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Article

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Designing Institutional Models for Renewable Energy Project Sustainability

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ABSTRACT

Access to adequate, affordable, and reliable energy is one of the first steps to poverty alleviation, especially in the remote areas, to increase productivity, employment, and social welfare of a community. For Yogyakarta, which have no an energy source, developing renewable energy project is a strategic step to make it happen. Many projects have been carried out both to increase the amounts of renewables in the energy mix as well as to electrify remote rural areas. 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 perspective on repair within only a few years of operation. This study aims to identify the sectors core problems and evaluate various renewable energy projects in order to investigate why some projects prosper, while others fail to have the right effect. Furthermore, a proper institutional model to keep sustainable renewable energy projects will be conducted to increase the productivity of rural businesses. Data obtained by using in-depth observation and Focus Group Discussion to provide answers of the problems faced to explain the phenomenon. SWOT technique used to determine supporting and hindering factors, to formulate the development strategy in achieving the proper of renewable energy project institutional model. Overall, tis research provides some important insights for local government to develop a sustainable renewable energy project.

Keywords: Institutional Model, Renewable Energy Project, FGD, SWOT
JEL Classifications: Q2, Q3, Q4, Q5

1. INTRODUCTION

There has always been a trade-off between security of supply, affordability and sustainability, commonly called the "energy tri-lemma," has long been recognized as a major problem of energy policy Ang and Choong (2015); Madriz-Vargas et al. (2017). The safest energy sources may not be the most affordable or the most sustainable, vice versa, building policies that simultaneously address energy security, universal access to affordable energy services, and the production and use of environmentally friendly energy is one of the most pressing challenges facing government and industry WEC, 2019. Constructing policies that simultaneously address energy security, universal access to affordable energy and take into account environmental sensitivity has been one of the greatest challenges for governments worldwide Martin, 2011. Security of supply has not been a concern in the past for Yogyakarta because energy needs always distributed by the central government in sufficient quantity, but is now growing to be a serious issue Setiartiti, 2011. Since Yogyakarta does not have any primary sources, like oil, these sources need to be imported which is costly. This is why Yogyakarta does not have it's own traditional energy generation and is mainly dependent on other provinces for electricity Derks and Romijn, 2019. This results in a reducing the energy supply to Yogyakarta, then growing concern in energy security. Yogyakarta has an extremely big potential for renewable power generation like solar panel, unfortunately, the affordability of this energy remains an issue, besides, sustainability of renewable energy projects, is also a big problem.

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 a new investments to increase the number of plants, so have not been able to provide services in remote areas MEMR, 2017. Development of renewable energy in Yogyakarta especially solar panel projects, was aimed to reduce dependence on fossil energy sources, as well as to improve the welfare of the people, especially those in remote/underdeveloped areas that have not yet grid-connection to PLN. The consideration, although in terms of investment costs is still relatively high, but when compared with building a cable network, development of solar panel projects became a necessity Ortiz et al., 2012. Development of solar panel was also a commitment of local governments to accelerate infrastructure in less development areas with the aim of catching up from other regions Paleta et al., 2012. It was in accordance to Government Regulation No. 3 of 2005, stating that the provision of electrical energy for less development and remote areas is the responsibility of local and central government. To change this and to increase the share of renewables in Indonesia's energy mix, renewable energy plants have been constructed in Yogyakarta. And there is many more potential for renewable energy production in Yogyakarta than what is currently being utilized.

Solar panel is the most renewable energy technology that can be used to increase the access of electricity in rural area. The electrification using solar panel increase along with the increasing demand of renewable energy, concerning the world climate change. Renewable energy usage still covers a small share of the total supply globally, although the number has been increasing. Most of the increase will likely solar, wind, and micro-hydro power Kusch, 2019. Three percent of the world's electricity generation in 2019 was covered by photovoltaic energy IEA, 2019. Over the past decade, solar energy cost already fell, and its installation would be less expensive to the households. This condition has greatly impact on encouraging residents to accept solar energy Mohandes et al., (2019); Wong and Cronin (2019). Many publication have noted that solar panel is very economical for rural electrification Sandwell et al., 2016. Economics aspect is the major stress in solar panel application Baurzhan and Jenkins (2016); Steel et al., (2016), Ramírez-Sagner et al. (2017). More, solar panel implementation in rural areas have very positive impact on income generating of household Stojanovski et al., 2017.

Besides an economic aspect, technical issues in solar panel implementation has been addressed Jamal et al., 2017. Their empirical study showed that more emphasis should be on past-installation of solar panel, can be done by optimizing the energy policy implementation where cooperation with vital stakeholder must be considered. Another barriers and challenges of solar panel projects are policy and regulation, financing, and infrastructure have also been identified Rathore et al., 2018. This study suggested that some government policies have an effective impact on overcome some identified barriers, and many research recommendations have been developed in India Shukla et al., 2018. As a part of the integrated energy planning, solar panel has an essential role in the energy self-sufficient program Hartvigsson et al., 2018. Many challenges to community-based energy initiatives in developing countries are identified in the literature, often concerning the long-term operation of Renewable energy technologies, and the overall sustainability of the projects Shaw et al., 2015.

As in many regions, many renewable energy projects in Yogyakarta already experience problem during their 1st years or even months of operation, arising from lack of a maintenance budget, task and responsibility allocation, and insufficient participation and capacity building Guerreiro and Botetzagias, 2017. Furthermore, quality of work and equipment remains challenging and is often unable to meet up to sufficient technology standards. In the case of small scale, off-grid power plants, there is often no budget for proper capacity building, training, mentoring and technical assistance. This target, however, includes only the number of projects completed each year, not the number of projects that are still in operation. This mechanism provides another incentive to focus on statistics rather than project sustainability. There are no rules regarding the quality and quantity of electricity provisions on when an area will be elected. This means that if the provision of electricity, for example a Solar Home System, was provided many years ago, the area is said to have been electrified. Although in most cases these projects broke down in just a few years.

How-ever there is no personal incentive to keep the project operational, as repair costs for operation and maintenance are small compared to installation costs which make taking bribes to hire certain companies to perform maintenance less profitable. Often there is no clear allocation of tasks and responsibilities. In most of the renewable energy projects initiated by the Central Government, many parties are involved such as the Local Government, District Government, local universities, NGOs and local communities. It is often unclear which party is responsible for what. This resulted in the reluctance of the parties involved to take financial responsibility for operations and maintenance, because these tasks were not clearly allocated in the first phase of the project. In practice this often means that after installation, the project is informally transferred to local communities, who are then responsible for financing operations and maintenance.

To restore confidence in the renewable energy project, to attract the private sector, and to guarantee project sustainability for future project, it is extremely important to evaluate existing project to see which lesson can be learned. In this research, many hamlets with many solar home systems and communal system, one hybrid power plant project and two micro-hydro system were reviewed and evaluated. The evaluation of these projects showed that the main problem is a lack of long-term vision and no clear task and responsibility allocation between involved stakeholders. All energy projects were treated as engineering design and build project instead of treated as facilities that deliver a service to society that need constant attention to keep delivering this service. These things combined have led to a lack of focus on participatory development, community involvement, training of local operators, and capital investment during the operation and maintenance phase.

The goal of this research is to provide an overview about the role of renewable energy in Yogyakarta in both electrification projects as well as in power production; solar home system, hybrid power plant, and micro-hydro projects. The urgency of this research is to provide some insights in the challenges that arise during the implementation and utilization of the type of renewable energy projects namely solar panel, hybrid system, and micro-hydro, and some insights into institutional model design. Through this study also can be mapped the energy needs of the community, the possible impact that will occur with the implementation of renewable energy electricity development, including agreements and consultation with the community. To achieve sustainable electricity in remote areas, renewable energy projects-based community participation is the most appropriate option to minimize the problem. In terms of institutional design of renewable energy projects, multi-dimensional thing needs to be seen in a holistically dimensions of institutional, financial, technological, social and environmental.

2. METHODOLOGY

This research is a qualitative research, which is conducted to obtain facts from the existing symptoms and find information factually and explanatory using survey methods, that provides answers for the problems faced and able to explain the phenomenon. Primary data was obtained using survey method, in-depth interview, and focus group discussion (FGD). The interviews followed a semi structured format with an interview guideline that was constructed beforehand, which consisted of open questions about procedures on how the projects were initiated, designed, planned, installed and maintained. The interviews focused rather broadly on (dis) incentives and motives of the actors involved with the energy system that make them deviate from keeping the systems in working order after installation.

Institutional model analysis is based on the review and evaluation analysis technique, which is the renewable energy projects for electricity were reviewed and evaluated in order to understand which problems often occur when implementing renewable energy projects in the region. Finally using SWOT analysis to determine the development strategies that will be used in designing the expected RE project institutions

3. YOGYAKARTA'S RENEWABLE ENERGY POTENTIAL.

3.1. Current Situation

The electrical energy demand of Yogyakarta is supplied from the islands Java, Madura and Bali (JAMALI). These islands form an interconnected grid. Yogyakarta in itself does not have any non-renewable energy sources such as coal, gas or oil. Prihandita et al., 2015 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 depend on the stability of the JAMALI interconnected network. Further-more 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 Setiartiti, 2011.

There are various rivers and open channel flows that are suitable for micro-hydro power plants in Yogyakarta. There are already more than ten micro-hydro power plants in the region (of which only three are still working), however the potential exceeds the existing generation facilities. Yogyakarta's water energy potential can be seen in Table 1. These potential from Kalibawang irrigation channel which flows throughout the year with low debit fluctuation. Another potential source of water energy comes from the Van der Wicjk ditch and the Mataram ditch. The problem with Kalibawang irrigation is that it is not well maintained so that the existing potential has not been optimally utilized.

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/m^2/day. The coastal area of Yogyakarta also has high potential for wind energy. The average wind-speed at the coastal area is between 4.12 and 5.14 m/s. The potential varies per beach and is between 10 and 100 MW Badruzzaman and Widiastuti, 2014. This condition can be seen in the following Figure 1.

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. Meanwhile, the potential for wind energy due to its geographical position on the southern coast of Java Island. Wind speed data per month can be seen in Table 2.

Another important renewable energy potential in this region are biomass and biogas. Feces from livestock can be used as biomass. Other animal waste such as urine can be used as raw material for biogas. The production of sugar cane and cassava

Table 1: Micro-hydro Potential in Yogyakarta

Name	Location	Potency (Kw)
Kalibawang Irigation	Kedungrong 1	90
Kalibawang Irigation	Kedungrong 2	100
Kalibawang Irigation	Semawung	614
Kalibawang Irigation	Tempel, Girimulyo	40.3
Kamal Ditch	Kamal, Girimulyo	34
Van Der Wicjk Ditch	Sleman Region	86.7
Mataram Ditch	Sleman Region	71.7
Bendung Tegal	Imogiri	106
Buntung River	Tegalrejo	12.4
Slumpret	Bleberan	41

Source: Field survey

Table 2: Wind energy potential in Yogyakarta

Location	Wind speed (m/s)	Capacity potential (MW)
Along the southern coast of Yogyakarta	2.5-4	Up to 100
Sundak Beach, Srangkan, Baron, Samas	4-5	10-100

Source: Field survey

could also increase the biomass potential Setiartiti, 2011. There are currently 1869 bio-digester systems in the Yogyakarta. Since 2012 collaboration between the Local Government, the NGO Pinbuk and the private sector, has managed to install 1076 bio-digester systems. Of which 90% are still working. The 10% that is not working is not because the bio-digester is broken, but the cattle that provided the feces as feedstock was sold. The initial cost of a bio-digester system is a lot lower than of other renewable energy sources, while it can have a great impact on local communities. This is why the Local Government has spent a lot of their budget and attention on these types of projects. The collection of human and animal waste for the bio-digester, prevents the dumping of feces in the river and thus helps in preventing water pollution and contributes to increasing sanitary standards. The bio-digester system delivers two products: gas for cooking and manure that the local community can sell to either Pinbuk, who then sells it on the market, or sell it directly to customers themselves. The income of the local community is increased via two mechanisms: they do not need to purchase expensive LPG gas anymore for cooking and they generate income from selling the manure.

3.2. Renewable Energy Projects: Rural Electrification Program

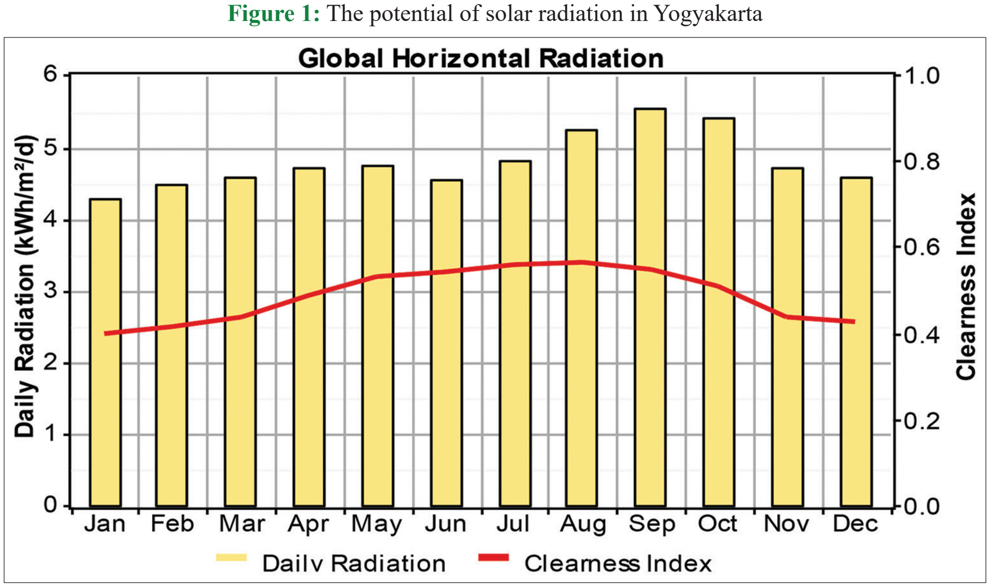
3.2.1. Solar panel

Currently in some villages in the region of Yogyakarta already developed solar energy, which is spread across districts/cities. Besides to provide easy access of electricity to the community, this program is expected to reduce the level of poverty (Pro-Poor), strengthen the community's economy (Pro-Growth) and improve the environment. Yogyakarta has reached 100 percent on electrified villages, but there are 296 hamlets have not enjoyed electricity, spread across in 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 accessible to the electricity grid. Besides, the development of the program is expected to reduce the level of poverty (Pro-Poor), strengthen the community's economy (Pro-Growth) and improve the environment. Table 3 below describes the construction of solar panels in Yogyakarta.

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. All families in the area are farmers and generate their income by selling bananas and other fruits on the local market. The income of the households in this hamlet is approximately 500.000IDR per month, which is equivalent to 36,0 USD. 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. The batteries of all fifteen SHS deteriorated after an average of three years. A new battery cost 800.000IDR, which was too expensive for the local community. The villagers had no knowledge of the availability of any kind of service point or about funding to receive another battery. The lack of operation and maintenance training, project monitoring and evaluation, shows the Local Government was not prioritizing project sustainability. The 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.

Figure 1: The potential of solar radiation in Yogyakarta



All solar home system and communal system in all villages broke down after 3 years of operation since the battery deteriorated and the local community did not have the financial means to replace the battery. Further-more they were not informed that the battery would need replacement every three years, and that is would be their responsibility.

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. The local government, who initiated the project, only installed the system and did not give any further training or assistance. In all project electricity was seen an end goal and out as a means to reach higher development goals such as poverty alleviation. Although the people were very happy with the electricity for 3 years, they did not see any change in their income or livelihood. After the batteries deteriorated, they were again dependent on kerosene or diesel lamps

The electricity supply for the people in the remote areas, must be a means to achieve a higher development than the end of development goal itself. Project sustainability and community development must be in the main focus. This confirms that every RE project institutional development, have to ensure project sustainability and achieve a higher level of community development.

3.2.2. Hybrid Power Station in Pantai Baru

Pantai Baru has both stable wind equality as well as adequate sunlight throughout the year, this is why hybrid plant (PLTH) was constructed in last 2011 ago, that consists of both solar panels as of wind turbines. The high availability of solar irritation in the area, makes solar energy a reliable source of energy for the construction of hybrid power plant. Table 4 below describes the amount of generator constructed.

The goal of the projects was to increase social welfare by not only fulfilling the basic human needs, but also to contribute to the regional/community development, income generating as well as equalization. The most significant contribution to the economic activity was the organization of places of business, namely the emergence of 60 food stalls along the coast of Pantai Baru, and receive electricity from the PLTH. Furthermore, the government contributes to construction of an ice factory to develop the fishery sector, to preserve the caught fish and also to supply the food stalls. The government has also improved the infrastructure of Pantai Baru in order to promote tourism in the area as a popular beach destination for domestic and foreign tourist. The local community clearly benefited from the projects by increasing their income, it is due to the food stalls that allow the community to sell food to tourist, and the parking fees. The farmers and fishermen also have greatly benefited since the market for their products has expanded.

Currently, the main problem of the PLTH are not the broken wind turbines, the local operators knows how to fix these and how to make the spare parts necessary to get them in operation again. The problem is the decreasing capacity of the batteries and the low capacity of the inventers. The salty sea breeze also affects the hybrid system equipment to corrosion (Figure 1). The local operators believe that fixing the wind turbines will be a waste of time since without a proper inventers and battery capacity this power cannot be used.

The lack of proper financial planning, seems to be the biggest problem in this project. There was no budget made available for

Table 3: Distribution development SPP In remote area in Yogyakarta

Region	District	Village	Unit of solar energy	Type solar energy	Condition
Gunungkidul	Gedang Sari	Watugajah	105	SHS Comunal	Broken
		TegalRejo	100	SHS	Broken
		Serut	1	SHS	Broken
	Tepus	Tepus	33	SHS	Broken
	Tanjungsari	Ngestirejo	59	SHS	Broken
		Banjar Rejo	41	SHS	Broken
Bantul	Kretek	Parangtritis	16	SHS	Broken
	Kasihan	Bangun jiwo	19	SHS	Broken
	Piyungan	Sri Mulyo	13	SHS	Broken
Kulon Progo	Temon		81	SHS	Broken
	Panjatan		20	SHS	Broken
	Kokap	Clapar	262	SHS	Broken
		Kali Rejo	25	SHS	Broken
	Giri Mulyo		10	SHS	Broken
	Nanggulan		46	SHS	Broken
	Kalibawang		45	SHS	Broken
	Samigaluh		32	SHS	Broken

Source: Field survey

Table 4: The Amount of generator constructed

Type of generator			Amount of unit	Amount of power
East group	System 48 V	Wind Turbines 1 KW/48 V	4 unit	4 KW
		Wind Turbines 1 KW/48 V	2 unit	2 KW
	System 240 V	Wind Turbines 2,5 KW/240 V	2 Unit	5 KW
			1 unit	10 KW
		Wind Turbines 10 KW/240V	1 unit	10 KW
			1 unit	1KW
		Wind Turbines 10 KW/240V	40 unit @100 W	4 KW
		Wind Turbines 5 KW/240V		
		Solar Panels 4 KW/240 V		
	System 120V	Wind Turbines 2 KW/ 120 V	2 Unit	4 KW
West Group	System 240V	Wind Turbines 1 KW/240 V	21 Unit	21 KW
	System 120 V	Solar Panels 15 KW/120 V	150 unit @100W/12 V	15KW
KKP Group	System 48 V	Solar Panels 10 KW/48 V	48 Unit @220W/24V	10 KW
Power in total				90 KW

Source: Field survey

proper needs assessment, financial feasibility studies, financial training, funds for battery or inverter replacement, or frequent visits from engineers in case of emergencies. The absence of the budget, shows lack of prioritizing project sustainability. Furthermore, there was no clear responsibility or task allocation between the involved institutions and the local community. It has led to all parties denying responsibility for capital to operation and maintenance. Thus, since the project is a pilot project, evaluation is extremely important to analyze which aspects went as expected and what could have gone better. It also can help prevent similar problem in the next project Terrapon-Pfaff et al., 2014.

3.2.3. Micro-hydro power plant (PLTMH)

There are two micro-hydro power plant are located in the hamlets of Kedungrong (Figure 2), and Blumbang (Figure 3), which are located in Kalibawang district, Kulonprogo Region. There are two micro-hydro power plant are located in the hamlets of Kedungrong and Blumbang which are located in Kalibawang district, Kulonprogo Region (Figure 4). The two micro-hydro system (PLTMH) are located within 100 m of each other in the same river flow. Kedungrong is currently still operational, but not for Blumbang, which constructed by the private sector. The PLTMH in Kedungrong was built in 2012 as a part of the DME program (Independent Energy Village Program), financed by the Ministry of Energy and Mineral resources. The project aims to increase security of electricity supply for home lighting and street lighting. Both PLTMH are fully off-grid system and were constructed for free. However, the villagers in Kedungrong needed to pay a connection fee of IDR.600.000 to be connected to the PLTMH. This fee is to cover the cost of electricity poles, cables, and the meter that necessary.

The planning of construction of the PLTHM Blumbang was started in 2014 and took three years, eventually the PLTMH was built and finished in 2017. This project providing electricity up to 60 Kilowatts, capable to produce 19,000 watts of electricity, and currently which is used for 111 families. Each family pays IDR 5000 every month. PLTMH Kedungrong has a power of 18 KVA, which has been utilized by no <40 households, each of whose houses have around 500 watts of electricity. For electricity service fees of this size, residents are only charged a fee of IDR.7000 for 35 days, with details of IDR.5000 network and turbine maintenance fees while IDR.2000 fees for village street lighting. The local community benefits a lot from the coming of the micro-hydro since their electricity supply is more reliable and they save between IDR 20.000 and IDR.30.000 every month.

Only one operator in the Kedungrong received training to operate the one of the turbine systems. There was no training on how to operate the other turbine system. In the Blumbang the operator did not any formal training. This lack of training shows the involved institutions did not prioritize sustainability. For both PLTMHs only one turbine can be used at a time, which results in only half of the total capacity being produced. If the two turbines run simultaneously the dynamo gets overheated which could severely damage the system. Unfortunately, in Kedungrong PLTMH, the first turbine system broke down after only a few months. The three operators do not know what happened exactly. There was a blast and smoke started coming out of the turbine. The PLTMH in Blumbang has only been in operation for 8 months and if there have been only some minor problems.

In general, there are three types of problems that often occur during micro-hydro project.

- Decrease in capacity because reduced flow rate is not anticipated. It is generally caused by an error in the design of the micro-hydro. Often the micro-hydro is designed with only minimal flow data and there is not enough attention put into the development of prototype and measurement on the channel flow
- Decrease in capacity because of interference with the component. It can be due to damage to the dam or the channel carrier which will interrupt the water flow or because of damage to the tub tranquilizer, the turbine or a disturbance on the cable network. Another important factor that limits the capacity is debris blocking the water intake and therefore limiting the channel flow through the turbines
- Increase in household that leads to an increase in consumption which was not anticipated on. It increases the frequency of blackout and limits the consumption of all consumer.

4. RESULTS AND DISCUSSION

The development of renewable energy project becomes a vital public investment to achieve the fulfillment of electricity, especially in remote areas. Renewable energy power plants built by the Central Government often run into problems when they are handed over to the Local Government. Local Governments do not have the resources or technical capacity to operate and maintain the power plant. This all results in the renewable energy power plants being operated for only a short period. Many banks also still see investing in renewable energy as risky. This is stimulated by the high failure rate of renewable energy projects funded by the government Therefore, it needs reliable institutional model of RE project management.

To restore confidence in the renewable energy sector, to attract the private sector, and to guarantee project sustainability for future projects it is extremely important to evaluate existing projects to see which lessons can be learned. Conceptually, the renewable electricity power based on community participation, has many advantages, among others:

- There are opportunities for new sources of financing for energy independence. Renewable energy investment requires a large number of capitals, usually sourced from foreign funds, so has an impact on the debt. Public participation will be a substitute for financing from abroad
- Reducing the investment costs of RE power. With a participatory model, community will be encouraged to invest because energy is a basic need. In this case, social motives are as strengthens factors in investing and maintaining RE power, which have short-term and long-term social and economic benefits
- The participatory model will increase community support to the government, as well as renewable energy power projects. The centralistic approach does not popularize government in development. With participation, will increase public awareness that the development of renewable energy belongs to the community, which is currently a necessity

Figure 2: Corrosion in wind turbine and PLTH system

Source: Field survey

Figure 3: PTLMH in Kedungrong

Source: Field Survey

Figure 4: PLTMH in Blumbang

- RE electricity generators can be built anywhere. Transmission and the network cost will be more efficient, thereby reducing energy waste on transmission because it is closer to the user.

4.1. Supporting and Inhibiting Factors for Designing Institutional RE Projects

In general, renewable energy project institutions are local institutions, and are voluntary. To develop an institutional model, it must be known what factor supporting and hindering the development of renewable energy projects. Based on interviews with managers, several supporting and hindering factors were identified for designing the RE project as follows;

- RE projects are supported by continuous resource availability
- RE electricity project is very important for the people who have not been served by the PLN network
- RE project manager has been formed
- Stakeholders' support: universities as applied research and community service
- Stakeholders' support: foreign funding and companies as CSR
- RE electricity development becomes national and regional policy
- Lack of RE infrastructure
- Limited capacity of RE project user and management
- Limited access to information and partnership
- Depending on the equipment supplier
- Low of management capacity, especially the knowledge and technical skills of tool maintenance
- Less financial capacity of group members.

4.2. Institutional Models Design for RE Project

4.2.1. Stakeholder analysis of re institutional

Based on document review, field observations, and interviews with the manager, RE project institutions have a complex stakeholder. Most of the institutional renewable energy projects have key stakeholders, namely beneficiaries, government and local governments, universities, renewable energy NGOs, and companies (Figure 5). Most of RE project institutions have a major stakeholder, namely the beneficiary community, central and local government, and universities. Its implementation also involves a local key person in the process of the manager appointment. The central and local governments play a dominant role in the management of RE projects, who will plan and finance the RE projects. This construction activity is usually only a project, so it affects the beneficiary community which is a public investment. Therefore, beneficiaries do not spend much at the starting time, only financing for maintenance, so the psychological aspect of asset ownership is relatively low.

In group formation, the most important stakeholders were the village government and local key figures. Their role is quite dominant in formulating the group rules. At the operational stage, the majority of the board members are the beneficiaries themselves.

In its activities, the group has several weaknesses, namely: (1) Limited of management capacity, low of technical knowledge and maintenance skills for RE equipment, as well as the ability to mobilize social resources, (2) organizational rules that are not yet detailed, (3) Management is not a legal entity regulated by law, (4) low financial capacity.

It's will be very difficult to solve this problem if only charged on the local institutional. Therefore, the potential of other stakeholders can be optimized. In this case, it needs the involvement such as state and private companies related to the implementation of CSR to support the operationalization of the RE institution. Besides, there is a need for a larger forum such as an association, to capacity building and advocacy. Facilitating the establishment of this forum is very important in order to strengthen the RE project management institution.

4.2.2. RE project institutional models

A proper RE project institutions are strongly influenced by the roles of various stakeholders which cannot be partial. They must interact synergistically in increasing institutional capacity. Based on the problems and SWOT analysis, there are four capacities to be developed, namely; human resource capacity, financial capacity, organizational capacity, and environmental capacity. Institutional capacity building is carried out in relation to internal organizations and public policies, in order to build interaction between stakeholders.

Since all capacities are established, a proper RE project institution will be realized. The design of the RE project institutional model for electricity can be described as follows;

Figure 6 explaining the implementation of an institutional model, done by strengthening and clarity of the stakeholders' role. Based on the needs analysis, supporting and inhibiting factors, and a SWOT analysis, interrelated programs and activities required to create a proper RE project institution. In detail, the main programs and activities formulated in each category of capacity building, can be seen in the figure below, and are described as follows:

4.2.3. Strengthening the capacity of the environment

1. Environmental aspects are the non-physical external environment associated with RE project management. RE project institutional development is strongly influenced by the implementation of policies, namely the National Energy Policy (KEN) or the National Energy General Plan, and the Regional Energy General Plan (RUED. For maintenance costs, public funds are needed. It can be an allocation of matching funds, grants, or other financing schemes. Thus, the manager has a reason that is used as a reference
2. Facilitating partnerships between stakeholders. This activity is carried out because no single institution can handle all programs. Therefore, the optimization of potential stakeholders must be carried out. The main elements to support institutional strengthening include; local governments, BUMS, BUMN, universities, and NGOs in the energy sector.

4.2.4. Strengthening human resource capacity

Independence in fulfillment energy needs is the key to institutional sustainability of the RE project. Some of the important agenda for strengthening human resource capacity are:

1. Beneficiary communities must realize that the electricity project provides benefits to meet their basic needs, hereby creating a sense of belonging and awareness to maintain the equipment
2. Increase the capacity of human resources, especially skills in maintenance and repair of electrical equipment
3. Improving the managerial capacity of managers. The effectiveness of institutional management depends on the managerial ability to mobilize resources to achieve sustainability of RE projects. The basic capabilities which must be improved is leadership, communication, and organizational management.

4.2.5. Strengthening financial capacity

Some of the important activities for strengthening financial capacity are:

1. Increase in household income. One of the obstacles in the RE project management institution is the lack of funds for maintenance and replacement of damaged equipment
2. Credit access facilitating to the groups. Financing scheme for procurement of RE project equipment are an alternative, so the members can purchase of damaged equipment

Figure 5: Stakeholder of RE project institutional

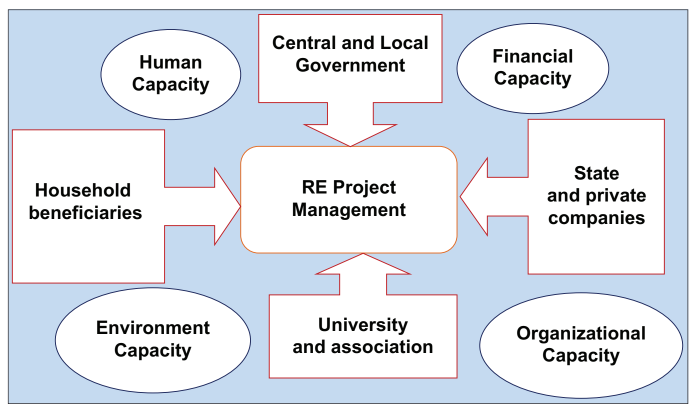


Figure 6: RE Energy project institutional model

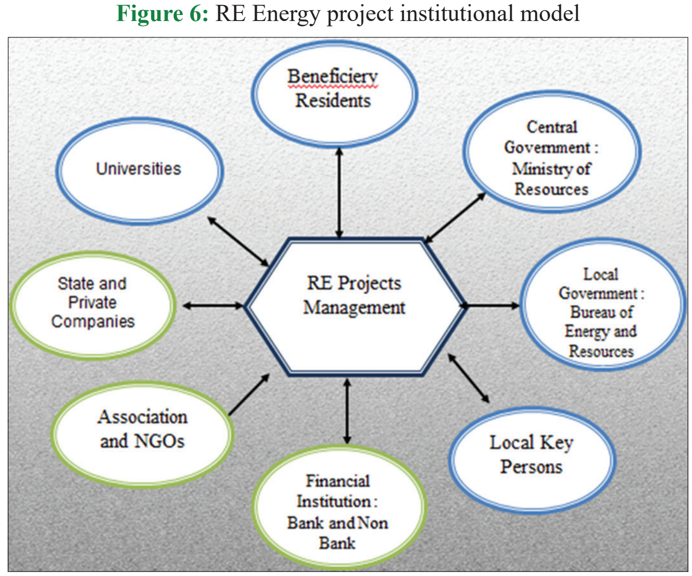
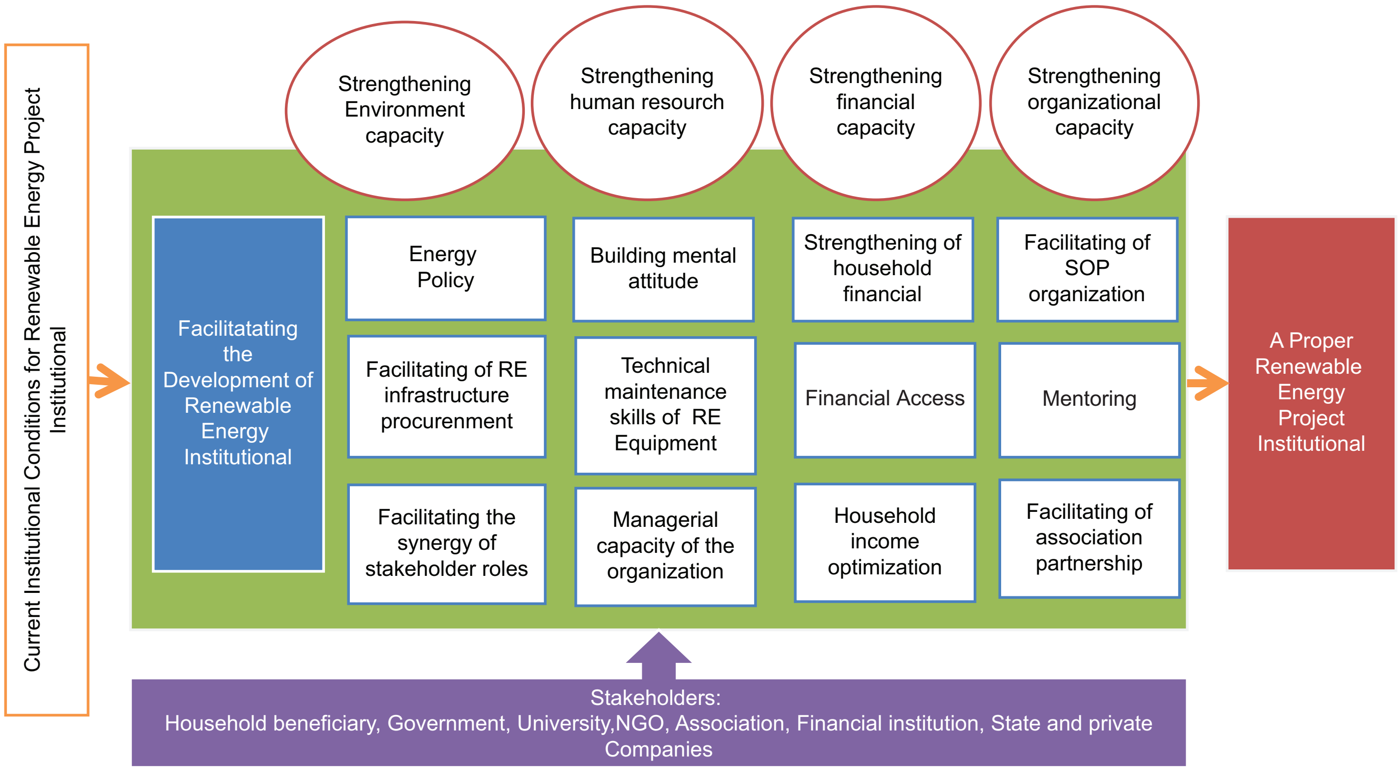


Figure 7: Operationalization flow of the RE project institutional



3. Optimizing people's income. Optimization is done by creating activities which can generate community's income.

4.2.6. Strengthening organizational capacity

Several strategic steps to strengthen organizational capacity are:

1. Preparation of organizational SOPs, awareness SOPs, financing SOPs, and various regulations and group agreements in the documents.
2. Regular group mentoring, by the facilitator
3. RE project management partnerships facilitating with association

In general, the operational flow of the institutional development model for RE project can be described in Figure 7 below:

5. CONCLUSION

The goal of this research was to gain insights in the challenges the renewable energy sector in Yogyakarta is facing, then designing institutional model to keep renewable energy projects sustainable. Based on the research findings and analysis on the institutional development of the RE Project in Yogyakarta, it can be concluded that:

1. Electricity projects utilizing renewable energy have failed to achieve the goals of poverty alleviation and rural electrification. Local government is only interested in installing the system rather than project sustainability. This can be explained by the fines imposed by the central government on regional governments if the electrification target is not achieved. Electricity provision should not be seen as an end goal, but as a means to reach higher development goals. Unfortunately ensuring project sustainability and community development are often not the main focus
2. Government initiated project have failed to reach the intended targets which makes the private sector even more reluctant to invest in renewable energy projects. To promote private sector investment clear regulatory framework and appropriate financing mechanisms are needed. To restore confidence in the sector, it is important for government initiate projects to have the intended impact so the private sector will see renewable energy projects can be profitable
3. The local community often does not have the financial means to pay for operation and maintenance and is not aware of the future costs. The operators, who are always people of the local community since most renewable energy project is located far from the city, did not receive proper training on how to operate and maintain the projects. There was no community involvement or capacity building too during the project. The local government only installed the system without any follow-up meetings with beneficiary residents. Project monitoring and evaluation were not carried out. The villagers did not receive any training on how to fix minor problems or information to fix them when big problems occurred
4. The institutional renewable energy projects in rural areas is a dimension that must be seen holistically, namely the institutional, financial, technological, social and environmental dimensions
5. The institutional RE project has a major stakeholder; beneficiary communities; central and local government, universities, associations; NGOs, local key people, state and private companies, and financial institutions. This institutional strengthening requires facilitation for the formation of a RE project manager.

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