

Solar Panel Technology for the Treatment of Eucalyptus Oil Refined Waste

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ABSTRACT

Banjarwaru Village, Nusawungu District, Cilacap Regency, has natural resources, especially eucalyptus plants, which have the potential to develop the economy of the village community. The biggest problem faced by LMDH Dadi Makmur as a unit that manages the eucalyptus oil business is that after the production of eucalyptus oil distillation, it will produce residual waste from eucalyptus twigs and leaves with quite a large volume and only allowed to be piled up around the yard where the distillery is, causing area storage of essential oil raw materials is narrow and also takes a long time to become organic fertilizer. The innovation offered through this community service activity is implementing a briquette printing machine from eucalyptus oil refining waste, which is energy efficient and based on solar panels. The dedication results show that the eucalyptus oil waste processing activity and reducing environmental pollution also produce biomass briquettes that the residents of Banjarwaru Village can utilize as a leading economic product of Banjarwaru Village. The test data of the briquette making machine shows that the output voltage from the inverter produces an AC voltage with a value of 216 - 221 V, so that it can rotate the AC motor with a rotation of 800 - 1400 rpm.

Keywords: Solar Panel; Eucalyptus Oil; Banjarwaru Village; Biomass Briquettes

1. INTRODUCTION

Banjarwaru Village (**Rukmi et al., 2023**) are administratively directly adjacent to Sidaaurip and Kubang Kangkung Villages in the north and Central Cilacap District in the south, then directly bordering Bringkeng village in the west and Jeruklegi District in the east. Banjarwaru Village consists of 4 hamlets (Banjursari, Banjarwaru, Sidamulya, and Kaliyasa), 7 RWs, and 57 RTs. Of the 57 RTs, there are approximately 2,000 families and 7,654 residents. Banjarwaru Village has an area of 14.46 km² with an altitude of 8 meters above sea level. In terms of climate, the average rainfall is 195.33 mm/year. (**Rahmat et al., 2023**). The total population of Banjarwaru Village is 10,512 people, consisting of 5,416 men and 5,096 women, in 2020

(Dawan et al., 2023). Banjarwaru village rice production is 6,464 tons, and corn is 1,566 tons. In addition to rice, the potential for brackish water plants can be found in Banjarwaru village. The Eucalyptus plantation area in Banjarwaru village reaches 785.30 ha with a total of 552,247 trees. **(Hafid et al., 2023)**.



Figure 1. Eucalyptus Distillation Activities in Banjarwaru Village

One of the economic potentials in Banjarwaru village is the process of distilling eucalyptus plants into eucalyptus oil as described in Figure 1. The management of eucalyptus plants involves the community around the forest with the Joint Community Forest Management (PHBM) system, and applies the spirit of sharing the results of processing forest products between Perum Perhutani and the Banjarwaru village community **(Kholis, 2019)**. The planting of eucalyptus is combined with marine aquaculture (ponds) and rice fields in certain mounds and locations, so that it does not result in irregular spacing, which results in suboptimal land productivity.

Through the Collaborative Forest Management system, forest management involves the participation of communities around the forest with available forest resources as growers and processors of forest products, so that they can help improve community welfare on an ongoing basis **(Bula et al., 2023)**. The collection of eucalyptus leaves and the process of refining eucalyptus oil are carried out jointly by the community and LMDH, and then the eucalyptus oil distillate will be sold back to Perhutani, so that it benefits both parties. The total production of eucalyptus oil in Banjarwaru village reaches 100 kg of eucalyptus oil per year, with a total yield of eucalyptus plants that are distilled by 300 kg **(Saptenno et al., 2023)**.



Figure 2. The condition of the Remaining Waste from Eucalyptus Oil Distillation

From the Figure 2 above, the biggest problem after the production of eucalyptus oil distillation is the remaining waste from eucalyptus oil twigs and leaves, which are left piled up around the distillery yard, causing the raw material area for the essential oil to become narrow, and also takes a long time to process into organic fertilizer. **(Claresta, 2023)**. What LMDH, as the manager, has tried is to take eucalyptus oil wood branches to be used as firewood by residents around the forest, but these efforts are still not optimal because there are still lots of piles of distillate waste.

In addition to problems in the environmental sector, another problem that exists in the partners is the limited energy sources used to process eucalyptus oil waste. To destroy the remaining eucalyptus distillation waste with a capacity of 200 kg/hour using a 5.5 hp gasoline engine or a 4000-watt electric motor, the total cost required to destroy 400 kg of waste requires a fee of IDR 5,200,000. Of course, this will be detrimental to the LMDH because it will affect the institution's balance of expenses **(Rumatiga et al., 2023)**.

There needs to be appropriate technological innovations that can process these waste materials so that these waste problems will become products that have economic value and help improve the economy of the people around the eucalyptus oil production site. The Cilacap State Polytechnic, as a vocational education institution, is responsible for helping solve these problems through higher education activities. One of the ideas or innovations offered through this applied research proposal is implementing a briquette printing machine from eucalyptus oil refining waste, which is energy-efficient. Waste that is no longer used will be dried within a certain time to remove the water content and then mixed with other ingredients to make briquettes. The briquettes will later be used by the community as fertilizer in agricultural fields or sold as a superior product of LMDH Dadi Makmur. The objectives of community service activities include: 1) Reducing the remaining waste from the eucalyptus oil refinery so that the storage area becomes wider; 2) Increasing partner skills, namely, achieving skills in operating and assembling a solar panel system on a briquette printing machine **(Azmi, 2023)**.

2. METHOD

The stages in the method of carrying out activities as a solution offered to overcome partner problems in Banjarwaru Village, Nusawungu District, Cilacap Regency, consist of :

2.1 Conducting Surveys

In the early stages of implementing the PKM program in Banjarwaru Village, Nusawungu District, a field survey will be carried out directly by the program proposing team, accompanied by two students. Things that will be carried out include planning PKM area objects, taking documentation, and verifying problems from potential partners to discuss problem-solving and coordination with the community in following up on problem-solving.

After conducting a survey directly in the field, the next step is to collect initial data to obtain direct information in the form of primary data, both quantitatively and qualitatively. Measurements that will be carried out by the scientific method and recorded will then be

processed to serve as initial data, which will be used as a reference in finding solutions to problems of potential partners. The results of interviews with potential partners can be used as qualitative primary data and will be used as a scientific approach to finding solutions to potential partners' problems.

2.2 Focus Group Discussion



Figure 3. Focus Group Discussion Activities

The FGD I activities were carried out by involving Partner Leaders and residents who received invitations, as well as youth who were ready to take part in PKM program activities as described in Figure 3. The FGD I event will contain an introduction and hospitality from the head of the PKM Program to the residents of Banjarwaru Village and LMDH Dadi Makmur followed by an explanation of the aims and objectives of holding the PKM program in Banjarwaru Village, Nusawungu District. Furthermore, in the FGD, groups of residents began to be formed who would be directly or indirectly involved in the field. The group of residents who were directly involved in the field consisted of men and youth from Banjarwaru Village, while the indirect group consisted of Dawis women. The head of the PKM program provides an explanation of the duties and responsibilities to the group of residents whose roles have been determined and is followed by an initial evaluation desk process regarding the exact schedule for implementing the program (Udin et al., 2019).

2.3 Service Methods and Implementation

The manufacture of briquette printing machines with solar panel energy sources was carried out at the Electronic Engineering Department Workshop of the Cilacap State Polytechnic. The briquette printing machine consists of several parts, such as a solar panel support frame, an electrical panel box, a shredding machine for the remaining waste from the distillation of eucalyptus oil, and a briquette printing machine



Figure 4. Training and Mentoring Eucalyptus Grinding Machine

The training and mentoring stages need to be carried out so that the briquette machine can run well and sustainably up to the maximum capacity of the designed tool. Figure 4 shows the training and mentoring for partners to jointly maintain the PKM program technology assets in Banjarwaru Village. Training and mentoring can be in the form of a learning process when the tool is damaged, or when the tool repair process or tool maintenance. Mentoring regarding waste shredder machines was carried out offline at the service location for members of LMDH Dadi Makmur. The head of the PKM program explained the work process of the service tool and the importance of maintaining the PKM program technology tools and continued with a presentation from the partner leader to invite all youth organizations as representatives of the community to maintain; care for; and utilize the goodness of the PKM program for the common interest for the advancement of the community's economy and for the achievement of an independent energy village. The training event also included a form of gratitude for the success of the program that had been implemented in the process of making briquette printing machines in Banjarwaru.

The assistance of the briquette printing machine was carried out offline at the location of the community service activity located in Banjarwaru Village, Nusawungu District, Cilacap Regency. The Community Service Team provided counseling to the management of LMDH Dadi Makmur regarding the technical operations of making briquettes using a briquette printing machine. The community service team, with the assistance of students from the electrical engineering study program, demonstrated how the process of mixing the composition of the briquettes to be made using starch flour, refined oil refining waste charcoal and water. All ingredients are mixed evenly by a mixer and then molded into briquettes using a briquette printing tool. The composition of starch flour and eucalyptus waste charcoal is 1:4. After the mixture was printed, the community service team showed the printed briquettes and explained the optimal drying process to obtain briquettes of optimal quality. In addition to demonstrating the making of briquettes, the community service team also provided counseling regarding the maintenance and repair process for the entire tool, which can be seen in Figure 5. The service team also provided a maintenance and repair manual for the equipment that would be provided so that, in the future, it could be carried out independently by LMDH Makmur.



Figure 5. The assistance of the briquette printing machine

3. RESULT AND DISCUSSION

Some of the problems above have been discussed through focus group discussion activities that have been held at the Banjarwaru village office, and the parties have agreed to make a briquette printer with a solar power plant energy source so that it will reduce the remaining waste of eucalyptus oil refining but is more economical in the use of electrical energy. To make the tool, several supporting components are needed so that the results of the briquettes are as expected. The main components of a briquette printer using solar panels include:

3.1 Briquette Making Machine Test

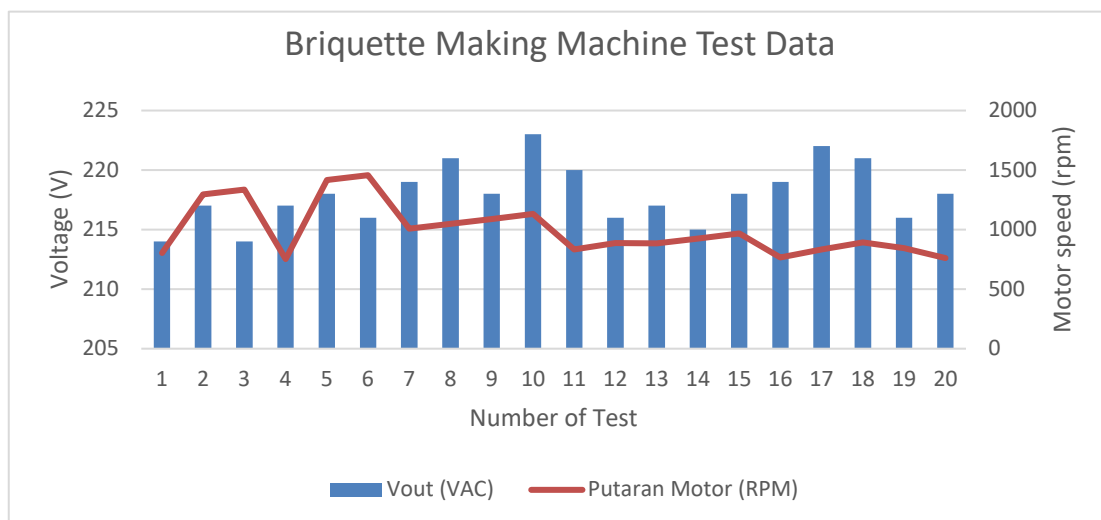


Figure 6. Briquette Making Machine Test Data

The test results of the solar panel voltage on the briquette making machine show that sunlight converted into electrical energy by the solar panel produces a variable voltage between 24 - 26 Volts to charge the battery. This test was carried out from 08.00 to 17.00 WIB, adjusting to the intensity of the sun in the test area as showed in Figure 6.

The DC electrical energy source produced by the solar panel is converted by the inverter into an AC electrical energy source. This AC electrical energy is used by the briquette making machine to turn on an AC motor with a capacity of 750 Watts as a motor to drive the chopping

knife and the briquette dough stirring screw. Figure 6 shows the test data of the briquette making machine that produces output voltage from the inverter with a value of 216 - 221 V, so that it can rotate the AC motor with a rotation of 800 - 1400 rpm. Based on the data above, it can be seen that the system can supply the energy needs for the briquette printing machine with solar panel energy sources, so the potential for application in the field is very large.

3.2 Increasing Economic and Environmental Value

Waste from the distillation process can be used to make two products with economic value, namely fertilizer and charcoal briquettes. Fertilizer is obtained from the results of shredding eucalyptus oil distillation waste so that a smoother texture is obtained and is reused as fertilizer for eucalyptus oil seedlings.

The production capacity of fertilizer from eucalyptus oil distillation waste in optimal sunny weather conditions produces a maximum of 40 kg of ready-to-use fertilizer with a total reduction in waste per day of 40 kg for 4-5 hours of tool use as shows in Figure 7. This capacity can be increased according to the needs at the eucalyptus oil processing site by using a hybrid energy system between PLTS + PLN.

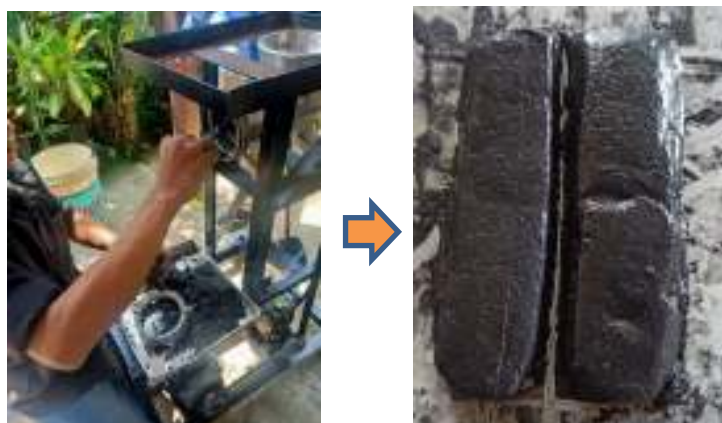


Figure 7. Briquette from the shredding of eucalyptus oil distillation waste

The plan for utilizing the shredded fertilizer in the future is to sell fertilizer in 40 kg sack packaging. The volume of accumulated distillation waste with a total mass of 300 kg will be the main source of processed fertilizer materials available at the service location. The main target of this fertilizer sales is farmers who will plant eucalyptus oil plant seedlings and it is expected to help reduce fertilizer costs which have been another problem in planting eucalyptus oil plant seedlings. The waste above can also be processed by drying it into charcoal flour which will then be combined with other ingredients such as starch and water into briquette dough. The evenly mixed briquette dough will then be molded using a briquette molding machine. The resulting briquettes will then be dried for several days to remove the water content so that they can produce optimal heat as a source of biomass fuel. The biomass briquettes produced can be produced with a capacity of 40 kg per day according to the capacity of the solar panels as the energy source. With a briquette price per kg of IDR 20,000, the estimated turnover received is IDR 800,000.



Figure 8. Minutes of Handover of Community Service Tools

The final stage of the training and mentoring activities for LMDH Dadi Makmur is to provide a handover report of the donated equipment. Figure 8 shows the community services handover consisting of a eucalyptus oil waste shredder, a briquette printing machine and a solar panel energy source that has been installed at the service location, the condition of the equipment has been operating well and can be used by beneficiaries to reduce waste while improving the economy through making briquettes. The handover report was signed by the service team and the head of LMDH Dadi Makmur, and witnessed by representatives of LMDH Dadi Makmur, the Assistant of Perhutani BKPH Rawa Timur, and members of the service team. This report is an official document that the equipment has been handed over to the beneficiaries to be used properly for the entire community involved in the processing of eucalyptus oil. The specifications of the service equipment provided are in accordance with the attachment to the report attached to this final report, and it has been ensured that all components are in good condition and ready to use.

4. CONCLUSIONS

The implementation of the community service program using solar panel technology for processing the remaining eucalyptus oil waste has been well implemented. A briquette machine with a solar panel energy source has been able to reduce the remaining waste from eucalyptus oil refining and be used as a biomass briquette product which has the potential to become additional income for the residents of Banjarwaru village. The energy capacity of the installed solar panels is 900 Wp capable of producing 2400 Wh of electricity or using a briquette printing machine for 4 hours without using electricity from the PLN. This community service activity is suggested to be developed by adding a waste burner machine and a briquette heating machine so that it can be used in conditions of minimal sunlight .

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