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Ocean Clean Energy: Optimizing the Use of Solar Panels to Increase Cooling Storage Efficiency for Fishermen in Sibolga Towards Sustainability and Climate Change Mitigation

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ABSTRACT
This community service activity aims to improve fishermen's welfare in Sibolga City by implementing more efficient technology. The main focus is enhancing fresh fish storage efficiency using refrigeration systems that utilize alternative energy. The activities involving faculty and students from the University of North Sumatra include raising awareness about alternative energy, promoting the use of solar panels, and installing them directly on fishing boats at Sibolga Harbor. The results of this initiative demonstrate increased awareness among fishermen about the importance of clean and sustainable energy. It is hoped that this will improve the quality of the catch, reduce operational costs, and contribute to local climate change mitigation efforts.

Keyword: Sustainable Technology, Refrigeration Systems, Awareness Raising, Energy Efficiency, Climate Change Adaptation

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1. Introduction

The SDGs consist of 17 main sustainable development goals, with the seventh goal focusing on clean and affordable energy. By 2030, all developing countries are expected to have and develop infrastructure capable of providing environmentally friendly energy. The expansion of technology is anticipated to encourage ecological growth in the social, environmental, and economic fields. In light of this, alternative energy sources and those derived from fossil fuels (petroleum, coal, and natural gas) are needed. One such alternative energy source is new and renewable energy, as it has a low impact and ensures energy continuity in the future [1].

Clean and affordable energy is one of the Sustainable Development Goals (SDGs), a government program that will be implemented by 2030. One of the indicators is the "renewable energy mix," which shows the ratio of

final consumption of renewable energy to total final consumption. Asia has the highest use of renewable energy sources, with an installed capacity of around 1,023,535 MW (1,023 GW), accounting for 43.54% of total renewable energy [2].

Energy consumption is an essential and inseparable part of a country's economic development. Population growth, improved lifestyles, increased production, and economic competitiveness are some of the reasons for the increasing demand for energy. The excessive burning of fossil fuels causes an increase in carbon dioxide (CO2), which has negative impacts on the environment, such as global warming. The continuous use of fossil energy will deplete energy reserves, while energy needs continue to rise [3].

New renewable energy comes from sources that can be replenished without limits, such as hydro/water power, solar power, wind power, and sources that can be produced sustainably, such as biomass. The primary renewable energy source is solar power, which can be used directly, for example, for heating and electricity, and serves as the primary energy source for several new renewable technologies. Meanwhile, hydro, wind, and biomass power are considered secondary sources of solar energy, as they still rely on solar energy in their energy formation processes [4]. Solar panels are devices that convert sunlight into electricity. They are made from semiconductors, primarily silicon, coated with unique materials. Solar panels capture sunlight; once they receive sunlight, electrons are released from the silicon atoms and flow, forming an electrical circuit to generate electricity.

Solar energy can be converted into electrical energy to meet human energy needs, which are essential in today's world. Indonesia is located in the equatorial region and is rich in solar energy, allowing us to harness this potential to generate electricity, one method being through solar cells. Solar cells are devices that directly convert sunlight into electrical energy. A solar cell can be likened to a two-terminal device or connection, where, in inadequate light conditions (darkness), it functions as a diode, and when illuminated by sunlight, it generates voltage.

The chosen partner is the Andalan Farmer Fisherman Contact Group, a community group actively engaged in fishing. The approach to fishermen involves prior outreach regarding clean energy, including open questions and answers and filling out questionnaires to ensure that the fishermen understand all the material presented. The questionnaire method emphasizes that fishermen comprehend clean energy's potential to replace fossil fuels with environmentally friendly alternatives. This educational approach will have a more direct impact on the implementation of socialization. Fishermen will receive explanations about the importance of using clean energy in fisheries activities.

Through this outreach, it is hoped that fishermen will begin to realize the importance of clean energy in the current era of climate change. Additionally, this socialization is anticipated to encourage fishermen to adopt and utilize clean energy, making it a long-term habit.

2. Methods

The implementation of this community service program targets fishing grounds, with fishermen as the primary subjects. The implementation method for the solutions offered in this community service requires a series of well-structured and organized stages. The implementation method is carried out through several phases, namely:

Phase 1: Socialization

At this stage, outreach regarding this community service project is conducted with the fishing community in Sibolga City. The socialization aims to provide them with an understanding of the project's objectives, benefits, and implementation process. Information regarding the use of solar panels to increase cooling storage efficiency and its benefits for sustainability and climate change mitigation will be presented in detail. This phase will also create opportunities for active community participation in the project.

Phase 2: Training

Following socialization, training is conducted for fishermen and other related parties on the use of solar panel technology, cooling storage management, and energy management. This training includes understanding solar panel installation, maintenance, and basic troubleshooting. Additionally, the training will impart knowledge about energy management to optimize the use of solar panels and maintain fish cooling efficiency.

Phase 3: Application of Technology
This stage is the core of the community service activities, focusing on the application of solar panel technology to enhance cooling storage efficiency. This involves installing solar panels at designated locations, setting up a cooling system integrated with the solar panels, and conducting tests to ensure that the system functions properly. Fishermen will be guided in using this system directly.

Phase 4: Mentoring and Evaluation
While applying the technology, the community service team assists fishermen in ensuring they can use it correctly. This assistance includes monitoring the operation of solar panels and cooling storage and providing technical support if needed. Regular evaluations will also be conducted to assess the effectiveness of the solutions in enhancing fish cooling efficiency and reducing environmental impacts.

Phase 5: Program Sustainability
The final stage involves ensuring the sustainability of the program after the project is completed. This includes transferring knowledge and skills to the fishing community so they can manage and maintain the solar panel and cooling storage systems independently. Ongoing monitoring will also ensure that the system continues to operate efficiently and provides long-term benefits to the community. Additionally, evaluations will be necessary to assess follow-up development and learning from the program, ensuring that the implementation of this service program has benefited the Andalan Farmer Fisherman Contact Group (KTNA).

3. Result and Discussion

3.1 Clean Energy Socialization
Clean energy outreach was conducted at the Resident's House Shophouse at Jalan Jati No. 104, Pancuran Dewa Village, Sibolga Sambas District, Sibolga City, North Sumatra, Indonesia. This socialization activity involved presenting material about the importance of clean marine energy and installing solar panels in cooling storage on fishing boats, which exemplifies the implementation of clean marine energy. The presentation utilized colorful visuals, and a question-and-answer session facilitated understanding and engagement among the fishermen, encouraging them to actively listen to the explanations regarding clean marine energy.

Figure 1. The atmosphere during the presentation of clean energy materials

3.2. Application of Inclusive Solar Panel Design in Cooling Storage
Inclusive design, also known as universal design, is an approach that views space as a system, focusing on creating and adapting products that consider all user levels and help everyone feel included. This design philosophy aims to create useful products for diverse populations. One such product is a solar panel, which offers numerous benefits for fishermen in Sibolga. Solar panels are a power source for cooling machines, absorbing solar heat radiation and converting it into electrical energy. The solar panel utilized is monocrystalline, with a power capacity of 450 WP and an efficiency of 20%. The cooling storage unit stores fish caught by fishermen, utilizing R600 refrigerant as the cooling medium. The cooling machine has dimensions of 80.2 x 55.9 x 84.5 cm, a capacity of 200 liters, a temperature range of -15°C to - 25°C, an electricity requirement of 125 watts, and weighs 34 kg.

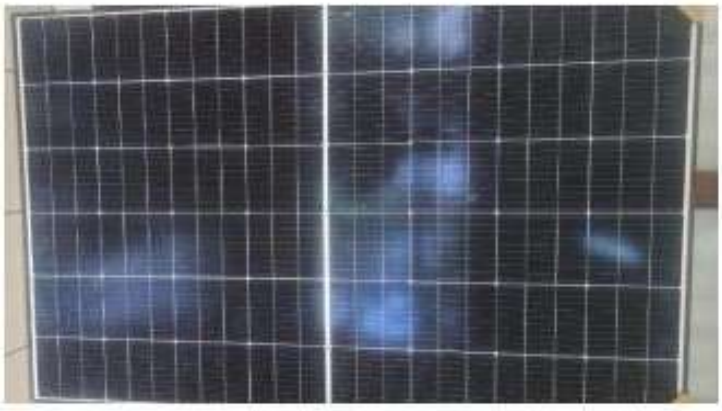

Figure 2. Solar panel

Figure 3. Cooling Storage

3.3 Layout for Laying Solar Panel in Cooling Storage

In the Community Service Program, the Service Team plans the site's placement to maximize energy efficiency and optimize performance. This placement ensures that the panels can effectively capture sunlight, providing a continuous energy source for the cooling storage system. A total of one solar panel will be installed inside the ship to power critical equipment, while one large panel will be installed outside for sunlight collection.

Figure 4. Layout of the location where the cooling storage is installed with solar panels

4. Conclusion

Conclusions from the implementation of this community service activity include:

1. Many fishermen were previously unaware of the importance of using clean energy. However, after the socialization, they showed increased awareness of the benefits of renewable energy, particularly solar panels.
2. Implementing a cooling system that uses solar panels is more effective than fossil fuels in maintaining the quality of fish catches and reducing operational costs for fishermen.
3. The implementation method was successful in providing the solutions offered in the community service program, as it involved fishermen in the problem identification process, which made them feel a greater sense of ownership over the program being implemented.

Suggestions that can be made for this activity:

1. The Community Service Team hopes that this activity can continue and be adopted by fishermen in their daily fisheries sector activities.
2. The Community Service Team encourages ongoing implementation and application of this activity by fishermen in their daily fisheries sector activities.
3. Implementing inclusive design can enhance socialization regarding the benefits of renewable energy, not only among fishermen but also among the general public, thereby increasing awareness of the importance of clean energy in addressing climate change.

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REFERENCES

[1] Puspita D. Energi Bersih Dan Terjangkau Dalam Mewujudkan Tujuan Pembangunan Berkelanjutan (SDGs). *J Sos dan sains*. 4(3):271–80. 2024

[2] Nurlaila, Yuianto AT. Perkembangan Energi Terbarukan Di Beberapa Negara. *Pros Semin Nas Infrastruktur Energi Nukl*. 11–21. 2019

[3] Afriyanti Y, Sasana H, Jalunggono G. Analisis Faktor-Faktor Yang Mempengaruhi Konsumsi Energi Terbarukan Di Indonesia. *Din Dir J Econ*. 2(3):865–84. 2018

[4] Desti I. Literature Review Upaya Energi Bersih dan Terjangkau. *J Sains Edukatika Indonesia*. 4(1):8–11. 2022