CHAPTER I
INTRODUCTION

Developing renewable energy sources, including biomass energy, has become a major policy concern of governments everywhere in the world. This heightened interest has been stimulated by the recognition that the diminishing supply of oil is becoming a very serious problem worldwide. Some economists have predicted that the world's oil reserves will begin to decline within 10 years (Aleklett, 2004; Laherrere, 2005; Kerr, 2007) and will be used up by 2050 (Laherrere, 2005). The consequence is a continuous increase in crude oil prices, which have risen from under US$25 per barrel before September 2003 to US$60 per barrel in August 2005 before reaching a high of US$147 a barrel in July 2008. Although the price subsequently dropped to below US$50 per barrel for a short time because of a small decrease in demand due to the global economic crisis, it has begun to rise again as the economy has shown signs of revival (Anonymous, 2010). It is expected that oil prices will rise rapidly as demand again comes to exceed supply. High oil prices have greatly affected developing countries, especially in Asia, because most of these countries are heavily dependent on oil imports (Bentley, 2002; Roubini and Setser, 2004; IEA, 2007). Thus, all countries have given high priority to strategies for mitigating this problem that include energy conservation measures, finding new technologies for seeking crude oil, and developing new and renewable energy sources (Senelwa and Sims, 1999; Omer, 2005; McKay, 2006; Prasertsan and Sajjakulnukit, 2006; REN21, 2006; Wald, 2007; REN21, 2008). It is widely anticipated that renewable energy sources such as hydro-electric, geothermal, wind, solar and biomass energy, will play an ever more important role in the future (BP p.l.c., 2008).

Biomass is viewed as an especially promising type of renewable energy because it is cheap, abundant and widely available. It has high potential as a fuel source and is considered to be a type of "green" energy that can be derived from a variety of sources (e.g., forest products, energy crops and agricultural residues). Although biomass and fossil fuels are both derived from solar energy, they operate on

completely different timescales. Biomass energy is contained in organic matter of recent origin whereas fossil fuels have taken millions of years to form. Biomass can also be locally produced in most rural communities so its supply is directly connected to the management of agricultural and forest lands in these communities. Increased use of renewable biomass for fuels may also reduce the use of expensive fossil fuel which will be a significant communal benefit. It also has positive attributes that can contribute to a healthy environment (Bartuska, 2006).

According to the International Energy Agency (IEA), 43.4 % of the energy consumed in the world in 2005 came from fossil sources, whereas renewable energy sources provided about 12.9 % (IEA, 2007). Biomass energy accounted for only about 2.2% of the total energy consumption (REN21, 2006) but is disproportionately important in developing countries, especially in rural areas. The Regional Wood Energy Development Program in Asia (RWEDP) of FAO reported that 70 % of biomass energy is used by the residential sector in developing countries in which 2.4 billion people live in rural areas (RWEDP, 2002). These people traditionally use biomass for cooking and heating. Biomass energy consumption has been increasing lately. For example, from 1991 to 2000, biomass energy consumption increased from 66.9 to 199.8 million tons of oil equivalent (mtoe) in India, and from 47.8 to 152.9 mtoe in China. This trend was observed in almost all countries (IEA, 2007; REWDP, 1999; REWDP, 2002). In Thailand, biomass energy consumption in 1981 was 11.5 mtoe, increased to 12.5 mtoe in 1991, then decreased to 8.5 mtoe in 2000, but increased again to 9.5 mtoe in 2004, when it accounted for 15.8 % of the total energy consumption in the country. About 79 % of biomass energy in Thailand was consumed by rural people (DEDE, 2006). Biomass is, thus, a potential source of alternative energy that is worth exploring. It has been shown that an increase of biomass energy use is possible in many countries (Parikka, 2004) but whether or not this is the case in Thailand is still an open question.

Generally, in the course of development, people choose to switch from biomass fuels to more convenient energy sources such as liquefied petroleum gas (LPG), electricity, and petroleum products. Several factors, both within and outside the household, have been found to influence these shifts in household energy

consumption, both the amount consumed and the types of energy sources used. The main factors are level of urbanization, economic development, and living standards. Of these factors, the level of urbanization has been found to have the greatest influence on the pattern of household energy consumption. Cai and Jiang (2008) reported that in China, in areas that are more urbanized, the people tended to use energy sources that are more convenient, cleaner, and more efficient. People in urban areas consume a considerable amount of electricity to power their modern appliances (e.g., washing machines, air conditioners, televisions and kitchen appliances), while people in rural areas mostly consume biomass energy for cooking, for which it is a suitable energy source. Studies of Indian households in urbanizing areas by Pohekar et al. (2005) and Dhingra et al. (2008) and of Chinese households by Cai and Jiang (2008) showed that they had recently shifted from use of fuelwood to modern types of energy. In the case of India, fuelwood consumption from 1959-2000 only increased by 3.7 % annually whereas annual LPG and electricity uses increased each year by 35.8 and 23.8 %, respectively. Major causal factors for these shifts are the rapidly increases in the levels of urbanization, economic development, and living standards in India in recent years, which are accompanied by changes in the style of living and the increased access to different sources of energy with the shift toward urbanization.

Even in rural areas, there are changes in types of energy used by households and a relative decline in the share of energy provided by biomass (Mahapatra and Mitchell, 1999; Senelwa and Sims, 1999; Dube, 2003; Xiaohua and Zhenmin, 2005; Ouedraogo, 2006). In poorer, less developed rural communities, biomass use may decrease as the result of scarcity since the supply of firewood has been declining with the decrease in forest area (Nansaior et al., 2006).

These studies all appear to support the conventional assumption that the role of biomass energy will diminish, and even completely disappear, as rural communities become more urbanized. If that is indeed the case, then household use of biomass energy is no longer a very important topic for research. However, there is considerable evidence that biomass energy still plays an important role as a household energy source. For example, in several countries in Africa the vast majority of rural households still rely extensively upon fuelwood as their energy source, and this has

changed only little over the past few decades despite increasing population pressures and changing socio-economic and environmental profiles (Madubansi and Shackelton, 2006). In the Asia-Pacific region, the share of fuelwood production in total round wood production in 2005 was still high (76.4 %) and actually slightly increased from the share in 1980 (75.3 %), indicating that fuelwood still plays a vital role in meeting energy demand in most of the countries in this region. In some countries, i.e., Lao PDR, Nepal, Pakistan and Vietnam, fuelwood even increased in absolute terms (Gumartini, 2009). Even in a developed country like Australia, wood for domestic purposes still account for 23 % of household, with an average of 4.5-5.0 million tons per year (Pual et al., 2006).

In Thailand, a study of energy consumption by urban households carried-out in 1989-90 found that in Bangkok 23.3 % of households used charcoal and 1.2 % used fuelwood while in Chiang Mai 63 % used charcoal and 16 % used fuelwood (Pongsapich et al. 1994). A recent study on charcoal utilization in Khon Kaen province of Northeast Thailand (Nansaior et al., 2006) revealed that a substantial amount of charcoal is still consumed in the highly urbanized parts of the Khon Kaen municipality. Moreover, stacks of firewood under the houses are still commonly observed in suburban villages in Northeast Thailand, and biomass energy seems to still be relied on by many households in these semi-urbanized villages. Such evidence should cause one to question the conventional assumption that biomass energy use has no continuing importance for the national energy budget of Thailand and other developing countries. What is needed, therefore, is empirical research to establish the extent to which biomass energy still plays an important role as a source of energy for household consumption across the urbanization spectrum of the communities in terms of absolute quantity used, relative share of total energy used, and functional roles for which it is used, as well as to identify factors causing the differences in energy sources used in communities at different levels of urbanization. In-depth understanding of these questions will be important for the national energy policy, particularly for the promotion of renewable energy utilization.

This thesis research was designed to investigate the above questions. The study was conducted in three villages in Khon Kaen province of Northeast Thailand

that represent different points along the rural-urban continuum of communities, i.e., rural, suburban and urban. In this study, therefore, space was substituted for time to assess changes in energy use associated with urbanization. This research strategy (sometimes called the "folk-urban continuum") has been used in many studies by anthropologists (Redfield, 1947), rural sociologists (Miner, 1952), and geographers (McGee 1964). This approach was based on the assumption that there is a developmental lag between urban and rural communities so that changes begin to appear first in urban areas and then gradually are adopted by nearby suburban communities before finally becoming evident in more remote rural villages. The city, thus, represents the most advanced state of development, while the suburban village has already undergone some changes in the urban direction, and the rural village represents more traditional patterns of energy use. In future years, it can be assumed that the suburban communities will continue to shift toward being more like the city while the rural villages will come to resemble the current state of the suburban ones. Of course, it must be recognized that rural villages in Thailand are not really traditional any longer. With the great progress in the national economic and social development during the past three decades, most rural villages in the country have become urbanized to a greater or lesser extent, with urbanization particularly evident in suburban villages near to district towns and provincial cities. All villages are now connected to the national road network and also have access to electricity. Most households have a television and many villagers even have mobile phones. Essentially, there are no longer any real rural villages in Thailand, except in the very remote areas in high mountains. However, communities located at the rural end of the rural-urban continuum still lag behind more suburbanized ones in terms of their degree of urbanization.

Khon Kaen province was selected for this research because it includes communities ranging from quite rural to highly urban. The provincial capital, Khon Kaen city, is the sixth most populous city in Thailand (DPA, 2008) and displays a high level of urbanization. Khon Kaen city is large enough that its impact is strongly felt in surrounding villages, with many having become strongly suburban in character in recent years. However, some villages, which are located in more remote districts, and enjoy less easy access to the city, still retain a rural character. The three study

sites, thus, represent three points along the spectrum of urbanization in the province, from having the least to the most urbanized character.

As the role of biomass energy could not be studied in isolation from other energy sources, these three communities were examined for overall patterns of energy utilization, both amount and sources, and factors affecting the behaviors of energy utilization of different households.

The main objectives of this research were:

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 levels of urbanization and to look into how some selected households manage their biomass fuel resources.

In particular, the major questions asked in this research were:

1. Does biomass energy still play an important role as rural community becomes more urbanized, and what is that role?
2. If it does, how do the individual households obtain their supply of biomass to meet their needs?

The hypotheses were:

1) That biomass energy still plays an important role in communities across the spectrum of urbanization.

2. That the individual households are able to obtain a sufficient supply of biomass energy to meet their needs, and

3. Most rural households have the potential to produce all of their own biomass energy.

It was anticipated that information obtained from this study should help clarify the extent to which biomass energy still plays an important role as communities becomes more urbanized. Such an in-depth understanding of this issue would have significant implications for the formulation and implementation of the national policies on renewable energy promotion, not only in Thailand but in other, currently less developed countries in Southeast Asia, such as Cambodia, Laos, Vietnam, and Burma. Rural villages in these countries would certainly become more and more urbanized in the course of national economic development, so that it was quite probable that in the near future the situation in those countries would come to resemble that of Thailand now in terms of urbanization of rural communities. The three study villages in Khon Kaen province, thus, could be viewed as representing the probable future situation of villages in those countries in the course of urbanization.

Scope of the study

Biomass energy is a very broad term that includes both traditional types of energy (e.g., firewood, charcoal, dung, and crop residues) and modern processed fuels such as ethanol and biodiesel. This study is not concerned with industrially-processed biomass energy, such as ethanol and other fuel; it is focused on household use of traditional types of biomass energy in the form of firewood and charcoal only (households in other part of Northeast Thailand may use agriculture residues as fuel but none of the sample households in this study do so). It is recognized that some of the gasoline used by households in this study may contain some biomass energy in the

form of ethanol but it was impossible to determine the quantities involved, therefore gasoline is not counted as a being biomass energy.

Conceptual framework

The present study consists of two parts corresponding to the two major questions previously indicated. The first part examines energy uses by households in the three communities with different levels of urbanization. The second part investigates how individual households obtain their supply of biomass to meet their need. Figures 1 and 2 illustrate the conceptual frameworks for the two parts, respectively.

For energy utilization by households in the three communities (Figure 1), the sources of energy are classified as biomass and non-biomass. The biomass sources used in these communities are firewood and charcoal. The non-biomass sources include electricity, LPG and gasoline. Household uses of energy are for cooking, living, transportation, agriculture and other income generation activities. Different households are expected to differ in energy utilization, both in the absolute amount and the relative shares of the different energy sources. Possible factors causing the differences in household energy utilization include size of household, size of land area being farmed, occupation of household members and level of household income. These factors can be used to classify the types of the households. Some of them may involve the amount of energy used, while others may involve preferences for using certain sources of energy, and some are related to lifestyles. Communities at different stages of urbanization are expected to differ in the proportions of different types of household, and these will contribute to the differences in their energy utilization.

For household biomass acquisition (Figure 2), there are three ways that households can obtain biomass for their uses, i.e., by collecting, by buying and by both collecting and buying. The places from which biomass is collected include their own land (paddy field, upland field and house plot), land belonging to their relative or neighbor, and public land (community forest, river forest and roadside). Households with different occupations are expected to differ in the way they obtain biomass for

household uses. Households that can obtain all the biomass from their own land are considered being self-sufficient in biomass energy. Differences in the proportions of different types of household among communities at different stages of urbanization will contribute to their differences in the way biomass is acquired.

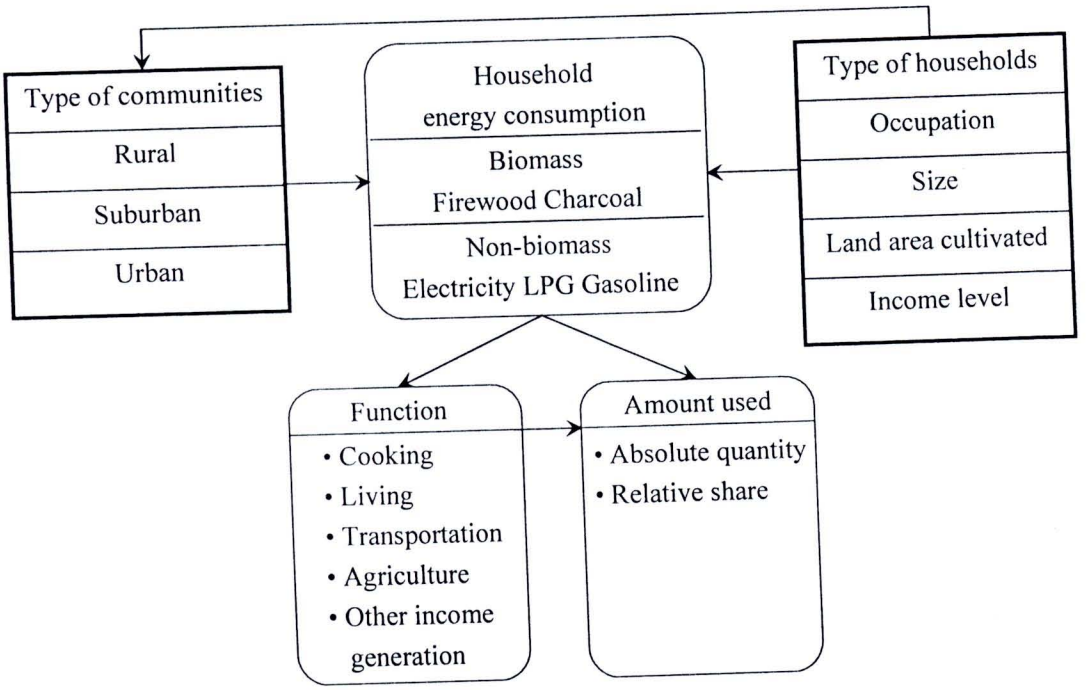

Figure 1 Conceptual framework for the study of household energy utilization in communities at different levels of urbanization.

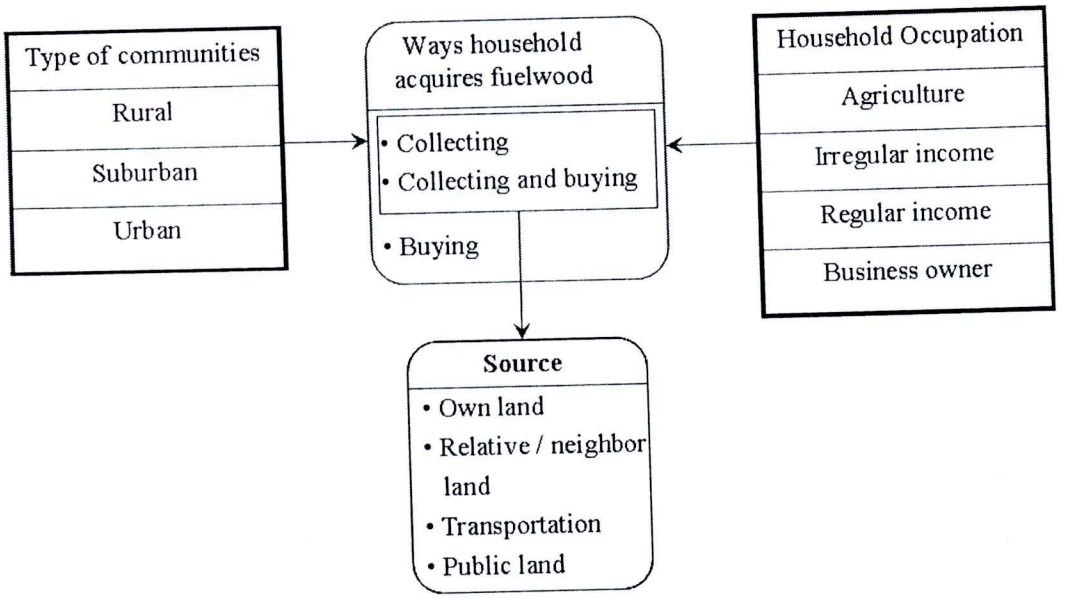

Figure 2 Conceptual framework for biomass energy acquisition of households in communities with different levels of urbanization.

Organization of this thesis

This thesis is not organized in the traditional style with a separate chapter on research design and methodology. Instead it is built around two chapters (Chapters III and IV) which are prepared in the form of manuscripts of stand-alone papers for publication in professional journals. Thus, each of these two chapters includes its own detailed discussion of methodology as appropriate for the specific topic under study. The thesis consists of five chapters. Chapter 1 presents the overall introduction to the study; Chapter 2 highlights the findings from the review of relevant literature; Chapter 3 is essentially the paper on household energy utilization in communities at different levels of urbanization in Northeast Thailand; Chapter 4 is the paper on biomass energy acquisition of households in these communities; Chapter 5 ends the thesis with an overall discussion and conclusion.