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Comprehensive Study: Building Community- Operated Renewable Energy Enterprise a Sustainable Energy Project for Barangay Kimbutan, Dupax Del Sur, Nueva Vizcaya

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Abstract:
This study aimed to look into the socio-economic condition of the residents of Barangay Kimbutan in the Municipality of Dupax del Sur, province of Nueva Vizcaya after their homes were connected to the 7-kilowat (KW) Micro-hydropower plant built through the effort of the community in partnership with support organizations like SIBAT and the DOE. Data were gathered using actual visit to the barangay by the researcher wherein he interviewed the officials of the Barangay Council and certain municipal officials of Dupax Del Sur. To strengthen the information he obtained, he also gathered data from certain offices of the Local Government of the Municipality of Dupax del Sur. He also interviewed the head of the families in the barangay to gather information about the contribution of the micro-hydropower plant. This study found that the power plant was built in 2003 to generate affordable and adequate energy for lighting, agro-processing, livelihood activities, potable water and irrigation systems, and battery charging stations for the residents. The findings also disclosed that it has a positive improvement on the socio-economic development of the families in the barangay. But, the lack of technical and financial and entrepreneurial skills of the residents requires for an adoption of an off-grid energy technologies as well as training that will increase their entrepreneurial skill. The power generated from the plant sustained a minimum of 2.48 KW during summer and a maximum of 7KW during the rainy season. It is concluded that the 7-KW Micro-hydro power plant has positive impact on socio-economic status of the residents in Barangay Kimbutan. Thus, building a community-operated renewable energy enterprise can sustain the electricity need of rural communities. Based on thorough study and findings, the plant will continue to suffer due to lack of technical skill from the residents. Therefore, the government should provide enough energy-access plans and budgets for adoption of an off-grid energy technologies. Furthermore, residents should be taught entrepreneurial skill to increase the production and ensure stable income growth. Finally, local government should permit the current study to be used as a reference for further research about micro-hydropower system in the future.

Keywords: Micro Hydro, Documentary Analysis, Questionnaire.

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Introduction

The very interesting evolution of electrification in the Philippines has caught the attention of this researcher, and being a foreign student in this country, made him decide to undertake this study. Similarly, the importance of

electricity to human life that without access to it will hamper all goals towards economic and social development, and the fact that the country imports oil to have sufficient electricity yet the country can overcome economic difficulty strengthened his desire (Bhattacharyya and Palit 2012).

Electric industry in the Philippines was started in 1890 when the streets of the Municipality of Manila, including parks and other public places was provided with electric lighting originally illuminated by lamp oil. Thirteen years later, Manila Electric Railway and Light Company (MERALCO) was established which paved way for wider expansion of its services in Luzon, and becoming Filipino-owned (Patalinghug 2003). The electrification program of the country was beset with problems concerning financial, technical and managerial problems. This resulted in many barangays remained unserved with electricity particularly those areas in the distribution networks that are difficult for grid expansion due to geographical isolation. This problem remains a challenge for the government to maximize connections to households in remote, marginalized, and with low income. A meaningful solution was found by the government through the enactment of the Electric Power Industry Act. The law ensures the quality, reliability, security, and affordability of the supply of electric power (Reddy 2015). Water is a source of energy that is indigenous, renewable and can be harnessed to generate clean and non-polluting power (Sims, Rogner et al. 2003). Therefore, the abundance of water in the Philippines have prompted the researcher to select the micro-hydropower plant built for the Barangay Kimbutan of the Municipality of Dupax del Sur in the province of Nueva Vizcaya the subject of his study.

According the US Department of Energy, hydropower has advantages over other energy sources but faces unique environmental challenges. Hydropower systems are fueled by water (Kaunda, Kimambo et al. 2012). Aside from clean electricity, it creates reservoirs that offer a variety of recreational opportunities, notably fishing, swimming, and boating including water supply and flood control. Contrary to these benefits, fish populations can be impacted if fish cannot migrate upstream past impoundment (Hart, Johnson et al. 2002). Also, hydropower plants can be impacted by drought. When water is not available, the hydropower plants cannot produce electricity (Egré and Milewski 2002).

Moreover, hydropower facilities range in size from large power plants that supply many consumers with electricity to small and micro plants that individuals operate for their own energy needs or to sell power to utilities. Large hydropower facilities have a capacity of more than 30 megawatts, small hydropower as facilities that have a capacity of 100 kilowatts to 30 megawatts. A micro hydropower plant has a capacity of up to 100 kilowatts and can produce enough electricity for a home, farm, ranch, or village (Borota 2008).

Pico hydro is hydro power with a maximum electrical output of five kilowatts (5kW). Hydro power systems of this size benefit in terms of cost and simplicity from different approaches in the design, planning and installation than those which are applied to larger hydro power. Recent innovations in Pico-hydro technology have made it an economic source of power even in some of the world's poorest and most inaccessible places. It is also a versatile power source (Kapoor 2013). AC electricity can be produced enabling standard electrical appliances to be used. Common examples of devices which can be powered by Pico-hydro are light bulbs, radio and televisions. Normally, Pico-hydropower system is found at rural or hilly areas (Desai, Mukhopadhyay et al. 2014). Depletion of fossil fuel, inability to meet the rising demand of electricity and carbon emission are some drawbacks for an intensive search for alternative sources of energy (Razan, Islam et al. 2012). These are the reasons Bangladesh focused on the potential of micro-hydropower plant due to its numerous rivers and canals.

Furthermore, an impulse turbine is where the water pressure is transformed into kinetic energy before the water reaches the runner of the turbine. The energy hits the runner in a form of a high-speed jet. A turbine, where the water pressure applies a force on the face of the runner blade is called a reaction turbine. The Propeller turbine and the Kaplan turbine are reaction turbines (Abdalla, Alnaeem et al. 2016). Also, the intake of the flow is radial. After the inlet the flow makes a right angle turn and enters the runner in an axial direction. The difference between the Propeller and Kaplan turbines is that the Propeller turbine has fixed runner blades while the Kaplan turbine has adjustable runner blades. Propeller turbines can only be used on sites with a comparatively constant flow and head while Kaplan turbines are quite flexible (Karthik, Menasinkai et al. 2014).

Methodology

Research Design

Two methods of research were utilized in the conduct of this thesis, namely, descriptive and exploratory research methods. Descriptive research was chosen because the present study desired to obtain information relating to the demographic profile of the families residing at Barangay Kimbutan. Under this scheme, the survey in the form of a questionnaire, interview and observation were the tools used. The exploratory research helped the researcher to gather information regarding the contribution of micro-hydropower plant on changing the life habits and livelihood of the residents. The researcher made use also of existing literature to verify his observations and come up with preliminary ideas regarding the research problem. In as much as this study was involved with investigating

the capacity of the rural electrification program through micro-hydropower system that was implemented in Barangay Kimbutan as well as determining the ensuing changes in the life habits and livelihood brought about by the electrification of the barangay, the researcher employed a number of instruments for an effective data collection. The following sections will describe the data gathering techniques made by the researcher.

Data Gathering Techniques

- **Site Visit, Observation, and Interview**

  The researcher made an actual visit, twice, to Barangay Kimbutan in Dupax del Sur in the province of Nueva Viscaya to have a first-hand information about the power house and including the water source and transmission of the power to the houses. An unstructured but in-depth interview was done and conducted to the barangay folks to get their opinion about certain issues relative to the questions of the present study. The researcher, with the assistance of the barangay officials, took measurements of the river profile that included water flow and water flow velocity using the float method. He also measured the water head. Result of this activity were recorded by the researcher.

- **Documentary Analysis**

  Concerning the demographic profile of the barangay, the researcher sought data from the office of the Municipal Hall and Barangay Hall. With regards to the technical matters about the micro-hydropower system, the researcher gathered documents from the barangay office.

- **Questionnaire**

To answer question number 3, the researcher interviewed the residents, especially the barangay officials using a semi-structured questionnaire written in Filipino language, and shown below.

Research Locale

The study was conducted in Barangay Kimbutan. It is one of the 5 barangays of Dupax del Sur, the latter, a municipality of Nueva Vizcaya Province. Also shown in the figure are the surrounding provinces of Nueva vizcaya.

Analysis of Data

This chapter discussed the findings obtained from the primary instruments (interview, questionnaires, and site/field inspection and measurements) used in the study. It focused on presenting the gathered data in a meaningful way, and to facilitate discussions, images are also included.

On the demographic profile of Barangay Kimbutan

Barangay Kimbutan is a mountainous agricultural barangay of Dupax del Sur in the province of Nueva Vizcaya. It is located 27 kilometers from Malasin, the nearest town center. It can be reached via a three-hour ride from Bambang through a combination of an all-weather type and dirt road. During rainy season when the muddy road from Brgy. Belance is not passable by car, one had to trek for almost three hours to reach the barangay's economic center where the barangay hall, barangay clinic, day care center and elementary school, and different churches are located. Upon interview with the Barangay Chairperson disclosed that there are only 30 households with a total of 1,444 individuals, majority are men. The residents of Kimbutan belong to numerous ethnic groups (i.e.,Bugkalots, Kan-kanaeys, Ibalois, Kalanguyas, and Ilocanos).

Files retrieved from the municipal office of Dupax del Sur disclosed that Barangay Kimbutan, being located in an upland area, produce vegetable, herbs and spices. Kaingin is still practiced by the farmers for clearing the land although diesel-powered (motorized) grass cutter is available. Farmers use grab-hoe, bolo, and spade for planting crops. Nurturing the crops is by using chemical sprayer and water hose to irrigate the plants that draws water from the watershed through gravity flow. Barangay Kimbutan farmers also plant rice for their consumption and corn as animal feeds. Farmers use Diesel-powered agri-tractor (also known as kuliglig) while some carabao and araro for preparing and cultivating their land. Only one thresher is available in the whole barangay and is privately owned. A diesel-powered rice mill also operates in the sitio and is privately owned too.

In terms of education, most of the residents have only reached secondary level since colleges and universities are too far from the barangay, not to mention the relatively high cost of college education that the residents cannot afford. According to the Barangay Chairperson, an assessment by the local government showed that the barangay has the potential to be the center of agricultural production in the upland areas. In relation to this, the researcher found from the records of the Barangay that as early as 2001, the concept of Community-Based Renewable Energy Systems (CBRES) was introduced to them. A micro-hydro power plant project was introduced to the barangay officials and was built in 2003 to generate affordable and adequate energy for lighting, agro-processing, livelihood activities, potable water and irrigation systems, and battery charging stations of the residents. The Kimbutan

micro-hydro power plant project is owned, operated, managed and sustained by the Barangay Kimbutan Farmers Development Organization (BKFDO) in partnership with Sibol ng Agham at Teknolohiya (SIBAT), Barangay Kimbutan Council, and assistance from Department of Energy. Being the owner and at the same time the operator, it was them who formulated policies in terms of tariff collection, operation and maintenance, as well as organizational development.

On the set-up of the Barangay Kimbutan Micro-Hydropower Plant according to several aspects

According to the Barangay Chairperson, the construction of the Kimbutan's 7-kilowatt (KW) micro-hydropower plant (KMHP) was started in 2001 and was inaugurated in September 2004. In the beginning it was operated manually (Figure 3) because it had no electronic load controller (ELC). It was improved in 2013 and this time with the inclusion of an ELC (Figure 1). At present, it provides electricity for 30 households, the community clinic, day care center, and the barangay hall. It is situated in a hilly site where the force from the river's current is capable of generating significant amount of power. Some factors that were considered in building the plant are outlined as follows:

Figure 1: Water resource

The sustainability of the water source for the 7-kW Micro-hydropower plant (KMHP) project primarily depends on the watershed which at this point in time is one of the major activities of the Kimbutan upland farmers, as this will spell out a big difference for the sustainability of the plant in the long run. According to the Barangay Chairperson, they are primarily focused on rehabilitating the watershed catchment area which is critical to the operation of the KMHP power enterprise. One of the identified activities is the reforestation of the KMHP watershed catchment area with indigenous tree/agroforestry species near the Dangui creek (water source of KMHP), and 4,000 indigenous agro forestry species will be planted by the 30 households in their upland farm lots. The Barangay Chairperson stressed that giving priority to the rehabilitation of the watershed catchment will help the KMHP produce electricity in 24 hours of operation even during dry seasons where there is less rain during this part of the year.

Turbine-Generator system

The KMPH is owned by the Barangay Kimbutan Farmers Development Organization (BKFDO). It was built through self-help effort of the residents with the supervision of Sibol ng Agham at Teknolohiya, Incorporated (SIBAT). The following discussions provided details of the procedures followed by the residents to obtain data about head, water flow velocity, and river profile as their basis for determining the type of turbine (Pelton type) and rating of the generator used (Permanent Magnet Generator) for the KMHP.

Measurement of Head

The required data for Head was measured using a transparent water hose with two persons: Person Y matches water level in the tube to his eyes, and Person X keeps the water level at the other end of tube to the expected forebay surface level. Person Y then measured the height H1 at expected forebay surface using a graded rod or measuring stick. Person Y stays in the same place and measures B1, just as Person X has moved downhill and measures H2, This procedure was repeated until Person X reached the water tank (Figure 2)

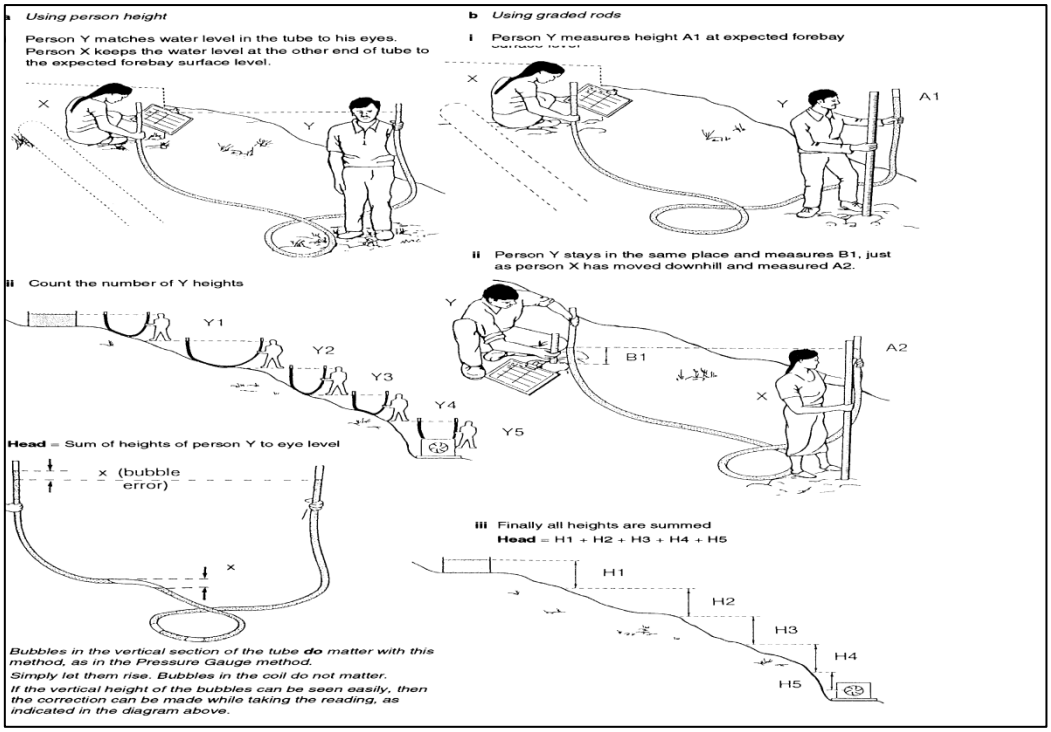

Figure 2. Water Tank

Water Velocity and Water Flow

The float method was used for this procedure. According to SIBAT, this method can be 100% total error especially in shallow and rocky streams. To validate this concept, the researcher conducted an experiment to measure the water flow and water velocity. They recommended to use a tree leaf as float material. With the assistance of a resident, he measured the time taken by the leaf to travel from its drop point to a distance of 4.8 meters using a stop watch. The researcher conducted 10 trials hence, recorded an average time of 30.853 seconds (Appendix B). In addition, he measured the cross-section area at both ends. This was necessary to determine the water velocity and water flow. The measured water velocity was 0.16 meter per second and the water flow was 16 liters per second.

Conclusion

This study found that the micro-hydro power plant built at Barangay Kimbutan, Dupax del Sur in the province of Nueva Vizcaya has a significant development on the life of the residents once their homes were connected to the plant. Having electric lights allow more time for both the parents and their children to perform their respective tasks: the parents to have enough time to be involved in household related activities including livelihood, social, and community developments activities even during night time. The children, on the other hand, can study their lessons at home with ease. For that matter, it can be concluded that building a community-operated renewable energy enterprise can sustain the electricity need of rural communities. Furthermore, this study comes to conclude that the 7-kilowatt micro-hydropower plant of Barangay Kimbutan has positive impact on socio-economic conditions of the residents.

Recommendations

- Due to lack of deeper technical and financial skills of the resident of Barangay Kimbutan, the plant will continue to suffer from a series of problems both, technical and non- technical problems. It is recommended that the local government which the barangay belongs, should provide enough energy-access plans and budgets to take into account the capacity development activities required for adoption of off grid energy technologies.
- It is also recommended that adult residents of the barangay should be taught entrepreneurial skills in order for them to learn how to increase their production which will ensure increase of income.
- Permit the current study to be used as reference by other researchers who intend to undertake research on micro- or pico-hydropower systems.

- In as much as there are also upland areas in the province of Tarlac with waterfalls such as those in the Municipality of Mayantoc, it is recommended that a communitybased micro-hydropower project be implemented to the municipality

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