungagung. *JURNAL AGRIBIS , 5* (1), 54-60.

Dwiyaniti, M., Riandini, & Supriyono, E. (2020). Pemanfaatan Solar Sel dan Budidaya Perikanan Sebagai Upaya Menuju Kemandirian Finansial di Sekolah KAMI. *Jurnal Panrita Abdi , 4* (2), 146-154. doi: https://doi.org/10.20956/pa.v4i2.7614

EBTKE. (2021). *Implementasi Peraturan Menteri ESDM tentang PLTS Atap.* Retrieved May 28, 2021, from https://drive.esdm.go.id/wl/?id=5XQv80ogkSp0tLQsY4wJNUPVSPpcgGtz

Fakhriza, R., Rahmat, B., & Astuti, S. (2021). Perancangan dan Implementasi Alat Monitoring dan Controlling Kualitas Air pada Kolam Ikan Koi. *e-Proceeding of Engineering , 8* (5), 5274-5289.

Firmansyah, W., Cokrowati, N., & Scabra, A. R. (2021). Pengaruh luas penampang sistem resirkulasi yang berbeda terhadap kualitas air pada pemeliharaan ikan nila (Oreochromis niloticus). *JURNAL PERIKANAN DAN KELAUTAN, 26* (2), 85-93. doi:http://dx.doi.org/10.31258/jpk.26.2.85-93

Gumono, G., Susilo, S. H., Setiawan, A., & Asrori, A. (2021). The Assembly and Installation of Solar Powered Public Street Lights (PJU) atPanti Asuhan Putri Aisyiah Dau Malang. *International Journal of Community Engagement Payungi , 1* (2), 52-58.

Gunawan, B., Nurkhamid, M., & Mulyani, S. (2020). Peningkatan Produktifitas UMKM Industri Kreatif di Era MEA dengan Pemanfaatan Teknologi Tepat Guna. *Abdi Dosen : Jurnal Pengabdian Pada Masyarakat, 4* (3), 251-260. doi: https://doi.org/10.32832/abdidos.v4i3.666

Hidayah, Q., Salamah, U., & Kusuma, D. Y. (2019). Solar home system di masjid kelurahan Serut Kecamatan Gedangsari Kabupaten Gunung Kidul. *Seminar Nasional Hasil Pengabdian kepada Masyarakat* (pp. 669-674). Yogyakarta: Universitas Ahmad Dahlan.

Lestari, N. M., Kumara, I. N., & Giriantari, I. A. (2021). REVIEW STATUS PANEL SURYA DI INDONESIA MENUJU REALISASI KAPASITAS PLTS NASIONAL 6500 MW. *Jurnal SPEKTRUM, 8* (1), 27-37. doi: https://doi.org/10.24843/SPEKTRUM.2021.v08.i01.p4

Nurhadi, N., Khambali, K., Kasijanto, K., Rifa'i, M., & Wiharya, C. (2021). Pembangkit Listrik Tenaga Surya sebagai Penggerak Pompa Air Kolam Lele Biponik di UKM Citara Desa Banjararum Kecamatan Singosari Kabupaten Malang. *Jurnal Aplikasi Dan Inovasi Ipteks SOLIDITAS , 1* (1), 24-36. doi: https://doi.org/10.31328/js.v4i1.1782

Parastiwi, A., Putri, R. I., Adhisuwignjo, S., & Rifa'i, M. (2018). *PhotovoltaicTerapan: Teknologi dan Implementasi.* Malang: Polinema Press.

Permatasari, R., Rinanti, A., & Ratnaningsih, R. (2017). reating domestic effluent wastewater treatment by aerobic biofilter with bioballs medium. *Earth and Environmental Science . 106*, pp. 1-6. IOP Conf. Series. doi: 10.1088/1755-1315/106/1/012048

Putri, R., Meliala, S., & Zuraida. (2020). Penerapan Instalasi Panel Surya Off Grid Menuju Energi Mandiri Di Yayasan Pendidikan Islam Dayah Miftahul Jannah . *Journal of Electrical Technology , 05* (03), 117-120.

Rizky, T. D., Ezraneti, R., & Adhar, S. (2015). Pengaruh media filter pada sistem resirkulasi air untuk pemeliharaan ikan koi (Cyprinus carpio L). *Acta Aquatica , 2* (2), 97-100.doi:https://doi.org/10.29103/aa.v2i2.341

Tambunan, J. M., Joko, P., Bangkit, S., Azis, H., Pawenary, P., & Yayi, S. (2020). Aplikasi Lampu Penerangan Rumah Tinggal Sederhana (Solar Home System) Berbasis Tenaga Surya Di SMA Pancaran Berkat Jakarta Barat. *Terang: Jurnal Pengabdian Pada Masyarakat Menerangi Negeri, 02* (02), 117-125.doi:https://doi.org/10.33322/terang.v2i2.409

Zaman, M. B., Siswantoro, N., Pitana, T., Priyanta, D., & Prastowo, H. (2021). Pemberdayaan Petani Ikan untuk Menunjang Agro Maritim di Tulungagung. *SEWAGATI , 5* (3), 1-5.doi:https://doi.org/10.12962/j26139960.v6i1.76

Zou, C., Zhao, Q., Zhang, G., & Xiong, B. (2016). Energy revolution: From a fossil energy era to a new energy era. *Natural Gas Industry B*, 1-11. doi:https://doi.org/10.1016/j.ngib.2016.02.001