AJARCDE
ASIAN JOURNAL OF APPLIED RESEARCH FOR COMMUNITY DEVELOPMENT AND EMPOWERMENT

Journal home page: http://ajarcde.safe-network.org ISSN 2581-0405

Economic Analysis of Applying Biomass Stove to Produce Hot Water Serving Child Development Center: The Case Study of Omkoi District, Chiangmai, Thailand

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ARTICLE INFO

Article History:
Received: July 29, 2019
Final Revision: November 24, 2019
Available Online: December 22, 2019

KEYWORDS

techno-economic analysis, hot water, hybrid biomass stove, Child Development Center

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A B S T R A C T

This research aims to perform the techno-economic feasibility of the applied hybrid biomass stove to produce hot water for serving Child Development Center (CDC) in Omkoi District, Chiang Mai, Thailand. The hot water generated from the stove could help to decrease LPG usage and enhance household economics. Many activities in CDC (i.e., children showering during the winter season, cloth washing, and utensils cleaning among others) require hot water to prevent the contamination of harmful germs which could cause many diseases such as diarrhea in young children. Presently, Asian Development College for Community Economy and Technology, Chiang Mai Rajabhat University (adiCET) has installed the hybrid stove to the in Omkoi district. The biomass stove could generate 90 °C hot water using plant/agriculture waste as the fuel. However, the economical parameters (i.e., Payback Period, Net Present Value and Internal Rate of Return) could strengthen the technology. The results from this study could be used as one of the guidelines for policymakers to design the appropriate programs for enhancing the CDC using the waste-to-energy concept.

1. INTRODUCTION

There are various technics to simultaneously generate bioenergy as and reduce wasted biomass in communities. Biomass stove is one of the promising tools to convert biomass such as agricultural and forestry wastes to energy for not only replacing LPG (Liquefied Petroleum GAS) for cooking but also to generating hot water. By installing heat exchanger to the stack of the stove, the heat from the combustions can convert the supplied water to hot water for further utilization. The survey reported that there are 67 tons of wood chips and agricultural wastes produced daily in Omkoi district. These materials could be used as the feedstock for the biomass stove and thermochemically converted to the energy with of 850 MJ/d.[1]

Child Development Center (CDC), typically, needs water for serving many activities including but are not limited to children bathing, laundering, and cleaning milk bottles and utensils. Those activities are necessary for preventing the children from many diseases such as dermatosis and diarrhea. Besides, weather in Omkoi district is generally cold all year round (i.e. average temperature during morning is between 15-20 °C). Therefore, hot water generation is essential for enhancing the hygienic of the student in CDC. Regarding to the aforementioned statements, hybrid biomass stove is suitable waste-to-energy tool for serving CDC. In addition, the biomass stove could simultaneously help reducing electricity cost for heater and reducing the accumulated wasted biomass in the community. This research aims to perform the techno-economic of applying biomass stove to the CDC in Omkoi sub-district, Chiang Mai, Thailand.

2. MATERIALS AND METHODS

The research was performed with respect to the flow chart as presented in Figure 1.

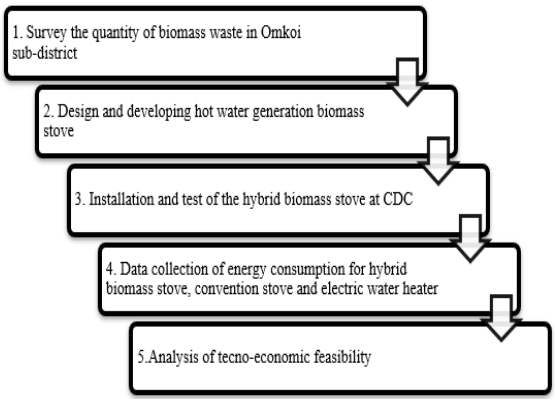

Figure 1**.** Schematic of the research methodology

https://doi.org/10.29165/ajarcde.v3i1.16

The Hybrid biomass stove was designed and installed with heat exchanger on the top of the stove's stack. The heat exchanger is a device used to transfer thermal energy between two or more fluids, which are at different temperatures. Thus, the heat exchanger recovered the exhausted heat with more 400 ° C from the biomass burning in the chamber to producing hot water around 65 - 90 °C with 100 – 180 liters per hour by utilizing 30 Kilograms plant/agriculture waste as the fuel.

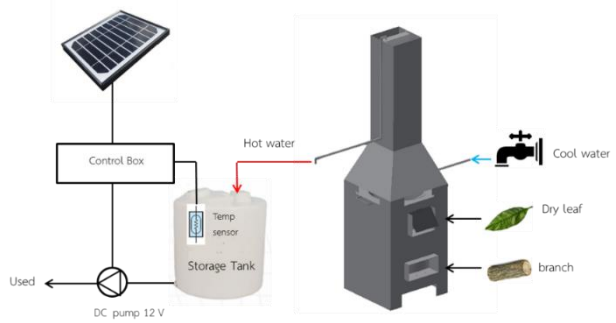

Figure 2. Hybrid biomass stove system

The combustion efficiency of biomass stove is higher than that of the conventional stove with respect to the appropriate air to fuel ratio. Thus, lower air pollution and smoke were generated. Thus, it could definitely help mitigating the air pollution. The boundary of the manuscript is to evaluate the tecno-economic analysis of the CDC contains 35 Childs. The assumptions of economic analysis are presented below.

Net present value (NPV), Internal rate of return (IRR) and Pay Back Period (PBP) were analyzed for Techno-economic assessment (TEA) [2] within conditions like

The project lifetime is 3 years.

The core inflation rate is 0.6 %. [3]

Expense are from the cost reducing from replacing LPG and electricity

The required hot water at least 100 liters per day with temperature at 65 °C

The economic analyzing of the 2 scenarios were performed:

Using biomass stove to replace conventional stove using LPG

Using biomass stove to replace conventional stove using electric water heater

3. RESULT AND DISCUSSION

The results from the field survey indicated that the monthly LPG consumption for producing hot water was 30 kg. The 4,500-watts electrical heater was used as a supplemental hot water generation unit for 2 hours/day. The appropriate biomass stove serving this CDC is the stove with the capacity of 30 kg of biomass feeding.

The calculated energy content of fuel (net calorific value) indicated that 30 kg of wood chips contain the energy of 479.70 MJ which could replace LPG of 9.73 kg and 133.25 kWh for electricity [1].

The Economical parameters as NPV, IRR and PBP were analysed as the Table 2.

Table 2. Result of economic analysis for scenario 1

Hot water source	Expense cost: LPG (baht)	Economical parameters		
		NPV	IRR	PBP
Convention stove using LPG	11,400	835	8%	2.58

The result of Convention stove replacement was NPV of 835 THB, IRR was 8% and PBP was 2 years and 5 months.

Table 1. Result of economic analysis for scenario 2

Hot water source	Expense cost: electricity (baht)	Economical parameters		
		NPV	IRR	PBP
Electric water heater	8,712	5,850	24%	1.97

And the result of Electric water heater was NPV of 5,850 THB, IRR was 24% and PBP was 2 years.

When considering of Economical parameters i.e NPV, IRR and PBP, Using the hybrid biomass stove to produce hot water replacing the conventional energy are feasible for both scenarios with respect to the positive NPV. However, the scenario 2 has higher IRR and lower PBP. Thus, based on the assumptions, the biomass stove should be used for producing hot water replacing electric water heater.

4. CONCLUSION

According to the study, it can be concluded that Hybrid biomass stove could potentially replace convention stove using LPG and electrical water heater for producing hot water serving CDC. Applying hybrid biomass stove could help decreasing LPG usage and enhance the household economics and it can be considered as the solution for managing the wasted biomass from agricultural activities of the communities which is normally burnt during the land preparation. The open burning of the agricultural residues is one of the important sources of the annual severe air pollution in the northern Thailand. Thus, by converting the waste biomass to hot water could simultaneously enhance the energy security of the community and mitigate the environmental issues.

AKNOWLEDGEMENT

Thanks to NRCT for the research funding. The authors also thank Omkoi village and Omkoi Sub-district administrative organization for the collaboration.

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