Research and Renewable Energy Potential Assessment with SMART Innovation for Support Community Power Plant in LIBONG Island Trang

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ABSTRACT

This research study aims to study and evaluate the potential of renewable energy in Koh Libong, Trang Province, and compare the potential of energy in the area. Including selecting energy technology, preliminary design and determine the steps for implementing the community power plant project. It was found that solar energy. It is energy that has enough potential to produce electricity for the target island area and is a system that requires low maintenance. For wind energy, it was found that it has sufficient potential only in cases where it is installed and used as a large-scale system. And the potential of agricultural materials and wastes in Koh Libong, that is, firewood and rubber tree roots. and waste that has no value, from calculations, the total weight is 2,141.667 kg/day. It can produce approximately 30.595 kW of electrical energy, accounting for 7.645% from the maximum energy demand of Koh Libong (400kW) and accounting for 9.271% of the energy demand on a normal day of Koh Libong (330kW). Therefore, waste-to-energy power plants, it is an alternative and would probably choose to use the new technology with a grill panel. which has advantages and is most suitable for Koh Libong. In summary, the community must participate in the management. And aim to the importance of the resources, feel a sense of shared ownership and help maintain resources, the guidelines for management community power plants with environmental management together.

1. INTRODUCTION

Currently, the fuel source used to generate electricity in Thailand includes fossil fuels such as natural gas, diesel, and fuel oil, as well as coal. However, these fuels are gradually diminishing and it takes a long time to replace or produce them anew [1]-[2]. Moreover, the coal available in the country is of low quality, necessitating the importation of high-quality coal from abroad. Natural gas, on the other hand, is found to be imported by more than 70 percent. As for oil, there has been a continuous price increase, and nearly 90 percent of it needs to be imported [3]-[4]. From the aforementioned reasons, it's evident that Thailand lacks stability in producing electricity from fossil fuels domestically in the future, as heavy reliance on board sources is necessary. Additionally, using fossil fuels for electricity generation has significantly contributed to environmental pollution, particularly air pollution issues. Therefore, developing renewable energy sources for electricity production has gained attention from the government, industry, and the public [5]-[8]. There are various types of renewable energy sources that can be used to generate electricity in Thailand. However, the full utilization of each type of renewable energy for electricity production has not been realized yet [9]. Hence, there should be accelerated development and exploration of ways to increase the utilization of renewable energy sources for electricity production. This includes seeking additional renewable energy sources, developing suitable technologies to maximize their benefits, planning policies and measurement by the government, advocacy and support, as well as serious implementation and goal setting. Additionally, selecting renewable energy that is suitable for the geographical and managerial capabilities is crucial, as it will lead to the development of appropriate and sustainable alternative energy solutions.

Koh Libong, located in Kantang District, Trang Province, is an island with an unstable and unreliable electricity system. Figure 1 shows on the map and location of Koh Libong, which is approximately 2 kilometers south of the coast of Ban Chao Mai, traveling by boat takes about 15 minutes from the shore to the island. Additionally, the consumer consumption in the area is not as convenient as it should be. There are also tourism operators such as hotels, resorts, tourism and restaurants that consume relatively high energy, leading to electricity system problems like power outages. Researchers have thus selected Koh Libong as the

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first clean energy island model in Trang Province. The island boasts diverse renewable energy sources and community readiness and cooperation, which are crucial for sustainable development. This project aims to support the development of community power plants as a clean and green energy island model for the future. It aims to reduce CO_2 emissions by reducing reliance on diesel fuel. If successful, it will promote learning about clean energy utilization and become an ecotourism destination for future enthusiasts [10], contributing to environmental conservation efforts [11].

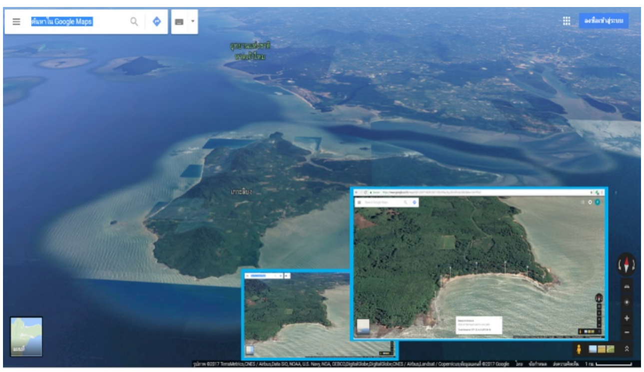


Fig. 1. Research area of Libong island.

The proponents of the project have recognized the importance and promoted the production of alternative energy electricity. They propose recommendations for managing community power plants on Libong Island, Trang Province. Therefore, it is necessary to study basic data to determine guidelines, survey, evaluate the potential of renewable energy in the area, and compare the energy potential in the area [12]. This includes selecting energy pattern and technology, preliminary design, and detailing project implementation steps. For the community power plant project, preliminary site surveys, feasibility, and suitability for both engineering and energy economic aspects are essential for decision-making in planning and project development processes effectively. Furthermore, technological innovations derived from this project can serve as a learning resource for renewable energy electricity generation systems, becoming a focal point for supporting and promoting government energy policies in the southern region and achieving energy conservation goals in the future. The objectives are:

1) To study the situation of community-level renewable energy management in the Libong Island area, Kantang, Trang

2) To analyze physical factors, economic factors. Social and cultural factors, including management factors affecting renewable energy management in the Libong Island area. Kantang, Trang

3) To study the feasibility of electricity production technologies, including their environmental impact and community involvement.

4) To propose appropriate guidelines and models for promoting renewable power generation in the Libong Island area, Kantang, Trang

2. MATERIALS AND METHODS

Project to study the potential of renewable energy to promote electricity production from renewable sources in Libong Isalnd, Kantang District, Trang Province.

***Community Power Plant*:** A community power plant is a small-scale power generation facility that utilizes local natural resources such as wind, water, solar, or biomass. It serves as an energy source managed by the community, typically organized as a cooperative or community enterprise [13]-[14]. Key considerations for community power plant development include;

- Energy Resource Potential : Ensuring sufficient local resources to sustain continuous electricity production throughout the project's lifespan.

- Appropriate Technology : The technology used should be manageable and not overly complex for community members to operate and maintain independently.

- Feasibility Study: Conducting a feasibility study to assess project viability and economic feasibility.

- Community Readiness : Building community capacity to manage and maintain the power plant effectively over the long term. This involves training personnel in production systems and plant maintenance.

- Community Participation : Encouraging community participation in power plant management fosters a sense of ownership and sustainable operation through joint responsibility for plant care and maintenance.

***Alternative Energy*:** Alternative energy refers to energy sources used to replace fossil fuels and natural gas. These sources can be categorized into two types [15]:

- Nonrenewable Energy : These are energy sources that are finite and once depleted, cannot be replenished. Examples include coal, natural gas, nuclear energy from uranium, and oil sands.

- Renewable Energy: These are energy sources that can be replenished and reused. Examples include solar energy, wind energy, hydroelectric power, and hydrogen.

a) Solar Energy: Solar energy is a renewable energy source that can be used indefinitely and is distributed directly to users. It is a clean energy source that does not pollute the environment. Solar energy potential varies depending on the amount of sunlight received in a particular area. Areas with higher solar radiation have greater potential for solar energy utilization.

b) Wind Energy: Wind energy is a clean and renewable natural energy source that never depletes. It is particularly abundant along coastlines and in certain regions of the Gulf of Thailand. This type of energy has been developed widely but requires significant initial investment, albeit lower than the cost of solar energy production.

c) Biomass Energy: Biofuels derived from organic materials or living organisms such as wood, bagasse, agricultural residues, and animal waste can generate heat and electricity.

d) Energy from Waste: Energy from household and business waste is a high-potential energy source. Most of this waste consists of biomass, such as paper, food scraps, and wood, which can be used as fuel in power plants. Waste is burned on grates, and the resulting heat is used to boil water in a boiler until it becomes steam, which then turns the turbine of a generator.

***Energy Conservation*:** Using energy efficiently and cost-effectively by fostering values and awareness in energy usage is crucial. Efficient energy use requires thorough planning and effective control to minimize energy loss at every stage [16]-[17].

a) Energy Management Systems

In general, Energy Management System (EMS) refers to an automated system imported for controlling production, energy transmission, and ensuring efficient energy use. Efficient energy management systems involve planning for production, energy use, and management with utmost efficiency, sometimes involving energy cessation or reduction to the minimum extent possible. Importantly, this should not compromise operational capabilities or productivity, nor should it adversely affect the health of individuals residing or working in the area.

b) Benefits of Energy Management Systems

Energy management systems enable electricity users, whether in residential households, buildings, or industrial factories, to understand their electricity usage patterns in detail and monitor how much electricity is consumed by various appliances. Implementing energy management technology enhances awareness of one's electricity usage details. Moreover, it can encourage the upgrading of electrical appliances to enhance efficiency.

2.1. Study the data on infrastructure of Libong Isalnd

Study the data on infrastructure, including physical, managerial, social, and cultural factors [18]-[19], that impact energy management.

2.2. Study the potential of renewable energy,

Study the potential of renewable energy, examining its feasibility and engineering and economic viability for electricity production from renewable sources in the Libong area, Kantang District, Trang Province.

(1) Gather basic data about the study area from various sources of information in Libong Isalnd.

(2) Analyze the data collected from different databases to plan field surveys, dividing the survey tasks into 3 main parts as follows:

- Survey to identify renewable energy sources, including hydropower, solar energy, wind energy, biomass energy, and energy from wastes.
- Survey the condition of the electrical transmission system within the target area.
- Investigate and study preliminary environmental impacts associated with electricity production from renewable energy sources

2.3. Study measurement, record data, and analyze the potential of renewable energy

Study, measurement, record data, and analyze the potential of renewable energy by conducting on-site surveys and collecting data. Utilize innovative weather monitoring systems to measure solar energy, wind speed, temperature, and humidity. Install and collect data for a minimum period of 6 months for analysis and evaluation. This monitoring device can automatically transmit data via mobile applications, enabling data recording and transmission through telephone network systems, facilitating ccess and utilization of data from anywhere.

Note: Permission has been granted to install a weather monitoring system for testing and experimental data collection in Koh Libong, Amphoe Kantang, Trang Province. This installation is temporary, from April 2023 to September 2023, spanning a duration of 6 months.

Design and development of innovation and technology for automatic Real-Time weather monitoring systems for tracking purposes, incorporating environmental sensor systems and solar energy generation in Fig. 2.:

a) Sensor system: the sensor part involves collecting data from 6 sensors: temperature, humidity, wind speed, wind direction, rainfall, and light intensity. Wi-Fi is used as the signal for connecting with the microcontroller board.

b) Solar power generation and battery system: This part utilizes 12 Volts, 60 Watts solar panel system along with a 60Ah Battery Storage for electricity backup of the innovation system, and installation of the weather monitoring innovation system.

c) Automatic control and display system via network: the microcontroller board collects sensor data and sends it to a database. Real-time data display is achieved through internet and Wi-Fi signals for user accessibility. Preliminary results of automatic weather monitoring testing, showed Figs 3-4.

From Fig.4. this monitoring system can automatically send data via an application, allowing data recording and transmission through the telephone network system. This enables users to download or access the data from anywhere.

Fig. 2. Part of automatic control systems and network display.

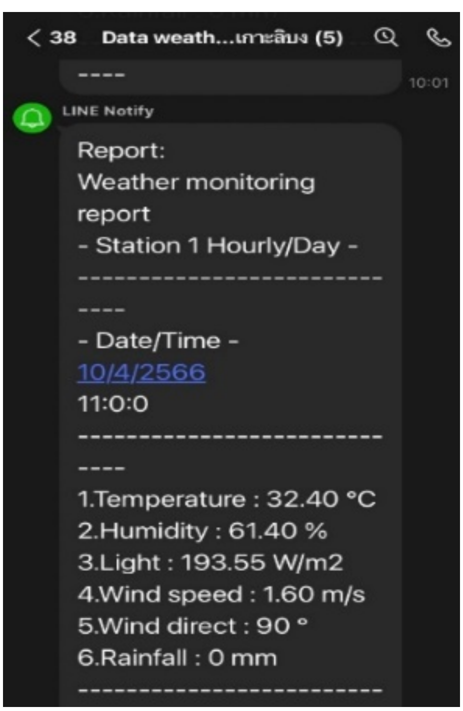


Fig. 3. Example of recording preliminary automatic weather monitoring data.

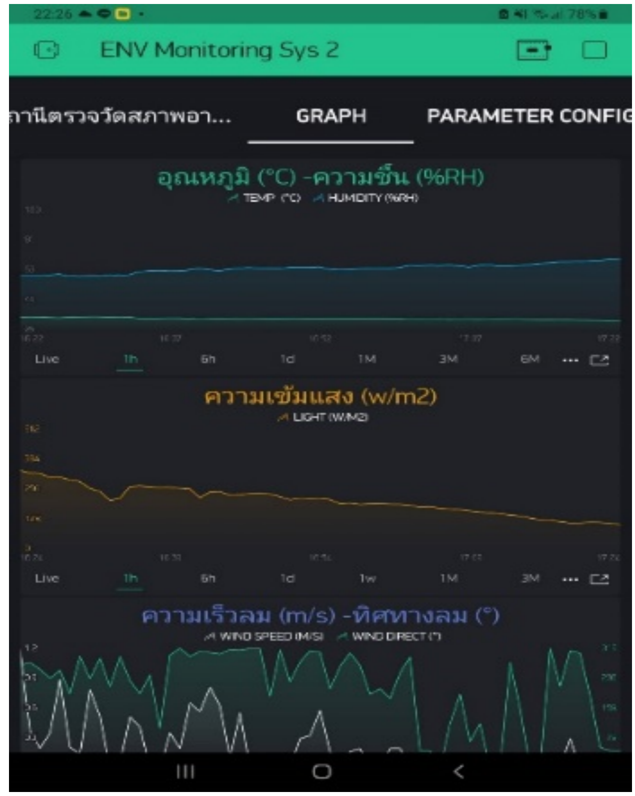


Fig. 4. Example of displaying preliminary automatic weather monitoring data.

2.4 Study on the suitability and feasibility of engineering and energy economic viability of the selected area.

Study the suitability and feasibility of engineering and energy economic aspects of the selected area. This includes studying the suitability and determining the preliminary location for the renewable energy production system. Key factors considered in determining the system's location include community acceptance, achieved through community participation to survey opinions and establish organizational frameworks for involvement.

The conclusion will summarize the discussion outcomes, separating them into results obtained from dialogue for use as guidelines for future problem-solving. This step requires collaborative review of collective outcomes obtained from community forums.

3. RESULTS AND DISCUSSION

3.1. Koh Libong

Libong Island, it is the largest island in the Trang Sea, covering an area of 25,000 acres. It has been declared a wildlife sanctuary. The island is surrounded by sea grass, which is the food source for the dugong, a milk-feeding marine mammal that is endangered. Libong Island triangular in shape, with a long base extending north-south, and both sides gradually narrowing towards the east. The western part of the island features mountains that span from north to south, while the land gradually slopes down towards the east until it becomes flat near the sea.

3.2. Electricity System and Distribution on Koh Libong

Currently, the community of Libong Island uses electricity from the regional power distribution system throughout the island. Additionally, there is a project to expand the distribution system, erect poles, and extend power lines to newly constructed households at the end of the electricity transmission line. This project is expected to be completed in the year 2025. Moreover, electricity on Libong Island can be accessed by all villages. Electricity distribution began on January 9th, 2011, and there is a sub-district electricity office on Libong Island. Electricity is supplied from the mainland (Hat ModtaNoi) to Libong Island using submarine cable 70 mm^2 XLPE technology, with a cable length of 5.0 kilometers. The estimated budget for this project is 100 million bahts. Previously, electricity was supplied on a scheduled basis using a generator and solar power plants with a capacity of 80 kilowatts.

From Fig. 5. Shows based on data collection and interviews with Provincial Electricity Authority (PEA) officials in Kantang District, Trang Province, it is known that the maximum electricity demand on Libong Island is 0.4 megawatts (MW) or 400 kilowatts (kW). This indicates peak demand during tourist seasons, while during non-tourist seasons or normal days, electricity demand is approximately 330 kW.

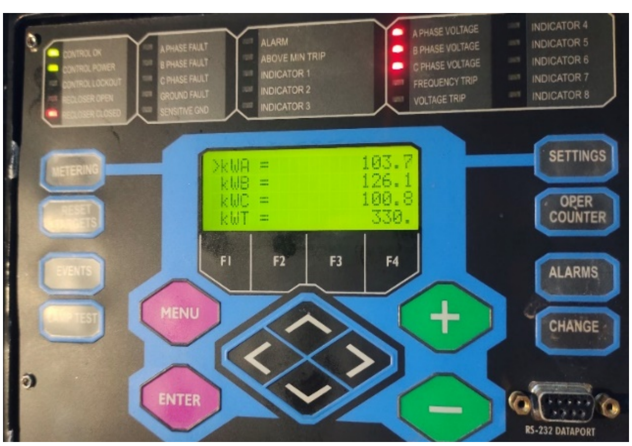


Fig. 5. Show on electricity consumption in Libong Island on 11 September 2023 at 6.23 p.m.

For the service rates, they are equivalent to the rates on the mainland, with poles and power lines installed across the island covering all residential areas. However, due to the underwater cable system laid from the mainland, voltage drops and power outages frequently occur. The main cause of these issues originates from the mainland. The longest power outage period is approximately 3-4 hours, especially during times when accommodations are using air conditioning units or when there is a high number of tourists on the island.

Particularly in the eastern-northeastern coastal areas, voltage drops are frequent due to being at the end of the power transmission line, as the endpoint of the power transmission line of the submarine cable system is located on the south-eastern coast of the island. Information obtained from electricity officials and local administrators indicates that there are plans to expand the distribution system, erect more poles, and extend power lines in the area of the endpoint of the power transmission line.

3.3. Data and Analysis of Renewable Energy

a) Solar Energy

From on-site installation and the implementation of automated weather monitoring systems, it was found that Libong Island has good potential for solar energy. The average solar energy impact in the target area per day is approximately 3.97 kWh/m2d, based on data collected from March to August 2023, a period of 5 months before the rainy season by comparing the results with other sources such as data from PVSyst software and solar energy potential maps from Solargis [20], it was found that the actual data collected only slightly deviated from other sources, possibly due to differences in data collection periods and weather conditions, which show in Fig. 6-7.

Libong Island has a substantial number of buildings and structures, including resorts and residential homes. Establishing a solar power plant there would require a large amount of space, much of which is either privately owned or designated as forested areas. However, if private landowners or areas within the forested zone could be utilized, it would be feasible to set up solar power projects. Alternatively, installing rooftop solar power systems on various buildings is another viable option.

Although Libong Island has good solar energy potential, implementing solar power plant projects may face installation space constraints due to the island's mountainous terrain and protected forest areas which is shown in Fig.8. Additionally, Libong Island receives electricity supply from the regional power grid via underwater cable transmission systems, thus avoiding electricity shortages on the island.

b) Wind Energy

Using installed instruments and automatic weather monitoring technology, and collecting wind speeds throughout the day to determine the frequency of wind speeds in the target area. Installing measuring devices on top of the water storage tanks, located in the eastern part of the island community, which is a good wind reception point. It was found that the wind speed data obtained mostly ranged from 4-5 meters per second, which is considered a moderate wind speed. It has the potential to harness wind energy. The appropriate wind speed for the installation of wind turbines for electricity generation should be higher than 6-7 meters per second.

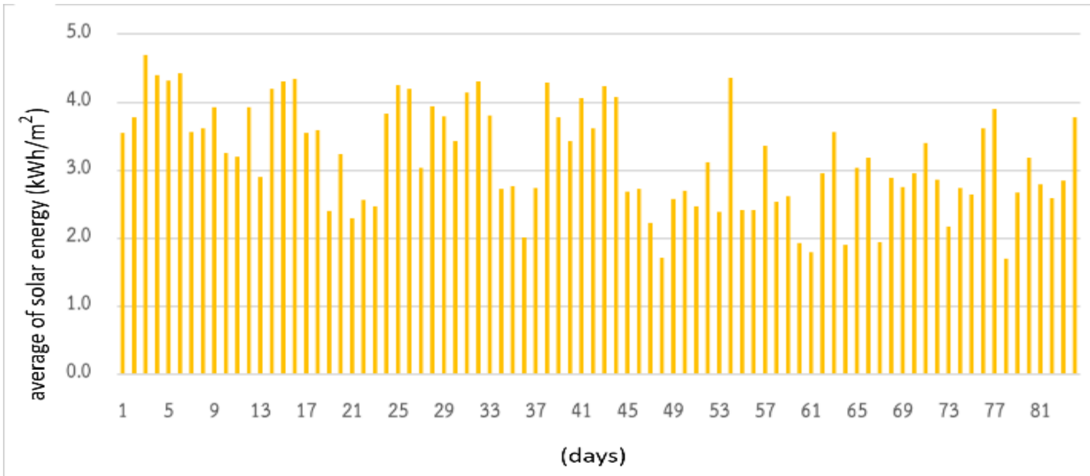
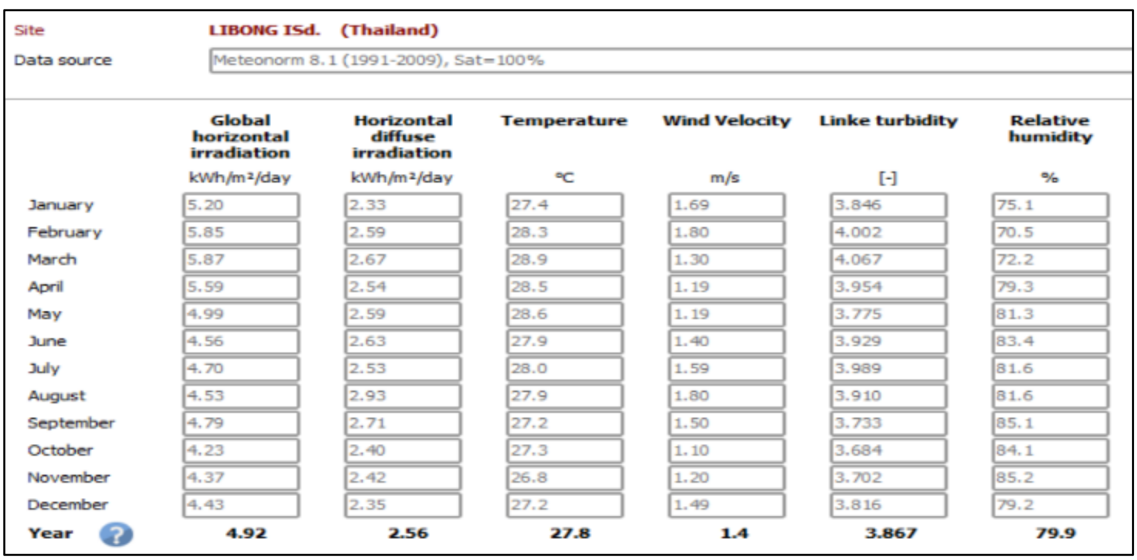


Fig.6. Average of solar energy in 1 day of Libong Island



Site: LIBONG ISd. (Thailand)

Data source: Meteonorm 8.1 (1991-2009), Sat=100%

	Global horizontal irradiation	Horizontal diffuse irradiation	Temperature	Wind Velocity	Linke turbidity	Relative humidity
	kWh/m²/day	kWh/m²/day	°C	m/s	[-]	%
January	5.20	2.33	27.4	1.69	3.846	75.1
February	5.85	2.59	28.3	1.80	4.002	70.5
March	5.87	2.67	28.9	1.30	4.067	72.2
April	5.59	2.54	28.5	1.19	3.954	79.3
May	4.99	2.59	28.6	1.19	3.775	81.3
June	4.56	2.63	27.9	1.40	3.929	83.4
July	4.70	2.53	28.0	1.59	3.989	81.6
August	4.53	2.93	27.9	1.80	3.910	81.6
September	4.79	2.71	27.2	1.50	3.733	85.1
October	4.23	2.40	27.3	1.10	3.684	84.1
November	4.37	2.42	26.8	1.20	3.702	85.2
December	4.43	2.35	27.2	1.49	3.816	79.2
Year	4.92	2.56	27.8	1.4	3.867	79.9

Fig.7. Solar average of Libong island by PVSyst program

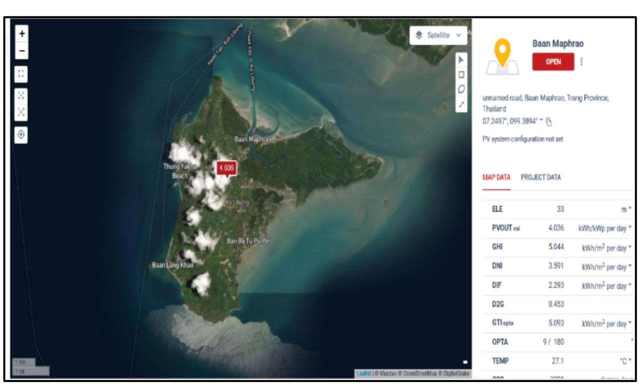


Fig. 8. Solar energy data from Solargis' solar map

In addition to the data from the wind measuring devices, there was also a search for information from websites and the Energy Potential Map of Thailand (2020) by the Research Division which is shown in Fig. 9-10. According to the data obtained from the map at a height level of 90 meters, it was found that Libong Island has a wind energy potential of 4.23 meters per second. It can be observed that the average wind speed from the Energy Potential Map is close to the actual data collected from the field survey. According to the Energy Potential Map, it is estimated that wind turbines could generate approximately 20 kilowatts of electricity. This indicates that the suitability of wind energy production requires high and appropriate wind speeds for large-scale wind turbines to efficiently harness electricity generated from wind energy.

c) Hydropower

Libong Island has received support for the construction of reservoirs for water storage. However, the water quantity is only sufficient for consumption during the rainy season, for the summer season arrives, water in the reservoirs becomes scarce, leading to water shortages for consumption.

Additionally, other water sources such as shallow wells and artesian wells also face shortages during the summer season. Therefore, utilizing water for electricity generation may not be sufficient to meet the potential demand.

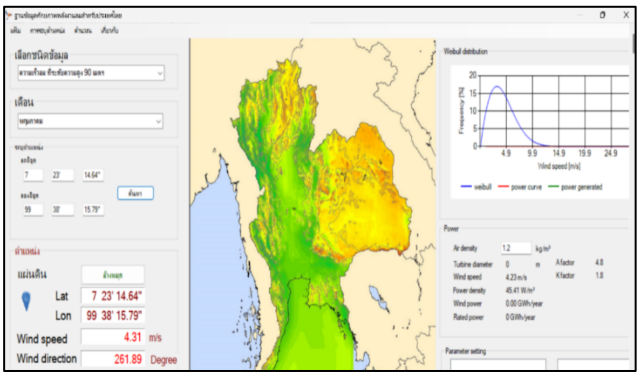


Fig. 9. Wind energy potential of Libong Island from Energy Potential Map website (2020).

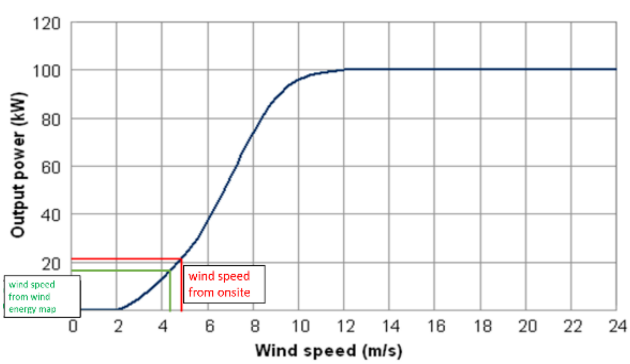


Fig. 10. Comparative graph of electricity generated from wind speed data.

(d) Biomass Energy and Waste Energy

Agricultural Residue (Rubberwood/Palm Oil) on Libong Island.

Based on surveys and interviews with Mr. Phitak Petchnoo, who works as a rubberwood cutter, it was found that agricultural residues from rubber plantations include rubberwood (rubber trees with a central diameter of less than 5 inches) and rubber roots, averaging about 3-4 tons per acres (3.95acres approximately equals 75 trees). This is done to preserve the condition of the wood. In one day, after processing, there are leftover rubberwood and rubber tree scraps. Rubberwood remnants amount to about 3-4 tons per 75 trees, which is calculated as 3 tons (at a minimum) for easier computation, for 30 trees fall in one day, the remaining rubberwood and rubber tree scraps are as follows:

$$\frac{3000\ kg}{75\ \text{trees}} = \frac{x}{30\ \text{trees}} \tag{1}$$

so, x = 1,200 kg/30 trees or 1 day.

After conducting surveys and interviewing Ms. Kulima Engchuan, the owner of an oil palm plantation, it was found that after harvesting, there are oil palm leaves left as agricultural residues. These leaves are stacked and piled between the trees to decompose naturally and become organic fertilizer. Additionally, they are shredded into small pieces to serve as feed for the cattle being raised. In summary, there are no agricultural residues from oil palm that could be used for biomass power generation on Libong Island.

Moreover, regarding the potential use of agricultural residues from rubberwood and rubber roots, inquiries were made to Mr. Phitak Petchanoo which is shown in Fig.11, so if a biomass power plant is established on Libong Island in the future, it will require rubberwood and rubber roots as fuel. These materials have prices comparable to topsoil. Therefore, the agricultural residues will definitely be sold to maximize resource utilization and increase income for both the owner and workers.

Fig. 11. Site visited and interview community for waste materials of agricultural.

- Waste Management

Waste management remains another unresolved issue on Libong Island. Despite efforts to manage waste on the island, it continues to be a problem. Waste is collected and transported to waste collection points by three-wheeled vehicles. The waste is then sorted, and valuable items are separated and placed in bags. The collected waste is further sorted at a larger workplace area where there are already sorted waste types, including cans, plastic bottles, glass bottles, cardboard boxes, clear plastic, and more which is shown in Fig.12.

In summary , the waste management system can collect approximately 1-2 tons of waste per day, averaging at 1 ton per day. The sorted waste weighs approximately 58.333 kilograms per day, which counts for 5.833% of the total waste. This indicates that within one day, approximately 941.667 kilograms, or 94.167%, of the unsorted waste remains which is shown in Table 1. All the sorted waste can be recycled, sold, or used to produce new materials. This demonstrates the potential for generating income from waste management activities.

Fig. 12. Site visited and interview community for waste.

Table1. Shows the approximate weight of unsorted and sorted waste in 1 day

On a typical day on Koh Libong	
Types of waste	*Quantity of waste (kilograms per day)*
Non-valuable waste per day	941 .667 (94.167 %)
Valuable waste per day	58.333 (5.833 %)
Summary	**1,000**

Table 2. Shows summary of the potential of agricultural waste materials and waste in Libong Island, daily, monthly and yearly

Types of waste	*Potential within 1 day (kilograms per day)*
Timber and rubber roots	1,200
Palm leaves	None, due to the versatility of oil palm leaves for other purposes
waste	941.667
Summary	**2,141.667**

Therefore, within a day, there will be raw materials that can be evaluated, timber and rubber roots, along with non-valuable waste. Both of these together weigh approximately 2,141.667 kilograms per day. The weight of the waste is calculated as 56.031%, palm oil leaves account for 0%, and timber and rubber roots account for 43.969% which is shown in Table 2.

After studying, collecting data, and proposing to the leadership and representatives of the "Panel-type Incinerator Technology" group, which is an incinerator used to generate electricity from waste, it is possible to burn timber and rubber roots as secondary variables. Because of their high heat value, they can be used together with waste as fuel for electricity generation. This technology is suitable for the potential of agricultural residues and waste on Libong Island. It includes:

• No need for waste sorting or grinding before entering the furnace.

• Popular and widely used technology with certification.

• Maximum heat efficiency up to 85%.

• Continuous burning capacity of up to 1,200 tons per day.

• Relatively high investment and maintenance costs.

3.4 Renewable Energy Power Plant Models Applicable in Libong Island

a) Solar Energy

The project "Libong Island Water Pumping Building with Water Pipeline System" located in Tambon Libong, Amphoe Kantang, Trang Province, utilizes **solar** energy for the water pumping station installed on the ground which is shown in Fig. 13.

- Maximum electricity production: 18.00 kilowatts peak (Kwp)
- Solar cells: SPPM-MG12-SS (Module) 600 Wp, 30 panels
- Inverter: Huawei SUN2000-20KTL-M2
- Connected to the power grid system Grid Connection Inverter System

Fig.13. PV of Koh Libong Water Pumping Building Project

Currently, Libong Island receives electricity from the underwater transmission system of the regional electricity authority, with a voltage of 33 kilovolts and a size of 70 mm^2 XLPE technology. The electricity service rate is equivalent to the rate on the mainland. Utility poles and power lines cover all inhabited areas on the island. However, the installation of underwater cable transmission systems from the mainland has caused voltage drops and frequent power outages, especially, when heavy rain and strong winds cause short circuits or damage to power lines passing through forests and trees. These issues occur mainly at the end of the power transmission lines, as the point of connection of the underwater cable transmission system is located on the southeast coast of Libong Island.

To mitigate voltage drops, especially in households at the end of the power transmission lines, small-scale solar energy systems have been implemented as a supplementary measure. Some areas and communities experience voltage drops due to being located at the end of the lines, resulting in lower electricity voltages than standard levels. However, from Fig.14 this problem is not constant and occurs mainly when there is high electricity consumption on the island, leading to a decrease in electricity voltage in the distribution system, affecting communities or households located far from the power station. To address this issue, the working group proposes the installation of solar power generation systems with energy storage systems to help stabilize electricity voltages. This system will be installed at the BatuPute school, which is close to the power station and connected to the electricity distribution system.

Fig. 14. Shows end-of-line areas and installation of photovoltaic systems.

b) Energy Production System from Agricultural Residue and Waste Potential

The maximum electricity demand on Libong Island is 400 kW, with the daily electricity demand during normal days or peak days being 330 kW. Referring to the article from the Department of Alternative Energy Development and Efficiency, Ministry of Energy, titled "Potential for Energy Production from Community Waste at Provincial Level," it mentions that a potential of 70 tons of waste per day can produce 1 MW of electricity. However, this calculation is a rough estimate of the waste-to-energy potential of the country as a whole. Therefore, the actual energy production from waste or waste conversion to electricity depends on various factors such as the quantity and composition of waste, readiness of the area/power transmission lines, and investment feasibility.

Therefore, to produce 1 MW of electricity, 70 tons of waste per day is needed in the incinerator. This incinerator technology is used to burn waste and may also utilize agricultural residue due to its high heat. Using mathematical principles and comparative ratios, we can estimate the electricity production from waste and agricultural residue on Libong Island, where the maximum electricity demand is 400 kW.

Daily calculation:

$$\frac{70000\ kg/day}{1000\ kW} = \frac{2141.667\ kg/day}{x}$$

$$x = 30.595\ kW.$$

Therefore, in one day, the potential of waste and agricultural residue to produce electricity is approximately 30.595 kW, which accounts for 7.645% of Libong Island's maximum energy demand (400 kW) and 9.271% of the energy demand on a normal day (330 kW), so when comparing the above data, it can be concluded that the electricity produced can contribute to supplementing the current energy usage on Libong Island. The information can be summarized in the following Table 3:

Table 3. Displays the electrical energy that can be produced to supplement the measured demand for electricity and the highest demand for electricity from PEA Kantang

Electricity in Libong Island	
Source of Electricity	Power (kW.)
The maximum electricity demand from the PEA Kantang.	400
The electricity demand during normal periods, as measured	330
The potential of agricultural residues and waste materials.	30.595

In summary, the study and research on the potential of agricultural residues and waste on Libong Island suggest that they can be utilized to generate electricity within the community to some extent. This includes residues such as wood from forestry and rubber roots, as well as waste without value. The total estimated weight of these materials is approximately 2,141.667 kg per day. Based on these calculations, the potential for generating electricity from these sources on the island is approximately 30.595 kW.

3.5 Community engagement and opinion exploration on Libong Island

The researcher team, together with students, organized a forum titled "Initiative to foster understanding and propose collaborative approaches and aodels for promoting Renewable Energy Production on Libong Island, Kantang District, Trang Province." From Fig. 15 shows the event took place at the conference room of Sawinah Homestay. Community leaders and representatives were invited to attend, engaging in knowledge exchange and presentations of research findings. A total of 35 participants joined the forum, contributing to the mutual understanding and sharing of knowledge.

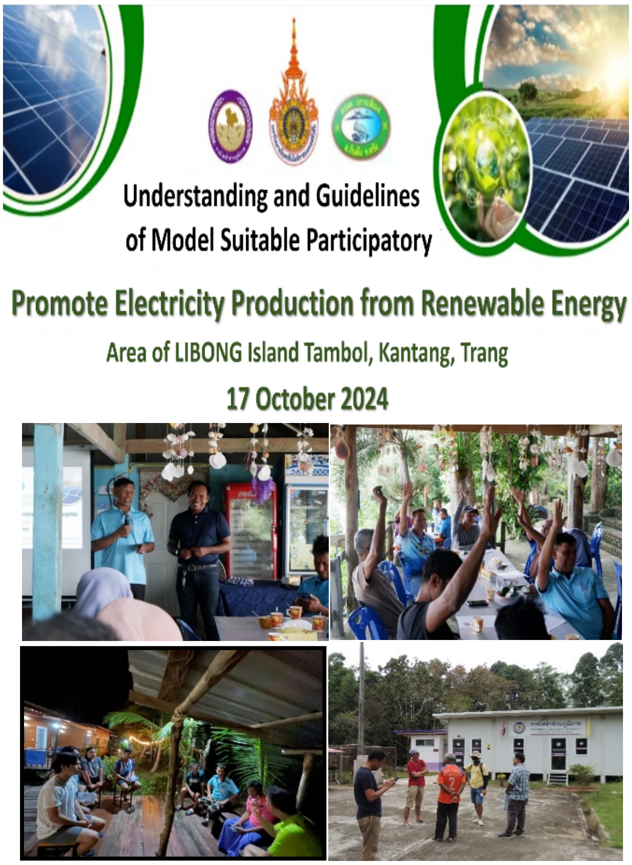


Fig. 15 Activities to understanding and Public Participation

The feedback on the presentation is as follows:

In this section, we will present the details and feedback from the government sector, business sector, and household sector, as well as compile their opinions. Here is the information:

1) Frequent power outages create daily life obstacles and tarnish the image of Libong Island, a top tourist destination in Trang province.
2) Voltage drops lead to damage to electrical appliances due to the instability of the electricity system.
3) There is a desire for increased use of renewable energy on Libong Island to ensure a more stable electricity supply.
4) Request for the installation of street lighting along routes to enhance convenience for tourists and local residents, such as along the KhlongToKhun route, which currently lacks street lighting.
5) Community waste management is crucial as a pathway and alternative for utilizing resources on Libong Island to produce electricity for future use.

4. CONCLUSIONS

This research aims to assess the potential of alternative energy sources to support a community power plant on Libong Island, Kantang District, Trang Province. The goal is to explore the use of alternative energy to supplement current energy needs and improve the efficiency and stability of electricity supply. The island has the potential for renewable energy sources, which can contribute to sustainability and reduce reliance on conventional energy sources.

Solar energy is a viable option for generating electricity for the target area of Libong Island. Data from measurement tools and other geographical sources, including information from programs like PVSyst, are consistent and point in the same direction. Additionally, solar power systems require low maintenance, allowing communities to perform basic upkeep tasks such as cleaning solar panels. In case of system issues, local electricians or government-employed electricians can assess and address them.

Wind energy has potential when installed and utilized on a large scale, using wind turbines with a height of no less than 50 meters. However, in terms of maintenance, specialized expertise is required. This may pose challenges in addressing basic issues with the system, and maintenance work on wind turbines may carry risks of accidents. Despite sufficient potential, practicality and suitability for island areas, especially concerning voltage drops, may be limited. In such cases, combining solar power generation with energy storage systems can help stabilize the electrical voltage. Various installation methods are possible, such as large-scale centralized systems or medium-to-small-scale distributed systems, which can be interconnected with microgrids or minigrids. For instance, the installation could be implemented at the BatuPute school, which is near the electricity distribution system.

Energy derived from agricultural waste and refuse materials on Libong Island can be a suitable alternative energy source. This includes wood residues, rubber roots, and non-valuable waste, totaling 2,141.667 kg per day. Therefore, a waste-to-energy power plant is one viable option, employing an incineration technology with grate-type panels, which is the most suitable and efficient. In summary, the potential of agricultural waste and refuse materials on Libong Island can generate up to 30.595 kW of electricity.

Therefore, establishing a renewable energy power plant on Libong Island is another viable solution to address these challenges. Such a plant has considerable potential to generate electricity from renewable sources. Moreover, there are public areas that are currently unused and vacant. Utilizing these areas to build power plants for community electricity production is feasible and promotes community engagement in renewable energy knowledge. It encourages community participation in maintaining and caring for the power plants and cultivates awareness of energy conservation and appropriate energy use.

Establishing a renewable energy power plant is a crucial step in addressing the energy issues on Libong Island. Before proceeding, here are some recommendations that might enhance the project's effectiveness:

1) Feasibility Analysis: conduct a thorough feasibility analysis considering factors such as access to fuel sources for renewable energy production and long-term maintenance and upkeep of the power plant.
2) Resource Management: consider efficient resource management for project establishment and execution, including the use of local materials for construction and local skill and knowledge development.
3) Building Understanding and Collaboration: foster understanding and engagement from the local community regarding the project and provide opportunities for community involvement from the outset.
4) Utilizing Evolving Technologies: utilize efficient and evolving technologies to ensure the project's efficiency and adaptability for future improvements.
5) Risk Management: properly manage potential risks associated with project implementation, such as disaster planning and emergency response.

Considering and implementing these recommendations could contribute to the effectiveness and success of the renewable energy power plant project on Libong Island, ensuring better community involvement and sustainable energy usage in the long run.

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