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Techno - socio - economic Assessment of Pico Hydropower Installations in the Northern Region of Thailand

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Abstract. This work assesses technical, economic, environmental, and social impacts of pico- hydropower applications in the Northern region of Thailand. Six existing picohydropower projects were selected based on different characteristics including system capacity, size of user, technical set up and site geography. Despite the evaluation of the technical aspects, that collected data on-site, the main source of data was obtained via questionaire survey. In addition to the economic and social analyses, the outcome parameters derived from the increase of any incomes that the villagers might gain from the use of electricity generated by the pico-hydro systems is proposed to reflect the socio-economic feasibility of the project.

Keywords: Pico hydropower, techno-socio-economic, Northern Thailand

1. Introduction

The majority of the energy consumed in Thailand is derived from fossil fuels, which are rapidly depleting. Moreover, fossil fuels negatively affect the environment. One way to reach a sustainable future is to choose alternative energy sources. Renewable energy may serve as an effective solution. While many types of renewable energy attract worldwide attention, the use of hydropower may serve a unique purpose in Northern Thailand. Normally, pico-hydro power systems are found in rural or hilly areas [1]-[5]. Based on the guidebook, most projects should utilize hilly and mountainous locations to site suitable projects [6]-[7]. From a report on electrification technologies by the World Bank Energy Unit [8], of the options currently available for off-grid generation, pico-hydro is likely to have the lowest cost (see Fig. 1). For mini-grid power, it is likely that only biogas plants provide more cost-effective electricity than micro hydro [9]. Northern Thailand is filled with mountains and high level. In areas with high rainfall, there is plenty of water. The watershed of the North River flows into the lower area of the Lower Central Plain, where the water is used all year. Moreover, there are some potential upstream watershed areas which can be used as energy sources for producing electricity by constructing hydropower plants such as waterfalls and dams or reservoirs. Even though some sites at upstream watersheds in Thailand are suitable for the multipurpose dam construction and installation with mini-hydropower plants. Unfortunately, most of them are located in a natural resource conservation zone where hydropower plants are in charge of the Ministry of Natural Resources and Environment with the risk of environmental impacts [10]. Fortunately, pico-hydropower plant is a more appropriate economic development strategy in mixed farming areas and conservation zones in such watersheds with lessened environmental impacts [11].

This research will assess impacts of established pico-hydropower projects in the Northern region of Thailand, including technical analysis, economic analysis, environmental analysis, and social analysis. Study

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survey sites were selected from projects using different characteristics such as size of capacity, size of end user, technical logical set-up and geological location.

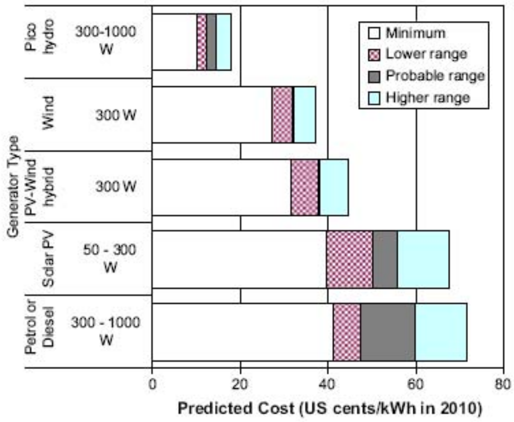

Fig.1: Predicted cost for generator type in 2010.

2. Methodology

The aim of this study is to assess already established pico-hydro projects. The methodology to identify and assess the potential sites of pico-hydropower projects can be classified into four criteria: technical, financial, environmental and social impacts. Technical analysis composes of site selection and technical problems evaluation. Economic analysis includes calculations of total investment cost and benefit of the engineering feasible projects. To assess the environmental impact, CO_2 emission from transmission line and diesel engine are compared with that of pico-hydropower system. Social impact is evaluated using the villagers' response to questionnaires regarding the quality of life when usage of electricity from the already established pico-hydropower project.

2.1. Technical analysis

Technical analysis concerns the problems that can occur while producing electricity, flow obstacles such as loose leaves and branches as well as the uncontrollable flow rate of water. Furthermore, the reliability of the system, the quality of power, durability of equipment and technical maintenance should be considered. According to the site geography mostly hilly area, the equipment reliability is of importance, because it is difficult to access for maintenances.

2.2. Economic analysis

For economic aspects, villagers' increased income and reduced expenditures before and after the projects established are assessed. In terms of the increased income, total cost of project and amount of electricity produced by the pico-hydro system are compared with the income gained from the extra jobs using electricity in the night. On the other hand, the reduced expense is a balance of the cost of fuel that used for the diesel engine in the past and the pico-hydro system's maintenance cost. For total system feasibility evaluation, a comparison of total outcomes and the total cost of the project are conducted. Additionally, the overall benefit of the project can be reflected by the ratio of the outcomes and total project investment cost.

2.3. Environmental analysis

In this study CO_2 emission reduction is the main concern for environmental impact. This can be obtained from the amount of fuel used to generate electricity in the past.

2.4. Social analysis

For social impacts, the villagers' quality of life before and after access to the project is compared.

3. Results and Discussions

The results from questionnaire survey of the established pico-hydro projects reveal interesting information as follows. The result from survey for 5 villages in the Northern region of Thailand showed in Fig.2 separates the source of electricity in 3 groups- only hydropower, hydropower mixed with PEA and PEA only. The technical analysis shows (see Fig.3) that most of respondents experienced the unstable power problem and limit of power from the project. Hence more power is needed. Further investigation on the unstable power issue can give a detail regarding the cause. That is the unstable power problem comes from tree branches in the water that hit turbines and made turbines stop running. To avoid this situation, villagers add more number of trash sieves to prevent trash hit the blades. However, there are 3 villages that use a system like a stand-alone system and another use a hybrid system (pico-hydropower and electricity from the PEA's distribution line). There are some reasons that they still use the electricity from pico-hydropower which are the unreliability of distribution line such as dropping of voltage drop and more often blackout.

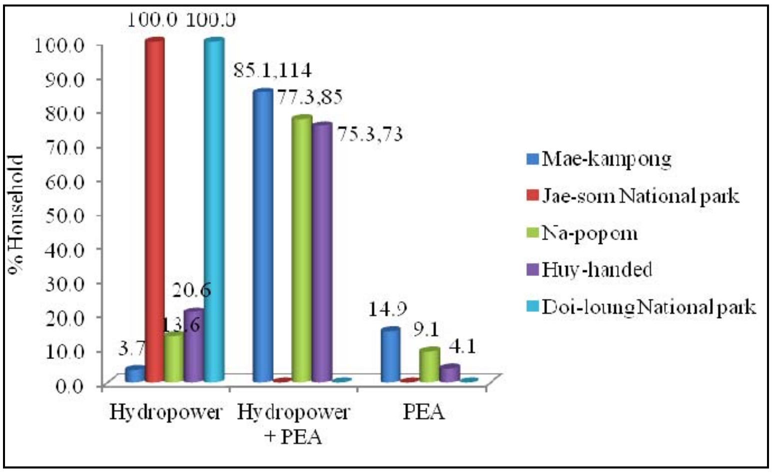

Fig. 2: Different source of electricity used

In terms of economics, some villagers used light from 4 am – 6 am to cut dry banana leafs and used light during 6 pm – 10 pm to boil tea leaves and pack it and made about 2,500 baht per month per household. In addition, diesel generators were used to generate electricity in the past for which fuel cost was high. So that pico-hydro project can obviously reduce the fuel cost. In part of production cost shows fig. 4. When comparing electricity prices with PEA it is lower. According to the unit cost of PEA until 36 units to 100 units the energy cost is 2.18 baht/unit and service charge for 8.19 baht/month, but high cost at Doi-loung national park because of the lower installed capacity. For the environmental aspect, (see Fig.3) the first thing that can be seen is CO_2 saving. Pico-hydropower has no needs for fuel and combustion process to generate electricity. Therefore, it is absolutely zero CO_2 emission. The amount of CO_2 saving can be figured from the amount of fuel used in the past which is 0.56 kg CO_2 saving per 1 kW from transmission line and 20.25 kg CO_2 saving per 1 kW from diesel engine. No impact with environmental while construction and operation. Finally, in terms of social impact it can be seen that most of people can receive more news and new technology from watching television longer. Moreover, children can use light for reading books in night time. This leads to that people have no need to move to other places because they can use electricity to do any activities they want.

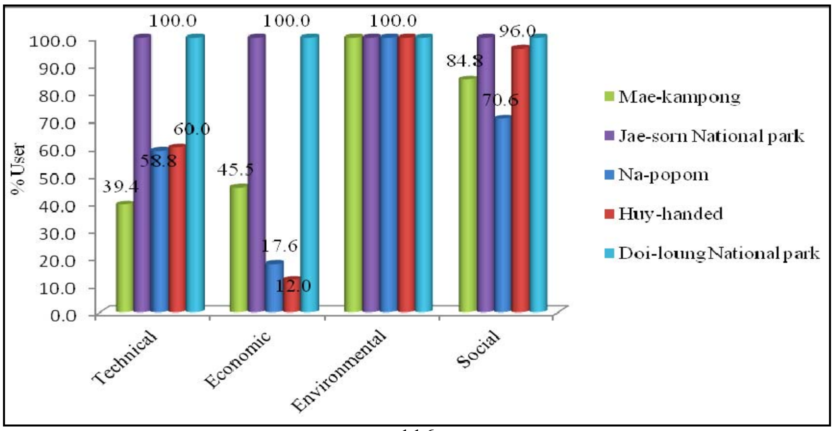

Fig. 3: The satisfaction for each village in the system

4. Conclusions

Most of technical problems that found from survey collected are about plants shutting down from over load of villagers' electricity consumption. Moreover the problems from natural occurrences such as tree branches near plants hit the penstocks in the rainy seasoning. Especially at Jae-sorn National park in rainy season the turbine would be destroyed by sand erosion despite of already protected. In terms of economic the results is clear at Mae-kampong village because most of them have the tea gardens and coffee gardens, so they can use electricity at night time to boil tea leaves and pack it for sale.

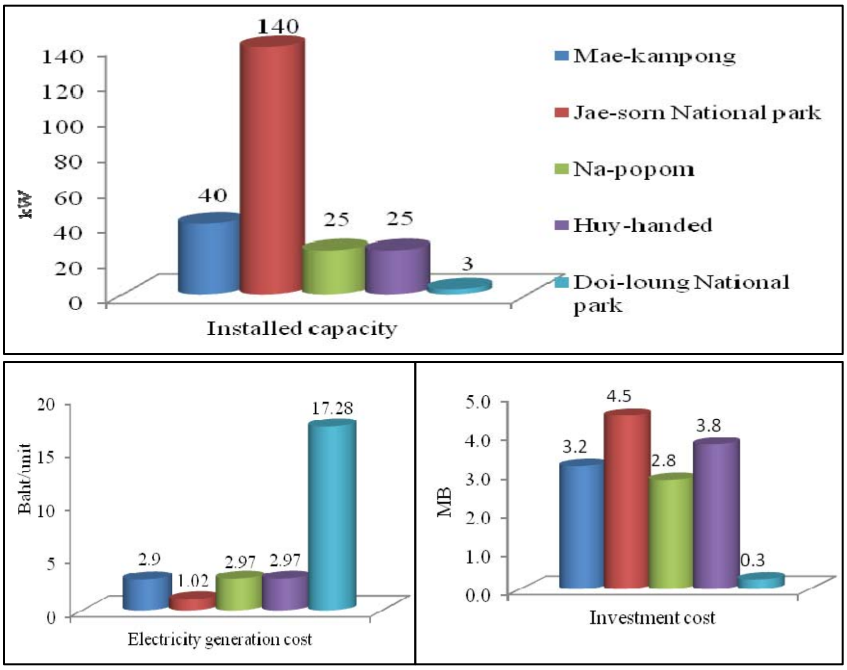

Fig. 4: The production cost for each village in the system

In addition, they have home stays to service tourists which increase incomes. Socially, second range is high percentage of users (Fig.3) are satisfaction in the hydropower. According to the light at night time the villager can take time for exchanging ideas with each other, the children read books longer time and old people understood more Thai language learnt from watching TV. Environmental impacts from the answers respond for pico-hydropower project are no pollutions with villages while construction or operated the system. The amount of water back the dam is still enough for farming, also quality of water both in front of and back the dam is still good it can see the nature around dam be fresh.

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