Implementation and Institutional Development for Solar Power Plants Management in Yogyakarta, Indonesia

Lilies Setiartiti[1,a)] and Muhammad Hisjam[2,b)]

[1]*Department of Economics, Faculty of Economics and Business,Universitas Muhammadiyah Yogyakarta, Indonesia*
[2]*Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret, Indonesia*

[a)]Corresponding author: Setiartiti.lilies1267@gmail.com
[b)]hisjam@staff.uns.ac.id

Abstract. The limited resources of fossil energy have an impact on the supply of energy and also exacerbated by the inability of the State Electricity Company (Perusahaan Listrik Negara, PLN) to increase the number of power plants to provide services to the rural areas, providing Solar Power Plant (SPP) is highly expected. Unfortunately, solar home systems project in a hamlet is not sustainable. The purpose of this study is to provide an alternative mechanism for the implementation and institutional development models of SPP, as a strategic development and implementation of sustainable SPP, so it is not just for lighting but can increase business productivity of rural communities. This research is a qualitative descriptive study conducted to obtain the facts from existing symptoms and seek factual explanations and explanatory. Data obtained by using survey techniques, in-depth observation and Focus Group Discussion to provide answers of the problems faced to explain the phenomenon. SWOT technique was used to determine the development strategy in achieving the proper of SPP institutional. Overall, this research provides some important insights for Yogyakarta, Indonesia to highlight possible steps for policy makers to develop a sustainable renewable energy project.

INTRODUCTION

Photovoltaic (PV) is the most renewable energy technology that can be used to increase the access of electricity especially in rural area. Many publications have noted that PV is very economical in rural electrification. With the combination of diesel generator, PV was used to increase rural electrification for rural in India [1]. The result of this publication also shown that PV also contributed in emission mitigation. Economic aspect is the major stress on PV application [2]–[4]. These studies show that PV can be very economically attractive in rural electrification. The case study of these publications was Sub-Sahara African, Ghana, and even Chilean case. Even so, economic aspect in the PV implementation for rural electrification is very location dependent [5]. More, PV implementation for rural area has a very positive impact of income generating of household [6].

. Beside economic aspect, technical issues in PV implementation have been addressed [7]. Several issues of PV for rural electrification had been identified [8]. This study shows that more emphasis should be on post-installation of PV. This can be done by optimizing the implementation of energy policy by related stakeholder of the rural electrification project. The other barriers and challenges of PV are technology, policy and regulations, financing, and infrastructure have also been identified [9]. This study suggested that some important government policies can be very effective to overcome some identified barriers. Some policy recommendations have been developed for case studies in India [10]. As a part of integrated energy planning, PV has an important role in energy self-sufficient [11].

The limited resources of fossil energy impact on the ability of providing energy supply in Indonesia, and led to the energy supply crisis within a long period of time. This condition also exacerbated by the inability of the State Electricity Company (PLN) in making investments to increase the number of plants, so have not been able to provide services to remote areas. Generation costs of electricity depend not only on the investment cost, but also on the cost of fuel. Many of the power plants in Indonesia that the PLN has built over the past years are coal or oil-based power plants. Although these power plants require less upfront capital, the primary source of non-renewable

energy is expensive, while the primary source of many renewable power plants is free. Especially since the oil price has increased by1000% over the last 10 years, the costs of operating these types of power plants keep rising and rising. This leads to a vicious circle, in which the PLN is not able to invest in power plants that have cheaper primary sources but require high upfront costs. The resulting capital from the government due to the subsidy cut, should be invested in rural electrification programs, (renewable) generation facilities, maintenance and strengthening of the network. Public opinion about electricity usage needs to change as well.

Over the last decennial many projects have been carried out both to increase the amount of renewable sources in the energy mix as well as to electrify remote rural areas. Therefore, utilizing renewable energy sources by providing solar power plant (SPP) is desirable for people in the remote areas. Solar Power Plant (SPP) as an alternative effort to diversify the renewable energy resources has been developed at first for home lighting in Yogyakarta Region. Unfortunately, many of these projects have failed to meet the intended target. Some renewable energy projects experienced low efficiency rates, while other renewable energy systems completely broke down without the perspective on repair within only a few years of operation. Reference [12] mentioned that problems often occur in these projects are funding mechanisms that only include upfront costs and exclude the costs of maintenance and repair, lack of capacity and knowledge with both the installers as the local community, poor project evaluation by the government, bad communication and guidance within and between central and local government and project executioner. The problems can be classified as problems of the market, economics, finance, institutional, technical and social-cultural.

In relation to the development and application of solar energy, a study of the conditions of society for its application is required. That's because the development of renewable energy in electricity infrastructure that will have to be managed by the community. Therefore, the understanding of social-cultural and economic potential becomes important because it is expected to formulate management institutions that involve the community, both in terms of utilization and maintenance up to the stage of management. In addition, through this study can also be mapped the energy needs of the community, especially in the position where electricity becomes the main energy, and the possible impact that will occur with the implementation of solar electricity development, including agreements and consultation with the community. Therefore, the study of community institutions in solar energy electricity management needs to be done, to achieve sustainable electricity fulfillment in remote areas.

The urgency of this research is that related to the increasing of the productive economy for the society, the adoption of solar power have not been identified and accommodated properly, so it is not known by the developers of the technology and energy policy makers about the factors supporting and hindering the implementation of the SPP. In the other hand, sustainable implementation of SPP is also determined by the existence and the ability of management of SPP to manage both of the technical and administrative aspects. That’s why the development and construction of solar power-based community participation is the most appropriate option to minimize the problem. In terms of institutional development SPP management is multi-dimensional thing that needs to be seen holistically dimensions of institutional, financial, technological, social and environmental.

YOGYAKARTA’S RENEWABLE ENERGY POTENTIAL FOR SPP

The electrical energy demand of the province of Yogyakarta is satisfied from the islands Java, Madura and Bali (JAMALI). These islands form an interconnected grid. The province of Yogyakarta in itself does not have any non-renewable energy sources such as coal, gas or oil [13]. Thus, for locally generated electricity these sources must be imported from other provinces which can be costly. There are no significant power stations in Yogyakarta, because of the lack of primary resources. This means Yogyakarta is totally dependent on the stability of the JAMALI interconnected network. Furthermore the distribution and transmission network on the Java island is already operating on its full capacity and the electricity demand in Yogyakarta is still growing. This has led to frequent blackouts. This all provides opportunities for power plants based on renewable energy sources in the Yogyakarta region [14].

Yogyakarta has the potential for development of solar power plants. This potential can be seen from the pattern of solar radiation in Yogyakarta are likely to be stable, which is about 4.8 kWh / m2 / day. The coastal area of Yogyakarta also has high potential for wind energy. The average wind speed in the coastal area is between 4.12 and 5.14 m/s. The potential varies per beach and is between 10 and 100 MW [15]. With this potential of solar energy in Yogyakarta, the development of this energy through a SHS and the communal system in order to improve access to energy society becomes a strategic.

Besides, as an effort to provide easy access to electrical energy to the community, the program also to increase the electrification ratio. Renewable energy development policy, particularly solar power in Yogyakarta also synergize with Energy Independent Village Development Program (EIVD Program). The reasons to synergize the development of renewable energy with an EIVD program, as an alternative for solving the problem of energy supply. Besides, the development of EIVD program is expected to reduce the level of poverty (Pro-Poor), strengthening the local economy (Pro-Growth) and improve the environmental aims.

SPP DEVELOPMENT IN YOGYAKARTA

Currently in some villages in the region of Yogyakarta already developed solar energy, which is spread across districts/cities. Besides, as an effort to provide easy access of electric energy to the community, this program also aims to increase the ratio of electrification. In terms of the ratio of electrified villages, specifically for Yogyakarta has reached 100 percent, but until now there are still 296 hamlets that have not enjoyed electricity, spread across 42 districts. A total of 296 hamlets, their presence is relatively dispersed and almost entirely located in remote areas that are geographically constrained because they are far from the existing power grid, in addition to the far-flung settlements that are not yet all can access to the electricity grid. Distribution of solar energy development in Yogyakarta can be seen in Table 1.

TABLE 1. Distribution Development SPP In Remote Area in Yogyakarta

No	Region	District	Village	Unit of SPP	Type of SPP	Condition
1	Gunungkidul	Gedang Sari	Watugajah	105	SHS Com	Broken
2	Gunungkidul	Gedang Sari	TegalRejo	100	SHS	Broken
3	Gunungkidul	Gedang Sari	Serut	1	SHS	Broken
4	Gunungkidul	Tepus	Tepus	33	SHS	Broken
5	Gunungkidul	Tanjungsari	Ngestirejo	59	SHS	Broken
6	Gunungkidul	Tanjungsari	Banjar Rejo	41	SHS	Broken
7	Bantul	Kretek	Parangtritis	16	SHS	Broken
8	Bantul	Kasihan	Bangun jiwo	19	SHS	Broken
9	Bantul	Piyungan	Sri Mulyo	13	SHS	Broken
10	Kulon Progo	Temon		81	SHS	Broken
11	Kulon Progo	Panjatan		20	SHS	Broken
12	Kulon Progo	Kokap	Clapar	262	SHS	Broken
13	Kulon Progo	Kokap	Kali Rejo	25	SHS	Broken
14	Kulon Progo	Giri Mulyo		10	SHS	Broken
15	Kulon Progo	Nanggulan		46	SHS	Broken
16	Kulon Progo	Kalibawang		45	SHS	Broken
17	Kulon Progo	Samigaluh		32	SHS	Broken

The SHS systems were installed in 2005 and all of them broke down before the end of 2008. No other attempts by the local government were undertaken to electrify the hamlet again. There have been various SHS projects that followed the same course. This is why it is important to understand why all these projects are not sustainable and run into problems within a few years. The village wherein the solar home systems were installed is on a hillside surrounded by hills, there is no paved road that connects the village to other villages. Before the installation of the solar home systems the inhabitants of the villages had no access to any electricity and used kerosene lamps to light their houses after dark. Firewood is used for cooking.

The villagers did not receive any training from the government representatives on how to maintain the system. They were solely informed how to switch the system on and off. There was nobody in the hamlet who was able to fix minor problems and nobody who knew where to go in case of major problems. Local Government saw it as their responsibility to deliver the Solar Home Systems to the inhabitants of the hamlet, but not to assist in guaranteeing sustainability of the project. Electricity provision should be a means to reach higher development goals instead of being used as an end goal in itself. Project sustainability and community development should always be the main focus. This section will discuss that Institutional Development of SPP Management should be taken to ensure project sustainability and reaching higher levels of community development.

METHODS

This research is a qualitative research that is the descriptive verification, which is a research conducted to obtain facts from the existing symptoms and find information factually and explanatory using survey methods, arguing that the explanatory survey method is the method that provides answers for the problems faced and able to explain the phenomenon under study. We collected the primary data using survey method, observation, in-depth interview, and focus group discussion (FGD) institutional planning analysis is based on the Evaluation Analysis technique, which is evaluating the programs that have been implemented using the single after program evaluation method. This means that an evaluation of the SPP institutional development program which implemented. Finally, we used SWOT Analysis to determine the development strategies that will be used in achieving the expected SPP institutions

RESULT AND DISCUSSION

Institutional development of community energy management in particular is a multi-dimensional problem that needs to be seen holistically dimensions of institutional, financial, technological, social and ecological because these aspects is indivisible. A multi-dimensional IFTSE (Institutional, Financial, Technology, Social and Ecology) in this study is the core of the problem identification activities, analysis, synthesis and formulation of recommendations on the institutional development of SPP management in Yogyakarta.

The results of field observations indicate that the main problem faced and could not be solved by the management or the users of solar power were low technical capacity in infrastructure maintenance of SPP. In addition, the funding system has not been built for the maintenance and purchase of broken equipment, especially on the battery. This problem becomes more complex because the economic capacity of households SPP users in general, including the poor and near poor condition and relatively low levels of education and access to relatively limited. Therefore, institutional development becomes essential to keep the SPP program can be sustained.

Stakeholder Analysis of SPP Institutional

Based on a review of documents, field observation, and interviews with management, SPP Management Institution have complex stakeholders. In the most SPP institutional in Yogyakarta have a major stakeholders, that is the citizen of the beneficiary; government and local government, and university. In the implementation, there is also involvement of the local key person to be included in the process of formation of the management group. Stakeholders of SPP Institution can be seen in Figure 1.

Stakeholders are playing a dominant role in the management of SPP is the central government and regional, which planning and public financing of SPP investment. Activities construction like this is more as a project, thus affecting the opinions of beneficiaries that are public investment, therefore the beneficiaries do not spend a lot of investment in the early stages, and only financing the maintenance phase, so that the psychological aspect in the form of ownership of the asset is not so high.

At the stage of the formation of groups, stakeholders also play a role is the village administration, and local key person, which also facilitated the formation of the SPP management group. They were quite dominant role in formulating the rules of the group. At the operational stage, the majority of management are citizens of the beneficiary's own. In its activities, most of the group has a major drawback, namely: 1) Limited capacity of the management, particularly in terms of technical knowledge and skills maintenance equipment of solar power, as well as the ability to mobilize social resources, 2) Organizational rules that have not been detailed, 3) Management Institutional not a legal entity that is regulated by the law, 4) Low financial capability of the group.

It is not easy to solve this and very difficult if only charged for the local institution to make the potential of other stakeholders be optimized. In this case, it needs the involvement of other stakeholders such as private companies and SOEs related to the implementation of CSR is intended to support the operation of the institutional SPP. In addition, there needs to be a much wider forum of the groups that can be either forum or association manager so that there is a network of capacity building and advocacy. Facilitating the establishment of this forum to become strategic in order to strengthen institutional management SPP.

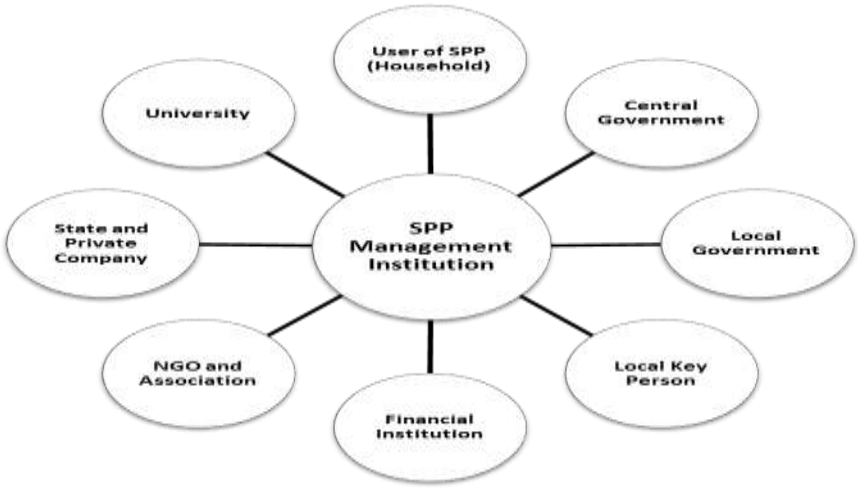

FIGURE 1. Stakeholders of SPP Management Institution

SPP Management Institution Models

SPP reliability institutional management is strongly influenced by the role of the various stakeholders in real terms. It could not be partial, but we must interact cooperatively in which there are capacity building activities. Based on the problems and SWOT analysis, can be divided into the four capacity needs to be developed, namely the human resource capacity, financial capacity, organizational capacity, and the environment capacity. In such capacity building with building institutions, both associated with the internal management organization and public policy so as to build interaction between stakeholders. Figure 2 shows SPP Management Institution Model.

The forms of program / major activities formulated in each category briefly strengthening the capacity can be observed in the figure below, and in detail can be described as follows:

1. Strengthening the Capacity of the Environment
   The environmental context in question is non-physical external environment related to SPP Management Institution.
2. Strengthening Human Resource Capacity.
   Some of the strategic agenda in the sphere of human resource capacity strengthening are:
   a. Users build mental attitude that the project benefits to meet basic needs him so awakened a sense of belonging and awareness to make sacrifices in the treatment equipment.
   b. Improving the capacity of human resource managers, especially skills in the maintenance and repair of SPP equipment.
   c. Improving the managerial capacity of managers. Basic capabilities that must be developed is leadership, communication, and organizational management.
3. Strengthening Financial Capacity
   Some of the strategic agenda in the sphere of strengthening the financial capacity is:
   a. Increasing in household income. One of the constraints in the SPP Management Institution is lack of funding for maintenance and replacement of broken equipment.
   b. Facilitation to credit access for groups. Pattern credit financing in SPP equipment is an alternative so that members are able to meet the purchase of faulty equipment.
   c. Optimization of Group revenues. Optimizing also constructed by building a group activity that can generate group cash-flows
4. Strengthening the Capacity of the Organization
   Some of the strategic agendas in the sphere of strengthening the capacity of the organization are:
   a. Facilitating the development of SOP organization, care SOP, SOP financing, and various regulatory and group agreements embodied in written documents.
   b. Group mentoring process routine by a facilitator in the group
   c. Facilitation of strategic partnerships in a forum/ SPP management association

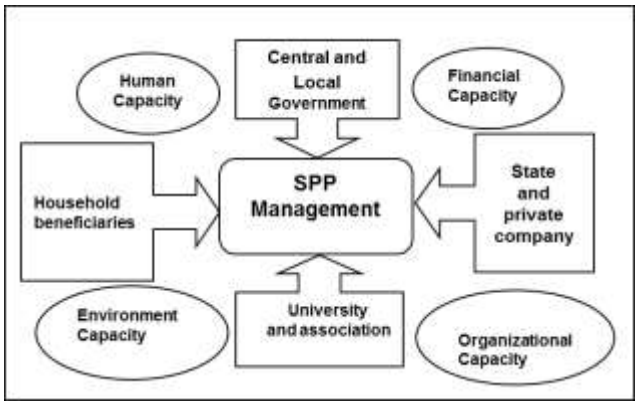

FIGURE 2. SPP Management Institution Model

CONCLUSION

Based on the analysis, related to the SPP Management Institution development in Yogyakarta, Indonesia can be concluded that:

1. There was no community involvement or capacity building during the project. The local government just installed the SHS and then left, without any follow-up meeting, monitoring of the project or evaluation. The villagers did not receive any training in how to fix minor problems or information on where to go in case of major problems.
2. The SHS project failed to have the desired impact, namely poverty alleviation and rural electrification. It seemed like the local government was merely interested in installing the systems rather than in the sustainability of the project. This can be explained by the fines the Central Government will impose on the Local Government if electrification targets are not reached.
3. SPP Management Institution development is a dimensional thing that needs to be seen holistically dimensions of institutional, financial, technological, social and environmental
4. SPP Institutional in Yogyakarta have major stakeholders: citizens of the beneficiary, central and local government, university, association, NGOs, local key person, state and private company, and financial institutions.
5. Strengthening of SPP Management Institution requires facilitation in the formation of relationships between SPP management forum.

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