Mini-Grid Concept for Rural Electrification in Thailand

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Abstract: The objectives of the project, entitled “Mini-Grid Concept for Rural Electrification in Thailand” are: (i) to study the efficiency of a Mini-Grid system, under actual conditions, jointly implemented by the Public Work Department (PWD) and the School of Renewable Energy Technology (SERT) in Naresuan University, (ii) to evaluate the suitability of Mini-Grid concept for rural application in terms of the technical and economic factors and, (iii) to study the energy management strategies needed to support the Mini-Grid concept to ensure system sustainability. In this paper only overview of the study results are presents.

Key Words: Mini-Grid, Rural electrification, Technical, Economic, Energy management strategies.

1 Introduction

The result of the reviewing the experience of PV rural electrification project shows that in many instances, rural electrification using photovoltaic fails due mainly to project administration and financial reasons. This is especially so if the project is heavily subsidized with no financial participation from the users or when no electricity service fee is levied. Rural electrification organization still lack of knowledge and understating in PV characteristic properly enough. A mistake of PV components selection is cause of PV system working not properly following specification, negative effect of user feeling to PV technology and it difficult to expand PV usage in the future. However, there are some interesting case studies in India and the Philippines when Mini-Grid Concept for rural are as have been proven successful and the experiences from these examples could be applied in Thailand. A common factor shared by many of these successful projects can be attributed to the strong governmental support given to the commercialization of Mini-Grid systems and the existence of a free market environment where competition ensures the sustainability of these projects.

2 Case Study of Mini-Grid

2.1 Ban Pank Praratchatan Village

Ban Pang Praratchatang (BPP) is a hill-tribe village as part of Doi Tung Development Royal Project (DTDRP) in the Mae Fah Luang district of the Chiang Rai province located in the northern part of Thailand. This area encompasses a total of 27 village communities of different ethnic minority groups and hill-tribes; Akha, Lahu, Tai Yai and ethnic Chinese immigrants continue to perform ancient rituals and celebrate traditional folk festivals throughout the year. With many aspects of their culture and way of life well preserved, these ethnic communities are of immense ethnographic interest and importance to the study and preservation of the rich cultural heritage of Asia. Access to education, vocational training and a range of employment opportunities this enables ethnic minority groups in the project area to preserve their heritage whilst progressing into modernity [1].

They earn a steady income and have become self-sufficient. As a result, there has been a substantial improvement in their standard of living and quality of life. The village communities have managed to achieve a level of sustainable development that fosters the harmonious co-existence of indigenous culture and the surrounding natural environment.

The BPP case study is especially suitable to show the trend of electricity demand in small hill-tribe villages with the potential to expand to big village in the future. Present and future electricity demands have been observed by SERT staff [2]. For the evaluation of RES, only the present electricity demand will be taken into consideration. BPP has about 22 households with 140 inhabitants. Income currently comes from work as employees under the DTDRP. In 1999, the village was electrified by the Public Work Division (PWD) with 5 strings of BCS with a total installed capacity of 750 Wp (150Wp/string). In 2002, PWD installed 3,000Wp PV standalone systems (PVS) [2].

2.2 Ban Pank Sumnakngan Village

Ban Pang Sumnakngan (BPS) has similar village conditions, it far from BPP about 4 km. The difference is the size of village as small as BPP. Only 5 households with 11 inhabitants, this classify very newly village. The PVS are installed in the same time with BPP (Fig.1).

Fig.1 The PV-diesel hybrid Mini-Grid system at SERT, the PV stand alone Mini-Grid system at BPP and BPS as use for this study

3 Technical Study

With regards to the technical study on the PV-diesel hybrid Mini-Grid system (PVHS) installed at the Energy Park (see Fig.1), results have indicated proper supply variable load profile in case of that demands is not larger than hybrid system generation capacity. All hybrid components working properly for control quality and quantity of electricity generation. The long-term data analysis indicated yearly energy consumption of this system
is 2,619 kWh, average daily energy consumption (Econsume) is 7.2 kWh and the energy produced by the diesel generator over the year is 227 kWh. Fig. 2 presents a brief overview of the analysis of energy balance of the PVHS. The daily average energy produced by PV (Epv) is 8.7 kWh, the daily average energy produced by diesel generator (Ediesel) is 0.6 kWh. The daily average PV energy use (Epvuse) is 6.9 kWh. The data shows the energy produced by PV is about 79%.

![Fig.2 Balance of energy of the PVHS at SERT](image)

The performance ratio (PR) of 66.6% indicates that on an annual base under the prevailing conditions 33.4% of the nominal energy is not available for load supply, even if the station is continuously used day by day. This potential of the system is comparably high to the potential range of PVHS. All performance indicator values from the monitor are high. One reason is the high uniformity of the irradiation profile throughout the year and the system testing making under controllable load conditions. Hence, the system performance results are probably higher than actual loads.

The technical problem during testing is synchronization of electricity from diesel generator frequently hybrid system fail form this reason and start/stop control as almost problem is a hardware parts. Automatic hybrid system still need local operator for some event.

### 4 Economic Study

In this section, the economic performance study results of the PVHS at BPP are presented. The results presented are based on life cycle cost analysis (LCC) and cost of electricity (COE). The difference assumptions of the economic parameter are considered. An analysis of the LCC of the different system assumption is explained in Fig. 3.

![Fig.3 LCC analysis of different assumption](image)

This figure shows that the LCC of case 1 - 3 the PV array and power conditioning represents a basic share in the energy levelized cost. In this case power conditioning share is about 20% of the LCC and has a COE of 0.60 - 0.55 €/kWh, caused by the high unit cost of (imported components from Europe). In case 4 - 7 cost of power conditioning is reduced by 27% by using local components, a COE of 0.52 - 0.47 €/kWh. These results match the obtained values from actual PV system cost analysis of Thailand country [2]. Comparing the PVHS COE, the result shows that PVHS has a more attractive COE than PVS and grid extension (GE).

### 5 Energy Management Strategies

Energy Management System is one part of this research. There are many methods such as Conventional Control Strategies (CCS), Predictive Control Strategies (PCS) and Variable Energy Price Strategies (VEPS) all of them have different advantage, disadvantage and suitable of application. Difficult to define the best one EMS for hybrid system in rural area of Thailand because still lack of experience and information. In this research only CCS have to test because limited of equipments and instruments for the experiments. The result shows that CCS is working quite successfully but still difficult to apply for real rural site. Because of CCS need local people as have enough knowledge to operate or supervise the hybrid system. CCS is still more relate with manual supervise. For other methods as PCS and VEPS, it still in the lab scale and need time to develop both hardware and software before apply used in the real site.

### 6 Conclusions

In the case of Thailand where the Mini-Grid system for rural areas has just been implemented, the result obtained to-date, based on the technical, economic and social aspects of the study, is still inconclusive. At this stage, it is too early to determine the success of the project because the system has operated only for a short time and the users are not very familiar with the system. Presently, one of sample villages already connects to the public grid. However, villager capable to manage their electricity used in the villages quite successfully.

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**References**
