

## CHAPTER IV

### CONCLUSIONS AND DISCUSSIONS

In this chapter, the main results of my dissertation research on “*Household energy utilization in communities at different levels of urbanization in Northeast Thailand: does biomass energy continue to play an important role as rural communities become more urbanized?*” are discussed in terms of their relevance to the objectives of the research and a number of conclusions and recommendations that arise from these are presented.

#### 4.1. Discussion

The research was designed to achieve four main objectives:

1. To compare utilization of energy (biomass and non-biomass) among communities at different levels of urbanization in terms of absolute quantity, relative share and functional roles.
2. To identify factors causing the differences in utilization of energy (biomass and non-biomass) among households in communities at different levels of urbanization.
3. To elucidate the causes for the differences in utilization of energy (biomass and non-biomass) among communities at different levels of urbanization.
4. To identify the sources of biomass energy utilized by households in the communities at different level of urbanization and to examine how selected households meet their needs for biomass energy.

Key findings relating to each of these objectives will now be reviewed:

#### ***4.1.1 Differences in energy consumption among communities in terms of absolute quantity, relative share and functional roles.***

This study found that biomass energy still plays an important role as a source of energy for household consumption in communities at all levels of urbanization, although there are variations in its quantities, relative shares, and roles among the communities, and overall, use of biomass energy declines with urbanization. In the rural community, biomass energy accounted for 47.1 % of the total energy consumed by an average household. Its share declined to 35.4 % in the suburban community, and to only 9.9 % in the urban community. The average amount of biomass energy used per household declined from 21,691 MJ/hh/yr in the rural community to 18,557 MJ/hh/yr in the suburban community to only 5,433 MJ/hh/yr in the urban community.

It was also found that different types of energy are utilized to serve different purposes or roles. Both firewood and charcoal were used primarily for living (i.e., cooking) and to a small extent for home industry, while LPG and electricity were used entirely for living and gasoline was mostly used for transportation with a smaller amount for agriculture. The roles of different types of energy were the same in the rural, suburban and urban communities, but, their relative shares of the total household energy mix varied among the three communities. The share of biomass energy was highest for the rural community and declined with greater urbanization, while the opposite trend was observed for LPG and electricity.

#### ***4.1.2 Factors influencing household energy consumption***

Of the four factors examined, i.e., occupation, size of household, area of land and income level, occupation had the greatest influence on both the amount and the type of energy used. Households with regular income and those owning businesses used much less biomass than the irregular income and the agricultural households. This could be explained by the differences in life style of households with different occupations as was reported in other studies (Senelwa and Sims, 1999; Nansaior et al., 2006; Bravo et al., 2008).

Even though they have easy access to abundant supplies of biomass energy, some households in the three communities mostly use electricity and LPG for living

activities because they lack the time collect wood due to their occupations. Lifestyle changes also have an important influence on biomass use. Households with an urban type lifestyle, even if located in the rural village, consume less of biomass energy but more of non-biomass, whereas rural lifestyle type households use more biomass energy than non biomass energy, even if living in suburban or urban communities.

Households with higher income, which tends to be associated with occupation, were also found to use more energy than those with lower income but the share represented by biomass energy declined with increasing income level. Thus, well-off people used relatively less biomass energy than poor people. Other studies also found that household income affected the form of energy consumed (Mahapatra and Mitchell, 1999; Senelwa and Sims; 1999; Dube, 2003; Ouedraogo, 2006)

The employees of government offices and private enterprises who have regular income and the business owner tended not only to have higher incomes but also to follow a more urbanized life style whereas agricultural households have lower incomes and also have a rural lifestyle that is compatible with greater use of biomass energy.

Although Thai society has been changing so that many women must go to work to earn more money to support their families so they do not have much time for cooking, and often decide buy food or shift from using biomass to LPG to save time, this study found many reasons why even urban people still used biomass. These reasons include: 1) Suitability of energy types for the purpose of usage. Thus, charcoal is still preferred for cooking, especially grilling food. It is difficult to use firewood or LPG for this purpose. Cooking barbeque or the sticky beef soup or grilling beef or chicken requires use of charcoal because it is easy to control the small fire. This is a major reason that firewood and charcoal still play important roles in the three communities. Charcoal is also preferred because it gives a good taste and good smell to food. 2) Economic cost factors. Biomass energy is generally cheaper than LPG or electricity. Most rural households can collect firewood for free from their own land. Even if households have to purchase fire wood or charcoal it is inexpensive. 3) Availability of source of energy. In rural and suburban villages, firewood is abundant and it can be easily be collected from nearby paddy fields, upland fields, communities forest, or housing plots. 4) Lifestyle and cultural preferences. People in Isan have a

long tradition of using biomass energy. Using firewood is a part of the community life of the Northeast. 5) Safety factors. The villagers believe that firewood and charcoal are safer to use than LPG, which is stored in a pressurized container that, if poorly maintained may explode.

#### ***4.1.3 Causes for the differences in utilization of energy among communities.***

The three communities differ systematically in the use of energy by their households. The percentage of households using biomass energy are 98 %, 89 %, and 78% in the rural, suburban and urban communities, respectively but the quantities and shares used decline markedly with urbanization.

These differences in average household consumption of biomass energy among the rural, suburban and urban communities to a large extent were found to be a reflection of their differences in percentages of households with different occupations. While almost all of the households in the rural community were engaged in agriculture, three quarters of the households in the urban community were regular income households or owners of businesses. The patterns of energy use in each of these communities, thus, reflected the lifestyle of people as determined by their occupations. The composition of occupations in the suburban community was in-between, but agricultural households and irregular income households were in the majority. Since these two groups of households continue to follow a rural life style they mostly use biomass as the main source of energy for their living, which could explain why the energy use pattern of the suburban community was not much different from that of the rural community.

#### ***4.1.4 The sources of biomass energy utilized by households in the communities at different level of urbanization***

Acquisition of biomass by the individual households: All of the households in three communities have easy access to all types of modern energy (e.g., electricity, LPG, gasoline, and diesel) but they differ with regard to obtaining biomass energy. Most urban people lack sufficient land to grow their own fuelwood so they either have to collect it from public land or unused lots of neighbors or purchase firewood and charcoal from rural producers at a cheap price. Rural and suburban villagers can either grow fuelwood on their own land or, if their houses are located close to the forest, are able to freely collect dead branches there but are prohibited by law from cutting down living forest trees.

Most agricultural households, who are the dominant group in the rural village, collected biomass fuel only from their own land, whereas households with irregular incomes, who are most numerous in the suburban village, obtained firewood from several different sources, including public land, their own land, or both public land and their own land.

At present, rural and suburban households do not appear to encounter any serious difficulties in obtaining enough biomass energy to meet their needs. Since the amount of firewood consumed by a typical rural household in a year could be supplied by the annual growth increment of 68 Eucalyptus trees, which can be grown on an area of only 180 m<sup>2</sup>, scarcity of land for growing trees is unlikely to be a limiting factor on the sustainable production of biomass energy in the future. The case studies of selected households who rely heavily in biomass energy showed that some farmers are already willing to integrate trees into their agroecosystems to produce not only fuelwood but also food and other needed materials. Most of case study households have grown multi-purpose trees, and some of these, they leave the forest trees, and some households then they have self-sufficiency in fuelwood production. The estimated area occupied by trees varied from 0.02 to 0.4 ha, though the minimum requirement is only 0.02 ha. Because people are concerned about competition for nutrients and light between food crops and trees, selection of trees that minimize competition is very important. Some fast growing trees such as Eucalyptus, are an

interesting choice for households that only have small area of land, since they can be planted on the paddy bunds or the property boundary. If households do not have sufficient land to produce their own wood can still readily obtain needed biomass from public land, or from land of kinsfolk and neighbors.

## **4.2. Conclusions**

In conclusion, the results of this study show that biomass energy is still widely used by households in communities at all levels of urbanization, with more than 90 % of all households in the sample making some use of biomass energy. Even in the urban community, more than three-quarters of all households still use biomass energy on at least some occasions. Rural and suburban households are still mostly dependent on biomass energy for their living activities. Although the share of biomass energy in the total energy mix of urban households is considerably less than for the rural and suburban communities, the absolute quantity used per capita is still substantial. Thus, contrary to conventional assumptions about the displacement of biomass energy by modern energy in the course of economic development and urbanization, in Northeast Thailand biomass energy continues to play an important role in the energy economies of households, not just in rural villages but also in suburban communities, and even, to some extent, in urban communities as well.

It does not appear likely that availability of land to grow trees is an important limiting factor on the ability of most rural and suburban villagers to sustainably meet their biomass energy needs in the long-term. The case studies provide some confirmation of this conclusion by showing that rural households already plant trees and manage them to provide biomass energy to meet their own needs, while some of them even have a surplus that can be supplied to their relatives or neighbors. They also indicate that many people prefer to continue using cheap and readily available biomass energy for their living activities rather than switching to LPG. Moreover, if their production of biofuels is sufficient to meet household needs, they can save the money they have to expend to purchase energy used for cooking fuel. This can amount to more than 37.00 US\$/ year, according to statistical data on average

household expenditures on energy of 3.18 US\$/month in Kalasin, Yasothon, Chaiyaphum and Nakorn Rajasima (TRF, 2008)

### **4.3. Recommendations**

Since in Northeast Thailand biomass energy will continue for the foreseeable future to play an important role in the energy economies of many households, it is recommended that, in developing alternative energy sources to cope with the diminishing supply and high price of fossil fuel, the government should pay more attention to biomass as a source of energy household consumption. Further research, however, is needed to investigate whether the supply of biomass for household uses can be managed in a sustainable manner without further destruction of the forest.

Biomass utilization by local people must be achieved in an efficient and sustainable manner. This study has shown that biomass available from rural sources can be sufficient to supply the quantities needed, and it appears possible to develop strategies for sustainable management of household sources of fuelwood.

One potentially useful strategy for promoting production of biomass energy for household use might be to encourage farmers to incorporate more multipurpose trees into their agroecosystems so they can earn additional money by selling timber, fruit and other products while the residual waste can be used for their household fuel and even sold for cash to urban households unable to produce their own fuel.

Sharing and learning between farmer to farmer, or farmer to farmer's group is one possible way to help disseminate the *self-sufficient concept* of fuelwood production.