Benefits and Costs Analysis of Micro Hydro Electric Power Generation of Enim Watershed Tanjung Tiga for Sustainable Development

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Abstract: The electricity demand of the population in Indonesia continues to increase over time, in line with the population growth. Currently, Indonesia highly demands on electrical energy which is mainly derived from fossil resources, while the availability of fossil endowment declines continuously. In 2009, the electricity demand in Indonesia exceeded the electricity supply, so the deficit is 15.22%. It is necessary to find alternative energy sources to meet the demand. Water is one of the alternative resources. If it is discerned from the potential of existing water resources, the availability of water resources in Indonesia is relatively abundant in the area, both located in upper and in the coastal watershed of cities. Mostly those located in the upper watersheds are not easily rechargeable by the electrical energy supported by State Electricity Company. Electrical energy can be supplied from the existing water resources in the watershed by using technology. Existing technology is used to build a source of electrical energy through micro hydro electric power generation that converts the water flow energy into electrical energy. Tanjung Tiga village is a village in the sub district of Semende Darat Ulu, Muara Enim Regency, South Sumatra Province, Indonesia. This village is one of the villages in Indonesia that has not been affordable electricity from the State Electricity Company. The flowing of Enim river is a part of Musi sub wathershed. In the past, people used kerosene of fossil for lighting. In 2003, people consumed electricity for television, computer other devices that used electrical energy. The villagers of Tanjung Tiga currently consume energy in the sources derived from micro hydro electric power generation, with a power of 200 watts per house. The economic value of water used for micro hidro electric power needs to be calculated, so that people understand how important protecting water resources to maintain sustainability with its economic value. Calculation of economic value is done in an effort to increase investment in the protection of natural water resources and as a basis for a policy. The policy can be used as the basis for ecological or environmental service payments on water resources and to optimally manage environmental condition. This paper aim to desk assess the value of micro hydro electric power generation respect to utilizing for a living in the areas. The paper encountered several questions: (i) How much the benefit and cost of water taken if the water used for electrical energy through micro hydro electric power generation, (ii) How long the micro hydro electric power generation can still be used to electricity demand of communities of Tanjung Tiga so that water resources in the village is still able to meet the demands of communities in the future. It is necessary to re-count on economic valuation of available water resources in Tanjung Tiga by using benefits and costs analyses. The results can cover the duration of micro hydro electric power and when it maintained properly, the people would use it longer.

Keywords: electricity demands, electricity supply, the village of Tanjung Tiga, micro hydro electric power generation, benefits and costs analysis

Introduction

Population growth over time have an impact on the need for water, land and housing. Likewise population growth affects the demand for energy. Each year, Indonesia's energy needs continue to grow is influenced by population growth. However the availability of energy resources in Indonesia is limited, especially energy resources derived from fossil energy sources, so that the availability of energy sources Indonesia cannot meet the needs of Indonesian.

State Electricity Company (SEC) to provide a source of electrical energy in Indonesia cannot meet the needs of the energy needed by the community, especially people who are at opposite ends of a hill or in upstream watersheds. In addition to the limited of electricity availability also happen in villages in the upstream watershed cannot be reached by the state electricity company.

In 2009, Indonesia experienced a supply deficit of electricity by 15.22%. Because of the need or demand for electricity is 30.943 mW, while net electricity supply only 26.235 mW [1]. The crisis has not been solved integrally by using a potential energy source especially in the area with sufficient water supply [2]. There are still many villages in Indonesia are not reached by the electricity, especially villages on the edge of the hill or village which is more than 1000 m above sea level. Such as Wanganaji village in Central Java province [3], the village of the sub-district Brumbung Kediri [2], rural sub-districts Meragun Nanga Taman, Sekadan Regency [4] Muntoi village Bolaang Mongondow sub-district, Karang Tengah, village Purbasari; Plakat Tinggi village Muara Enim regency of South Sumatra province [5], Tanjung Tiga village of this study, and many other villages in Indonesia that cannot be mentioned one by one. Because of the availability of fossil resources dwindling, and the average electricity sales in Sumatra 10.5% per year which is relatively higher than the Java-Bali, Kalimantan and Sulawesi, as in the final report [6], then to meet the electricity needs in the villages of alternative energy sources is used, one of the alternative energy source is a source of energy derived from water resources.

Tanjung Tiga village at Semende Darat sub-district, Muara Enim Regency islocated in the upper watershed of Enim is a sub watershed Musi in South Sumatra province. Desa Tanjung Tiga is also not reached by the illumination electricity from SEC, since SEC energy source for the electricity is using fossil energy sources [7]. Alternative energy sources derived from water resources are used to meet the needs of the energy source of electricity in the village. Because of the availability of water resources in the village is relatively abundant when viewed from the potential availability of water resources so that new and renewable energy resources can be utilized as a source of energy by hydroelectric power plants built on a small scale such as the micro hydroelectric power generation (MHPG). By using the technology, the energy flow of the water can be converted into electrical energy [8].

Since 2003, Tanjung Tiga village has established micro hydro power plant to illuminate the village, for other uses such as TVs, computers and other public facilities, the cost of the establishment of the government through the Ministry of Energy, department of Mining and Mineral Resources. Sources of energy from micro hydroelectric power generation (MHPG) impacted the Tanjung Tiga villagers both the socially, economically and environmentally [7] . In particular, the economic impact of MHPG in the village will be calculated and analyzed by using analysis of benefits and costs. What is the value of benefits and costs awarded or imposed on society from water use in the Enim watershed which is a sub watershed of Musi for micro-hydro power plants. How long the micro hydroelectric power generation can still operate as energy sources in the village. For that need is calculated using the value of the benefits and cost analysis of benefits and costs

Materials and Methods

Study Area

This research is conducted in the village of Tanjung Three, Semende Darat Ulu sub-districts, Muara Enim Regency, South Sumatera Province of Indonesia. The village is fed by water from the river Enim flowing from upstream rivers and boils into the Lematang river which is a sub-watershed of the Musi. At Tanjung Tiga village, the location can be seen in Figure 1.

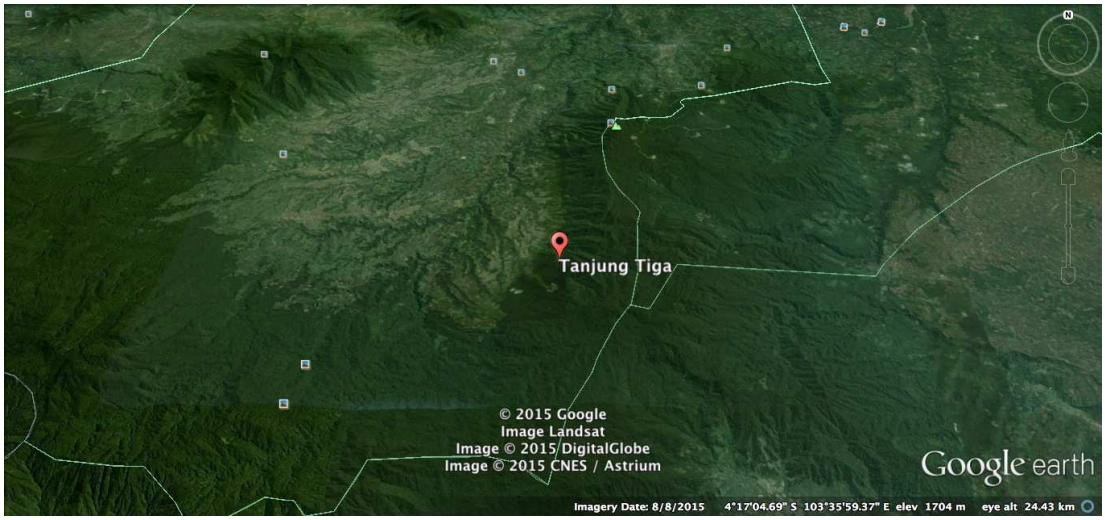

Fig. 1. Location of Tanjung Tiga Village (Sources: Geogle Earth)

Methods

This research was conducted by explanatory research and survey methods to determine the perceptions of rural people about the benefits of the micro hydroelectric power generation (MHPG) and to know the willingness to pay (WTP) from the community based on the discussion among community and village apparatus. The instrument used to determine the public perception is detailed questionnaires and interviews. List of questionnaire are: age, education, occupation, number of family members, income, knowledge relating to the use and maintenance of water and others. The questionnaire was given to a sample of rural communities and interviews addressed to the sub-district heads, village heads, village secretary, the head of the village consultative body, and village elders.

Result and Conclusion

Tanjung Tiga village is one of villages at Semende Darat Ulu sub-district, Muara Enim Regency in South Sumatera Province, Indonesia. This village is located at the height of 1200-1400 above sea level, with the coordinates south latitude and east longitude is (103.5895, -4.2588). The total population in 2010 is 1361 inhabitants and in 2014 is 1537 inhabitants. Average improvement in Tanjung Tiga villagers last four years was 3.1% and there are 214 homes for 338 families. Village wide is 37 km^2, with a population density of 39 inhabitants/km^2. Livelihood of these villagers are mostly coffee gardening, vegetables and farming. Only a few work as civil servants (PNS), 2 people as PNS, and 6 people as teacher, 12 people as self-employed, and only 1 as midwives and nurses respectively [7].
Education attainment of the villagers are mostly only a primary school education. Percentage of population education is starting to primary school, junior high school, senior high school and higher education/university in succession as follows, those are: 32.79%; 14.12%; 8.46%; and 1.10%. The rest were not finish from primary school and children age lower 5 by 43.53%.

Tanjung Tiga village is located in the upper Enim Enim which is a sub of Lematang watershed and Musi watershed is difficult to reach by the energy source of the state power company other than due to the limited availability of energy sources. If seen from the potential availability of abundant water in the village, eventually water in the upstream Enim watershed used for the production of light electric source micro-hydro, and in 2003, this village was built MHPG to meet the energy source for rural communities are well used for lighting , and for good entertainment such as television, and radio.

The water from the stream that is used for MHPG is waterfall which has 33 meters height and distance of the turbine engine to community house is around 700 meters. To operate the engine turbine MHPG, it has formed the board of management. The number of administrators who manage consist of 4 people as the chairman in charge, treasurer of the record intake and expenditure of the operational costs turbine engines and two people in charge of engine operator as well as the cleaning machine or dirt in the water tank. The board elected by the villager discussion with working tenure for one year. When his term is already one year, the board extended according to the results of the deliberations in the village or if they have to replace the old board must train and assist the new board until a new board can perform their duties. The caretaker will paid from a small portion of money paid dues as payment for their

work. The amount of dues for villagers who use the energy source of micro hydro power plant and the salary for the board also determined on the basis of community meetings. Every home that uses electrical energy source in this village will be charged IDR 12,000 per month. Money from this fee go into the village cash, and will be used for pay the salaries of administrators, routine maintenance of turbine engines and major repairs in case of damage, and to villages charity such as voluntary work that requires purchasing inventory tool, helping families affected disaster.
The cost of cash coming into the village from the use of water in the Enim river for MHPG calculated using analysis of benefits and costs. And cost benefit analysis is used to calculate the value of the benefit received by the villagers in the presence of water energy resources and the costs incurred if the energy source is used instead of using micro-hydro power plants.

According to [9], is the assessment activities related to the development of the concept and methodology to estimate the value of goods and services. Assessment of the ecosystem, including the conservation and utilization of water for human welfare is a very complex job covers a range of factors related to social values. Value that occurs based on the interaction between humans as subjects and objects ([10],[11]).
The magnitude of the economic value of water resources is influenced by several factors: (a) the availability of water reserves, (b) the type of water use, (c) the impact caused by its users (d) the location. Calculating economic value can be used as a reference in the planning of water resources management and the determination of levies or taxes on the use of water [12].

The budget to build micro hydroelectric power generation at around IDR 350,178,000 in 2003. The calculations used benefit and cost analysis to value of the use of water for energy sources generated the willingness to pay by the Tanjung Tiga community untill 12 years and 6 months, netto is IDR 398,916,000 if rate of interest is not included in the calculation. If community used kerosene for lighting, the cost is IDR 735,288,000. The costs incurred to buy kerosene 84.32%, more expensive than the costs incurred uses micro hydroelectric power generation. If the interest rate included in the calculation is 7%, the refund period which gives a value greater than zero occurred in the year to 27 is IDR 5,371,537 after deducting the cost of construction of micro hydroelectric power generation. The ratio of benefits and costs of water is used to micro hydro power plant is given sustainable.

The results can cover the duration of micro hydroelectric power generation and when it maintained properly, the people would use it longer.

Conclusion

- The amount of benefits for rural communities Tanjung Enim of water in Enim watersheds utilized as a source of electrical energy through micro hydroelectric power generation is IDR 336,372,000 for 12 years and 6 months.
- The amount of costs to be incurred villagers as a source of electrical energy used is not derived from micro hydroelectric power generation is IDR 735,288,000.
- Water from Enim watershed utilized for micro hydroelectric power generation in the village Tanjung Tiga can still be used for the next few years until the source of electrical energy from the energy source is replaced by a state electricity company.

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