Society willingness to pay towards application of renewable energy for household electricity needs in Kepulauan Seribu Regency

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Abstract. In the context of regional and local development, energy plays a very important role in all economic activities, so as in the small islands. The Kepulauan Seribu Regency already has an existing power system, but it needs to be improved. One of the available alternatives is by using solar power which is a type of renewable energy. Before the implementation of renewable energy, people participation in the use of such energy needs to be reviewed to obtain information about the conditions, needs, and attitudes of the local people. This research is a qualitative study using a human geography approach as its foundation. People's participation in this research is represented by the willingness to pay at the household scale on the islands with different functions in its connection with people's knowledge of renewable energy and the level of electricity consumption. The research results show that willingness to pay for types of households with businesses both in tourism and governmental islands are not influenced by knowledge of renewable energy, but rather by the amount of electricity consumption. On the other side, the knowledge affects the willingness to pay for the ordinary households on all islands. The deeper or more complete the knowledge, the more willing to pay.

1. Introduction

In the context of regional and local development, energy plays a very important role to drive all financial activities, no exception in the area of small islands. The small islands have unique challenges in terms of the development process due to a high dependency on the mainland including in energy supply [1]. Energy itself is a vital resource needed to do a various activities of life [2]. Nowadays, Kepulauan Seribu Regency has an existing electric power system consisting of Medium Voltage Sea Cables and Medium Voltage Cable Channels that need to be improved [3]. For those reasons, PT PLN (Persero) has a plan to expand the electricity system, one of which is by using solar power plants as a source of renewable energy. All efforts to improve the reliability of electricity in the Kepulauan Seribu are significant for the equitable distribution of people's welfare through economic, social, and cultural development. Unfortunately, solar technology has not been applied evenly throughout the island, but only on the islands of Macan and Sebira. Therefore the view of the local community regarding the possibility of its application is unknown. This can result in low effectiveness and participation.

Participation in the use of solar power needs to be assessed because community participation is a tool to obtain information about the conditions, needs, and attitudes of the local society [4]. Society participation, in this study, was measured by using Willingness to Pay (WTP). Basically, WTP describes the consumer’s desire to pay some money to obtain a particular product or service [5]. This
research aims to look at how the community's willingness to pay for solar electricity services to meet household needs. In accordance with the discipline of Geography which emphasizes variations between places, the focus of this research is to examine the spatial differences of WTP among local people on the most populous islands with different social-economic functions. Those islands are Kelapa Island with designation functions as a tourism destination, Pramuka Island as a government or public services centers, and Panggang Island as a settlement area.

2. Methods
This research used the qualitative approach. Qualitative research is a research that aims to understand phenomena about what is experienced by research subjects, such as behavior, perception, motivation, actions [6]. This approach was chosen to explore and emphasize the interpretation of the factors that influence the decision making to be willing to pay in applying renewable energy as an energy source for household electricity needs, closely related to human behavior or actions.

Secondary data collection is obtained through online documents and special requests to related agencies, while primary data collection is collected by conducting in-depth interviews and field observation. For the purposes of data analysis, this research transforms primary data into groups or categories to represent important themes related to people knowledge and perception on renewable energy, daily consumption of household electricity, WTP, and electricity services by company or government. Spatial visualization is displayed as maps, sketches, and matrices that allow to identify spatial association between people knowledge, electricity consumption, and WTP. The research then applies descriptive and spatial analysis to conclude the role of both locational and socio-cultural factors and their interactions on the WTP.

3. Results and Discussions

3.1 Society’s Knowledge
In this research, people’s knowledge was measured through 5 aspects that were listed in the interview guidelines. The five aspects of knowledge are:

1. The renewable energy as an alternative resource
2. The application of renewable energy on the neighbor islands (Macan and Sebira Islands)
3. The advantages and disadvantages of the renewable energy
4. The additional costs for renewable energy
5. The quality of renewable energy system.

Cumulatively from the bottom up, these five aspects reflect the depth of public knowledge about renewable energy. A people that has accumulated knowledge up to the fifth means deeper and more complete knowledge than those who have knowledge up to the third or fourth. With more complete knowledge, decisions about WTP of renewable energy are expected to be more rational.

Each island in this study had different characteristics in terms of community livelihoods reflected in the profile of the informant (Table 1). In the residential area of Panggang Island, there were only a few people who work in the formal sector. Most of them were fishermen who spend a lot of time at the sea. Meanwhile, there were more people who have formal jobs on Kalapa and Pramuka Island because of the existence of government services and tourism businesses. However, both informal and formal work needed to travel outside the island. That caused the presence of women on each island more visible than the head of the household.

| No | Livelihood     | Educational background | Age | Aspect of knowledge |
|----|----------------|------------------------|-----|---------------------|
|    |                |                        |     | 1 2 3 4 5          |
| 1  | Fishermen      | Junior High school     | 48  | √       |
They did not have enough information about the costs and performance of renewable energy in daily life.

3.2 Household Electricity Consumption

Household electricity consumption in the study area was explored by comparing its magnitude based on the category of household types in different function of the islands. The important elements related to electricity consumption behavior at the household scale are ownership and patterns of utilization of electrical appliances that will affect the level of electricity consumption [9]. In addition, the level of household income is also an important element in determining the amount and type of electricity demand. In this case, the high-income households tend to increase purchases of electrical equipment, whereas the low-income households tend to hold purchases of electrical equipment that are not in accordance with basic needs [10].

In general, there were three types of households, namely ordinary households (households without business), households with stores, and households with the homestay. An ordinary household is a household whose electricity consumption is only used to meet the needs of household members without

| No | Livelihood     | Educational background | Age | Aspect of knowledge |
|----|----------------|------------------------|-----|---------------------|
|    |                |                        |     | 1 | 2  | 3  | 4  | 5  |
| 2  | Housewives     | Elementary school      | 55  | √ |    |    |    |    |
| 3  | Housewives     | Senior High school     | 55  | √ |    |    |    |    |
| 4  | Formal sectors | Bachelor               | 42  | √ | √  | √  | √  | √  |
| 5  | Housewives     | Elementary school      | 41  | √ |    |    |    |    |
| 6  | Housewives     | Elementary school      | 28  | √ |    |    |    |    |
| 7  | Housewives     | Senior High school     | 44  | √ |    |    |    |    |
| 8  | Formal sectors | Senior High school     | 45  | √ | √  | √  | √  | √  |
| 9  | Housewives     | Junior High school     | 46  | √ |    |    |    |    |
| 10 | Housewives     | Senior High school     | 44  | √ |    |    |    |    |

According to Table 1, there was different knowledge among the local population regarding the type of work. People with formal jobs both as public and private employees had complete information about the application of renewable energy outside the island where they live. Mr. Solihin (Informant 4), for example, was an honorary employee. He lived in Pramuka Island and worked at the District Office on Kelapa Island. Mr. Solihin had far better knowledge about the renewable energy compared to a local fishermen named Mr. Lukman (Informant 1) who lived on Panggang Island. During an in-depth interview, Mr. Solihin was able to explain well five aspects of knowledge about renewable energy; starting from the general knowledge of renewable energy as an alternative resource up to the quality of services. The same level of knowledge is owned by Mr. Tiko (Informant 8), a formal worker on Kalapa Island. Meanwhile, the local fishermen only have knowledge of the advantages and disadvantages of renewable energy, without knowing the additional costs that must be spent.

Although knowledge of costs can already be taken into consideration for allocating costs on various types of goods or services [7], more complete knowledge regarding product and service quality is a determining factor for the desire to pay. The simple comparison above shows that the work environment contains patterns of interaction that enable someone to gain additional experience and knowledge, both directly and indirectly, about various aspects of life [8]. Besides being related to work behavior, it seemed to state that the function of the island as a public service center and tourist destination associates with the completeness of knowledge. Both characteristics allowed more information to flow into the island. In contrast, fishing communities outside the two islands had relatively incomplete knowledge limited to the benefits of renewable energy.
commercial purposes. Meanwhile, a household with a business (store or homestay) is a household that consumes electricity not only for the needs of household members but also to run a business for profit simultaneously. The three types represented the difference in behavior and level of electricity consumption. The ordinary households were expected to have a lower level of consumption rather than households with a business.

Figure 1 shows the spatial variation in the distribution of households with respect to the different functions of each island. Although ordinary households were found on all islands, but on the tourism and residential islands this type of household was situated in two settlements, namely slums and regular settlements. There were no slums on the government islands. Meanwhile, as the expectation, most households on the tourism island had lodging businesses in response to the progress of tourism activities. Local people provided rooms and facilities deliberately at their houses for tourists who want to lodge for several nights. Those rooms become a source of income for the household. Overall, the tourism islands had more varied types of households than government islands. On the contrary, the households on the residential island did not have any business.

Regarding the ordinary households, Figure 2 reveals the locational effect on the electricity consumption. The impact of location was more visible in internal variations on an island compared to external variations between islands. On the same island, the households in the slums had far lower consumption than the households in the regular settlements in terms of number of kilowatt-hour (kWh) and monthly expenses. These were affected by smaller number of equipment ownership and different
equipment’s consumption load. For ordinary households in regular settlements, the biggest electricity consumption was related to cooking equipment that was not owned by households in slums such as refrigerators. As for slums, the biggest electricity consumption was for lighting which had a lower wattage than refrigerators. Therefore, the monthly electricity costs of households in slums were around 20% to 50% of the costs for regular settlements.

Households that run businesses, both shops and homestays, had higher electricity consumption than ordinary households (Figure 2). Surprisingly, the homestay business on the government island pushed electricity consumption to the highest level compared to other households on all islands. The electricity consumption of homestay businesses on this island was almost 1.5 times greater than the same business on the tourism island. However, the government island had a greater gap in electricity consumption between business and ordinary households than the tourism island.

One of the reasons is the difference in tourism activities. On the tourist island, tourism is volatile because tourists do not come constantly every day or every week. Some tourist accommodations have also been transferred to the next island called Harapan Island. The tourism activities on Pramuka Island are more stable, although with more limited variety and attractions.

Meanwhile, for the household with a small store, the average electricity costs were about Rp 400,000.00 - Rp 500,000.00 per month. There was no significant difference among the islands. Their largest electricity load was for the cooking purposes because each household has several units of the refrigerator for storing products all day long.

3.3 Willingness to Pay

3.3.1 Ordinary household’s willingness to pay
As described in previous section, this type of household was found in all three islands. However, ordinary households that were willing to add spending for renewable energy (solar power) in the future were only located in tourism islands (Table 2). Based on the results of the interviews, these households tended to have not such large electricity consumption. The level of knowledge about solar power only covered aspects of strengths/weaknesses and additional monthly expenses. On the residential island (Panggang Island), the ordinary household stated that they were not willing to pay. This statement seemed to associate with the minimal knowledge about solar power. Therefore, decision making just refers to the current experience of electricity usage. People with incomplete information tend to be hesitant in making decisions so they choose to be consistent with current habits and conditions.

| Island’s Designation Function | Knowledge | Electricity Consumption (.000 Rupiah/Month) | Willingness to Pay |
|------------------------------|-----------|---------------------------------------------|--------------------|
|                              | Good      | Less | Bad  | 90-100 | 200-450 | Yes | No |
| Settlement                   | v         | v    | v    | v      | v      | v   |
| Tourism                      | v         | v    | v    | v      | v      | v   |
| Government Center            | v         | v    | v    | v      | v      | v   |

3.3.2 Household with homestay’s willingness to pay
In contrast to ordinary households, households with homestays were found in 2 islands, they were the tourism and the government island. All households in the two islands were willing to pay if renewable energy would be applied despite having less knowledge about solar power prospects (Table 3). But, due to a quite large amount electricity consumption, they were more oriented to the current electricity needs. They believed that those needs would be too large for running homestay business.
They expected that there would be the appropriated policies in the future related to the expansion of solar power services so they would desire to pay. Therefore, it can be concluded that the WTP for this type of household was not influenced by knowledge of solar power, but rather by the amount of electricity consumption at this time.

### Table 3. Household with homestay willingness to pay

| Island’s Designation Function | Knowledge | Electricity Consumption (.000 Rupiah/Month) | Willingness to Pay |
|-------------------------------|-----------|---------------------------------------------|-------------------|
| Tourist                      | v         | 500-510                                     | Yes               |
| Government Center            | v         | 700                                          | No                |

### 3.3.3 Household with store’s willingness to pay

Similar with the ordinary household types, these household are found in all three islands. All of them had insufficient knowledge. Only some of them were willing to pay for renewable energy, those who live on the island of tourism and government (Table 4). Whereas households on the residential island stated not willing to pay despite having a large electricity consumption due to the use of several refrigerators. It indicates the influence of locational factors in decision making to pay or not for renewable energy in business activities. The profitable business location will certainly affect households in maintaining the business, including for increasing electricity power in the future. This is why households with store in tourism’s island and central government’s island tend to be willing to pay for renewable energy.

Thus, for the households with a store, it can be concluded that the WTP is not influenced by knowledge of the solar power, but rather by both the amount of electricity consumption at this time and the business prospect in the future.

### Table 4. Household with store willingness to pay

| Island’s Designation Function | Knowledge | Electricity Consumption (.000 Rupiah/Month) | Willingness to Pay |
|-------------------------------|-----------|---------------------------------------------|-------------------|
| Settlement                    | v         | 500-600                                     | Yes               |
| Tourism                       | v         | v                                            | No                |
| Government Center             | v         | v                                            | v                 |

### 4. Conclusions

The people’s knowledge on islands with different functions does not have a wide variation in depth, where most knowledge only includes general knowledge related to the application of solar power. However, there are several local people who had a better knowledge, including the understanding the strengths/weaknesses and the performance of renewable energy. They are the formal worker with more open access for having better knowledge. The willingness to pay for the households with a business (homestay or store) on both the tourism and government islands are not influenced by knowledge of renewable energy, but rather by the current amount of electricity consumption and the future prospect of the business. Meanwhile, the willingness to pay for the ordinary households on all islands are influenced by knowledge of solar power. The deeper or more complete the knowledge, the more willing to pay.

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