Journal of Engineering and Applied Sciences 13 (9): 2647-2650, 2018
ISSN: 1816-949X

Energy Consumption and GHG Emission Assessment for Supporting a Community Energy Plan: A Study Based on the Rural Household Energy Survey

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Abstract: The community energy plan development is one of the projects promoted by the Ministry of Energy, Thai government in 2006 with the purpose to self-reliance on the energy, the use of alternative energy and energy conservation of a rural community. The energy potential is also one of the main factors made to the success of community energy plan, however, the characteristics of energy consumption of each local community area is different. The aim of this research were thus to study characteristics of rural household energy consumption and to estimate emission of greenhouse gases in residential sector. Moreover, the appropriate energy policy to suit in rural community was investigated. The study of household energy consumption based finding on the collecting information in Huaiwai village, Kanchanaburi Province.The results showed that Bann Huaiwai village consumed a total energy of 179.78 toe (tonne of oil equivalent). The energy related GHG emission. The GHG emissions from the rural household energy consumption by energy types was approximately 593.9 tCO_2-eq. Three energy measures proposed for the studied rural community which is corresponded with the national energy policy.

Key words: Community energy, energy consumption, GHG emission, planning, rural household, community

INTRODUCTION

Traditionally, residential energyconsumption for rural community level has been managed by individual regional utilities. Therefore, there is recently the trend to create plans to directly manage the energy for the rural community (Dennis and Parker, 2009). In Thailand, the Ministry of Energy of Thai government has promoted the local energy planning project in 2006 to support the participation of local in energy management for community and household level. The community energy plan is expected policy to help local people manage energy community with efficiency, self-reliance on the energy, increasing the use of alternative energy, decreasing Greenhouse Gas (GHG) emissions as well as to help reduce the fossil fuels usage (EPPO., 2015; Kriyapak, 2009; Phoochinda, 2012). Recently, many studies have been investigated the community energy planning of sub district level in many provinces in Thailand such as Surin, Nakhon Ratchasima, Roi Et, Ubon Ratchathani and Khon Kaen. The results showed that the energy consumption in community was reduced, self-production of energy for own community and more careful and efficient energy usage. The energy planning was thus a successful tools to provide sufficient a good quality of energy for a rural community (Chaiyaphan, 2011; Phoochinda, 2012) and to support the rural people and communities to take part as the energy planner. The community energy plan project was set and expanded continuously covering in every province as well. However, the characteristics of residential energy consumption in various rural are different from social behavior and lifestyle changes (Tonooka *et al*., 2006; Yaungket and Tetsuo, 2013). The aim of this study were thus to understand the characteristics of residential energy consumption in rural households and to estimate greenhouse gas emissions. Moreover, to provide the guideline for data supporting to local energy planning to regional energy coordination office 4, Huaiwai village, Nong Pla Lai subdistrict, Nong Prue District, Kanchanaburi province was thus selected rural community for data collection in this study which was the one of community to join in this project as well. In addition, the appropriate energy policy measures to suit in local community of energy saving were also investigated.

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MATERIALS AND METHODS

Study area: Huaiwai village, Nong Pla Lai subdistrict, Nong Prue District, Kanchanaburi province is selected area in this study which locates on the west part of Thailand. The total of 212 households in Huaiwai village (MICT., 2010).

The data collecting: This research is focused on the residential energy consumption of rural households which including fuel consumption and electricity consumption. The study of residential energy consumption based finding on the collecting data by sample survey on 212 households in the Huaiwai village and then analyzed energy consumption and GHG emissions from households in Huaiwai village.

Quantification of energy consumption: To evaluate the energy consumption was calculated in term of toe (tonne of oil equivalent) unit which multiplied the each fuel type consumed by conversion factor (1 toe = 42 GJ) (DEDEMOE., 2013). In terms of rural household energy consumption, this study considering fuel type (or energy type) and energy end-use activity (Zheng *et al*., 2014).

Quantification of GHG emission: GHG emissions were accounted from fossil fuel combustion in household living. The greenhouse gas emissions could calculate by multiplying the energy consumption with emission factors from the database of Thailand greenhouse gas management organization (Apiratikul, 2015).

RESULTS AND DISCUSSION

Characteristics of residential energy consumption: Figure 1 shows the characteristics of rural household energy consumption by energy type in Huaiwai village. It was found that its characteristic of energy consumption is assessed by six fuel types, i.e., diesel, gasoline, LPG, charcoal, electricity and fuel wood. The total rural household energy consumption was 179. 78 toe. Of this amount commercial energy was 157.03 toe (diesel, gasoline, LPG and electricity) and traditional renewable energy (fuel wood and charcoal) was 22.75 toe.

Diesel oil consumption was the greatest proportion 48.2% (86.7 toe) of the total residential energy consumption, followed by gasoline, charcoal, electricity, LPG and wood shared 22.5, 11.6, 10.9, 5.8 and 1.0%, respectively.

Residential energy consumption depended: mainly on diesel, gasoline, charcoal and electricity, respectively. This is because the fuel mainly uses in vehicles for transportation (Fig. 2).

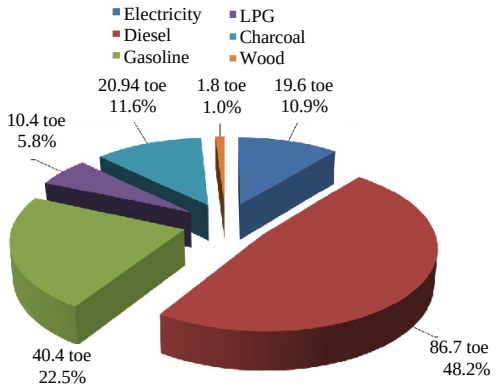

Fig. 1: The characteristics of residential energy consumption by fuel type in Huaiwai village

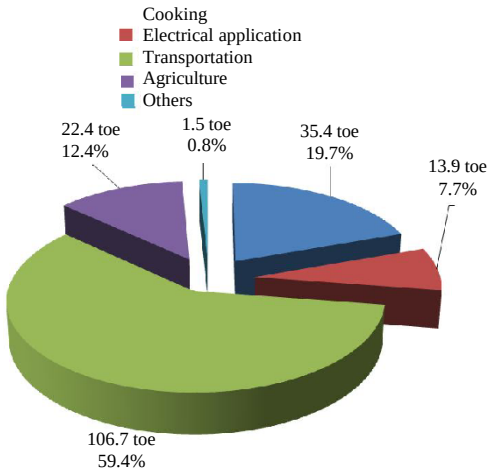

Fig. 2: The characteristics of residential energy consumption by end-use activity types in Huaiwai village

The energy consumption of Huaiwai households by end-use activity types are shown in Fig. 2. Energy end use activities are divided into five categories, transportation, cooking, agricultural, electrical appliances and others. Transportation showed the greatest proportion 59. 4% of total energy consumption in amount to 106.7 toe, followed by cooking, agricultural, electrical appliances and others in shared 19.7, 12.4, 7.7 and 0.8%, respectively.

Moreover, the results showed that almost all fossil fuel energy consumption in the transportation sector is from petroleum-based fuels (diesel and gasoline) due to motorcycles are the primary mode of transport in rural area 212 consumers of gasoline fuel and pick up, trucks as the major consumers of diesel fuel.

However, a high the petroleum products, i.e., diesel, gasoline and electricity consumed led to a high the GHG

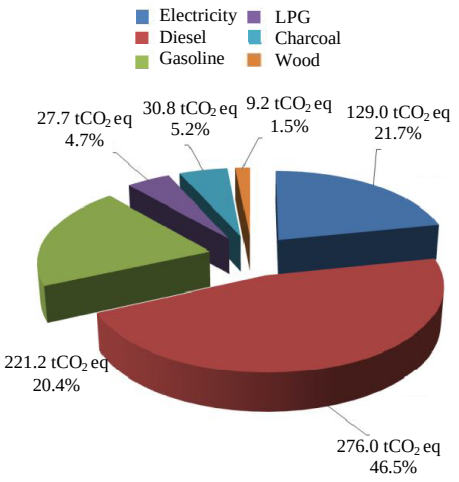

Fig. 3: GHG emissions from residential energy consumption

emission as shown in Fig. 3. These emissions of CO_2 equivalent increased with increasing energy consumed of Huaiwai households.

GHG emission: When considering the GHG emission from the rural household energy consumption it is shown in Fig. 3. The emission from Huaiwai households by energy types was 593.9 tCO_2-eq. The commercial energy was mainly high CO_2 emission, especially diesel oil which was shared 46% of total GHG emission from residential energy consumption in Huaiwai. Therefore, possible policy measures were proposed in this study to driving force the energy conservation and reduce GHG emission in community.

Energy measure guideline for community: To manage energy community with efficiency, increasing the use of alternative energy, reducing the fossil fuels usage and finally reduced Green House Gas (GHG) emission. There was three energy measures relevant diesel, gasoline and electricity were proposed to the guideline for this rural household.

Fuel consumption: Biofuels (ethanol and biodiesel) are an important alternate energy source. The use of biofuel is thus promoted the Alternative Energy Development Plan (AEDP) by Thai government's policy which supports to help partly substituted fossil fuel for transportation, reducing oil imported. Presently, Renewable and alternative energy development plan for calls for 25% usage within 10 years (AEDP 2012-2021) and has targeted to increase ethanol consumption to 9.0 million liters/day by the year 2021 (DAEDEME., 2011). In order to implement the mentioned plan, the government had plan to cease using regular gasoline octane 91 and to support the extension of E20 (20% ethanol, 80%gasoline)service stations on the demand side.

For diesel policy, B5 biodiesel (5% biodiesel, 95% diesel) was compulsory requirements on the demand side. In addition, policy managed on compulsory of B5 palm oil production and increase the blending share up to 20% in diesel as well.

Electricity consumption: In this study, electricity was more consumed by home appliances. Electricity policy could be provide the energy efficiency labeling on equipment-electrical appliances which established by the Minimum Energy Performance Standards (MEPS). It had then decreased electricity consumed of around 6-35% (EPPO., 2015).

CONCLUSION

This study presents a comprehensive overview of energy consumption in residential sector in Huaiwai village, Kanchanaburi Province is selected for studying in 2010 based on local energy plan dataset of 212 surveyed households. Energy consumption is also estimated by six types of energy and five types of end-use activity. The characteristics of energy consumption in studied rural area are identified as diesel is the first consumed fuel, followed by gasoline is a secondary fuel. Next, charcoal, electricity, LPG and wood, respectively. In addition, the emission from Huaiwai households by energy types was 593. 9 tCO_2-eq. The results could thus help evaluated the effectiveness of community energy policy.

ACKNOWLEDGEMENTS

The researcher express their sincere appreciation to Suan Sunandha Rajabhat University, Pilot Plant Development and Training Institute, King Mongkut's University of Technology, Thonburi and Regional Energy Coordination Office 4, Thailand for support of this research.

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