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Electricity Generation from Producer Gas in Cambodia: Implementation

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ABSTRACT

The implementation is discussed of a 30kW electricity generation plant using diesel fuel in combination with biomass in Svay Sronos village, Roka Ar commune, Kampong Cham province, Cambodia. The main purpose of the project was to provide a source of affordable electricity to a rural area without access to the electricity grid. The survey results of locations for a favorable site were considered. The electricity infrastructure for 125 households was constructed and detailed. Cost and income values were estimated.

Key words: gasifier, Cambodia, dual fuel, diesel fuel reduction

INTRODUCTION

In 2007, the Department of Alternative Energy Development and Efficiency (DEDE) in the Ministry of Energy established a project on electricity generation in a rural area of Cambodia, as a pilot project to improve the standard of living of people in that area (Ayuwat, 2008). The area with availability of electricity in Cambodia has been reported to be less than 30% (Ayuwat, 2008). Furthermore, the main source of electricity in areas without access to the electricity grid is still diesel generators, which are relatively expensive to run (Ayuwat, 2008). However, Cambodia has high potential to use biomass as an energy source (Abe *et al*., 2007) and a substitution of the diesel fuel used in a diesel generator with producer gas from the biomass gasification process (Kjellström et al., 1986) may prove to be helpful in reducing the cost of operation. The Energy and Environmental Engineering Center (EEEC), Faculty of Engineering, Kasetsart University has been responsible for this project, which has been funded by the Ministry of Energy of Thailand and accommodated by the Ministry of Industry, Mines and Energy (MIME) of Cambodia. The first author has been a project leader.

The main purpose of this project was to improve the living quality of people in a rural area of Cambodia, who had yet to have access to the electricity grid or even electricity generation, by providing them with a 30kW diesel generator with a gasifier. The gasifier was added to reduce the consumption of diesel fuel, through substitution with a combination of producer gas and diesel fuel. This aspect of the project has been discussed in detail in Ayuwat and Siwakosit (2008).

The implementation of this project has involved the selection of a suitable demonstration area, along with determining the availability of

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biomass that could be utilized in the area, the availability of local technicians for maintenance of the diesel engine electrical generator, and most importantly, the willingness and readiness of the local people to accept the cost of having electricity.

MATERIALS AND METHODS

The process of project implementation involved the selection of a favorable site, based on the highest total "score" of the following issues: biomass availability, transportation, suitability, attitude and technical readiness, and sustainability of electricity generation. This was to involve thorough survey trips of EEEC staff to four Cambodian communities. Then, after the selection of site, a 30 kW diesel generator would be purchased locally and a building to house the electrical generating system would be constructed. A downdraft gasifier capable of generating producer gas to supply an engine would be designed and constructed in Thailand (Ayuwat and Siwakosit, 2008), and sent to the demonstration site for installation and commission. Transmission lines and electrical meters to about 125 households would be built in the area and connected to the generator. Trial runs for 100 h would be performed. Afterward, the small power plant would be handed over to the community through MIME, as a gesture of friendship to Cambodia.

RESULTS AND DISCUSSION

The Ministry of Industry, Mines and Energy (MIME) of Cambodia offered four possible demonstration sites for EEEC to choose from: Chan Tung village, An Cham Commune, Ankor Knong village, and Roka Ar Commune (Svay Sronos village). The survey results and weighted scores were analyzed to produce Table 1.

Table 1 Summary of site surveys in Cambodia.

Item	Full score	Chan Tung	An Cham	Ankor Knong	Roka Ar (Svay Sronos)
1. Biomass availability					
1.1 Biomass sources	Yes/No	Yes	Yes	Yes	Yes
1.2 Amount of biomass	5	3	3	1	5
2. Transportation					
2.1 Distance and road condition from biomass source to power plant	5	5	5	3	5
2.2 Distance and road condition from biomass source to diesel fuel station	5	4	3	2	3
3. Suitability of community					
3.1 Number of households	5	3	3	0	5
3.2 Electricity demand	5	5	3	3	5
3.3 Inclusion in the future electricity grid in Cambodia	5	5	5	5	5
4. Attitude and technical readiness					
4.1 Community leader awareness	5	5	4	1	5
4.2 Community commitment	5	1	2	1	5
4.3 Availability of technical staff	5	1	1	1	5
5. Sustainability of electricity generation	20	15	5	0	20
Total score	65	47	34	17	63

Based on the results, Svay Sronos village was chosen as the most favorable site. Figure 1 shows a map of the village in the Roka Ar commune. A diesel generator, "Denyo", with a capacity of 60 kVA, 60 Hz and a power factor of 0.8, was acquired locally from Phnom Pen, the capital of Cambodia (Figure 2). All other necessary equipment, for example power meters, multi meters and an air flow meter, were brought to the site by EEEC.

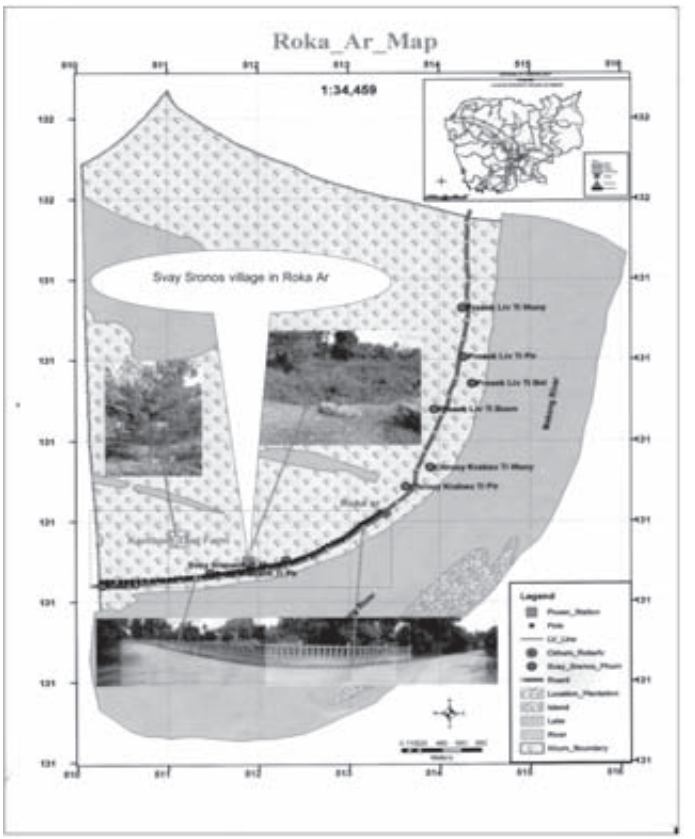

Figure 1 Svay Sronos map.

Figure 2 "Denyo" diesel generator.

A gasifier (Ayuwat and Siwakosit, 2008) was constructed and brought to the project site from Thailand (Figure 3). A building was constructed at the village inside the Buddhist temple compound (Figure 4). Figure 5 shows the layout of the electrical transmission lines (low voltage, 3-phase system) from the power plant to 125 households in the village. The total electrical demand was expected to be about 30 kW, with a total length of the lines of 1,820 m, using 57 posts.

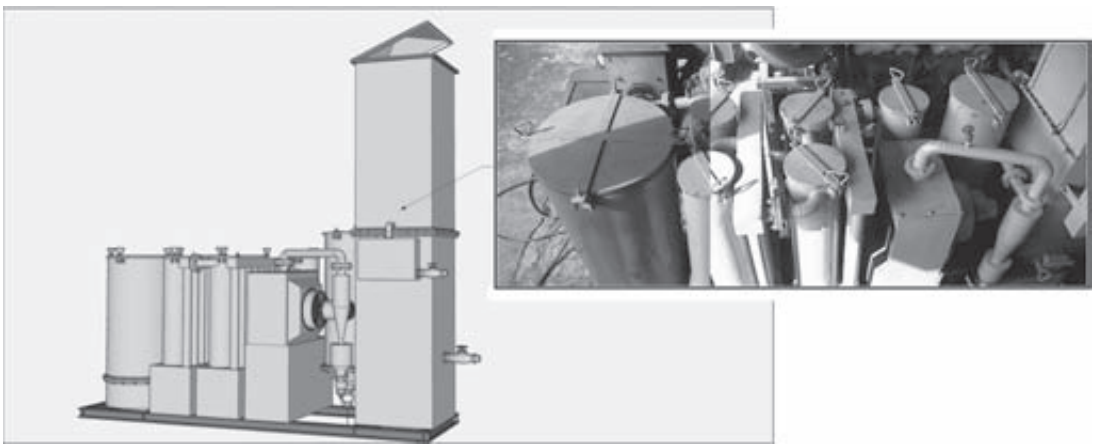

Figure 3 The gasifier constructed for this project.

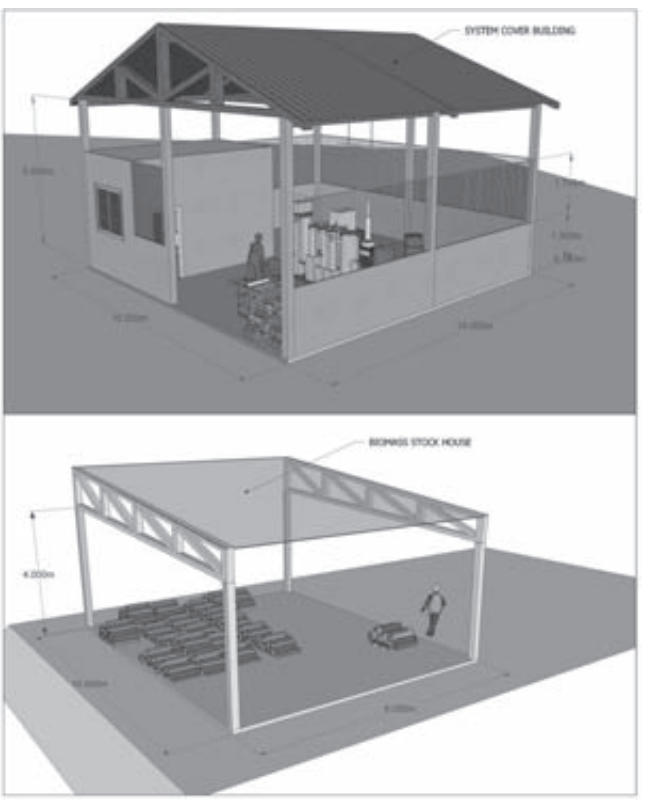

Figure 4 "Power plant" building and biomass storage.

The type of line constructed was "THWA", single aluminum core with PVC insulators and cross sectional areas of 50 mm^2 and 35 mm^2. The maximum current to each household was limited to 3 A.

A diesel generator was used with producer gas from a gasifier and diesel fuel consumption was reduced by 70.16% (Ayuwat and Siwakosit, 2008). The power plant layout can be seen in Figure 6.

After 100 hours of trial runs, the villagers were pleased with the results and committed to pay for the cost of electricity (Figure 7). Table 2 shows the income that was expected to be obtained from the project. The total capital cost of the project was 2,914,900 baht (in 2007). The annual cost of the project is summanzed in Table 3.

The difference between the annual income and annual cost was 285,123 baht. The break-even period was estimated to be about 10.22 years (without interest).

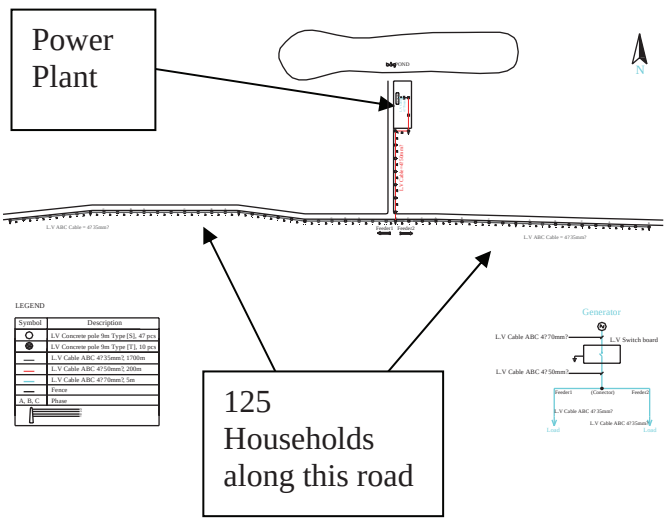

Figure 5 Layout of transmission lines from the power plant to 125 households.

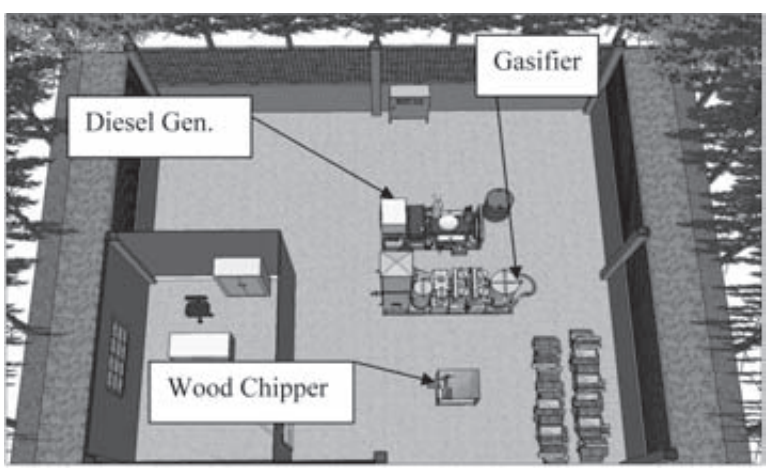

Figure 6 Power Plant Layout.

Figure 7 Trial runs to 125 households.

Table 2 Estimation of annual income of the power plant.

Items	Units	Income
Electricity cost	baht/kW-H	10
Annual cost	baht/year	540,000
Electrical units	kW-H/month	4,500
Number of 12V batteries to charge	pieces/month	4,500
Battery charging cost	baht/piece	5
Annual battery charging cost	baht/year	270,000
Total income	baht/year	810,000

Table 3 Estimation of annual cost.

Items	Cost (Baht)
Staff annual salaries	43,800
Diesel fuel annual cost	273,750
Biomass annual cost	167,535
Annual maintenance cost	39,792
Total annual cost	524,877

CONCLUSIONS

A project to generate 30 kW of electricity in the Svay Sronos village in the Kampong Cham province of Cambodia was implemented successfully by EEEC, with 125 households being supplied with electricity at a cost of about 10 baht per unit. It is hoped that MIME in Cambodia will use this pilot project as a model to provide electricity to rural areas that do not currently have access to the electricity grid.

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