ENERGY SECURITY IN THAILAND

Prepared for

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by

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Executive Summary

Thailand imports oil, coal, gas and electricity to meet its increasing demand, and accounts for 46% of the total primary energy consumption. In term of available energy resources, Thailand has some reserves of coal (lignite) and natural gas. The estimated reserve to production ratio is 12.5 years in the case of natural gas and 100 years in the case of lignite. Coal and natural gas are the major energy resources expected to be used for electricity generation in future, while nuclear power is proposed as an option in the power development plan by Electricity Generating Authority of Thailand beginning from 2020/21. Total estimated hydro electricity generation potential of the country is 1770 TWh per year and with the potential for maximum hydropower capacity of about 3,500 MW. The country has wind sites of different categories, i.e., 150,000 MW of fair wind sites, 2,990 MW of good wind sites and 52 MW of very good wind sites. However, only few wind power sites have been developed so far. Thailand's annual biomass production is about 47.3 kt. Biomass and biogass projects supplied 222 ktoe of energy during 2004. There are several solar PV plants operating in in the country, which supplied 1.2 ktoe of electricity to the national grid in 2004. Besides, there is one geo-thermal plant of 300 kW operating in the country.

Total primary energy supply of Thailand was 105 Mtoe in 2006, which has been growing at an average annual growth rate of 5.38% in recent years. Imported energy accounted for 46% of the total primary energy supply. Energy import dependency of the country has increased over the time: The share of imported energy was 43% in 1994 and increased to 47% in 2005. Total final energy consumption of the country increased from 43.9 Mtoe in 1994 to 63.2 Mtoe in 2006. An annual average growth rate of 4.6% for the total final energy consumption was recorded during 2002-2006. The share of household sector in the final energy consumption has been decreasing over time; for example, it declined from 22.6% in 1994 to 14.3% in 2006.

Thailand has taken many positive actions to improve energy security by promoting energy efficiency and renewable energy. The Energy Conservation (ENCON) program was established in August 1994 with the objective of promoting energy efficiency, energy conservation, and sustainable use of natural resources. It is one of the major actions undertaken by the Thai government towards the improvement of energy security. One of the current strategies to promote renewable energy based power generation is to give incentives to small power producers (SPPs) and very small power producers (VSSP) in terms of favourable buyback rates. Incentives are targeted to Small Scale Power Producers who produce electricity using renewable energy technologies, especially, those based on biomass/biofuels, solid waste and solar electricity. The National Energy Policy Office (now the Energy Planning and Policy Office (EPPO)) funds R&D on energy efficient and renewable energy technologies as well as on policy studies. Thailand biofuel program has now reached the commercializing stage. In 2006, the production capacities of ethanol and pure biodiesel were 1.155 million litres per day and 0.06 million litres per day respectively. Both ethanol and pure biodiesel are produced through cultivated energy plantations. At present, Biodiesel and Gasohol (i.e., Ethanol and Gasoline blend) are available in the

country for use. Thai government plans to increase the production capacity of ethanol to 3 million litres per day by 2011 and that of biodiesel to 8.5 million litres per day by 2012.

The average share of household expenditure on energy commodities in total household income was 8.2% during the last five years and it has been increasing over time. The share of energy expenditure on average monthly income is 17% in the case of the lowest income group, while it was only about 5.1% in the case of the highest income group. With the current state of the international oil market, it is a worrying prospect that the petroleum products have the major share of nationwide household energy expenditure in Thailand. The rising urban population implies a further increase in the energy demand in the residential sector and further rise in the level of dependency on fossil fuels both at the household and national levels. Moreover, as the level of energy consumption shows a positive relation with the level income in Thailand, with the average household income in the country growing, dependence on fossil fuels (which are largely imported) is also expected to rise. The rate of electrification is high (about 97%) in Thailand, which means both rural and urban households have good access to electricity in the country. While LPG is widely available, use of traditional fuel for cooking is also significant in household sector in Thailand. Thus, efficient use of traditional fuel can have a good prospect for improving energy security. Measures taken under programs such as ENCON are mainly focused on five tools/activities: standards and regulations, financial incentives, awareness raising, technical assistance and information service. Promotion of renewable energy in the household sector has mostly been focused on rural areas with a view to increase household access to electricity. As high access to electricity has been achieved in the country, the renewable energy promotion programs could diversify their focus to other applications as well, such as, solar water heating etc.

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List of Acronyms and Abbreviations

AIT	Asian Institute of Technology
AHP	Analytic Hierarchy Process
BOO	Build/Own/Operate
GDP	Gross Domestic Product
DEDE	Department of Alternative Energy Development and Efficiency
DEDP	Department of Energy Development and Promotion
DPAEPU	Demonstration and Promotion of Alternative Energy Production and Utilization
EGAT	Electricity Generating Authority of Thailand
ENCON	Energy Conservation
EPPO	Energy Policy and Planning Office
GMS	Greater Mekong Sub region
KBD	Kilo Barrel per day
KBOED	Kilo Barrel Oil Equivalent per Day
KTOE	Kilo Ton of Oil Equivalent
LPG	Liquefied Petroleum Gas
MMSCFD	Million Standard Cubic Feet per Day
MEA	Metropolitan Electricity Authority
MOC	Ministry of Commerce
MOE	Ministry of Energy
MOF	Ministry of Finance
MOI	Ministry of Interior
NESDB	National Economic and Social Development Board
NGV	Natural gas for vehicles
NEPO	National Energy Policy Office
NSO	National Statistics Office
PEA	Provincial Electricity Authority
PV	Photovoltaic
SPP	Small Power Purchase
REPC	Renewable Energy Production Credit
RPS	Renewable Portfolio Standard
R&D	Research and Development
WEO	World Economic Outlook

Chapter 1

Introduction

1.1 Background

One of the widely used definitions of energy security at the national level is "securing adequate energy supplies at reasonable and stable prices in order to sustain economic performance and growth" (APERC, 2003). The concept of energy security emerged in early 1970's with the first oil crisis. At that time energy security was considered as a geopolitical issue. Over time, energy security has been considered to have a wider scope than only national energy dependency. Furthermore, the energy security could be also viewed from not only national perspective but also from and the sectoral perspectives. Diversification of energy resources, diversification of energy suppliers and economic vulnerability are some of the key indicators of national energy security.

Thailand is one of the fastest growing economies of South East Asia. Figure 1.1 shows the primary energy consumption of Thailand over the period of ten years starting from 1996. Total primary energy requirement increased at an average annual growth rate of 4.1% during the period of ten years. As can be seen, oil has been the main energy source in the country with its share being over 43% of total primary energy supply in 2005. Natural gas consumption has shown the most significant increase among the energy commodities in recent years. Biomass and coal consumption shows slight increase during 1996-2005.

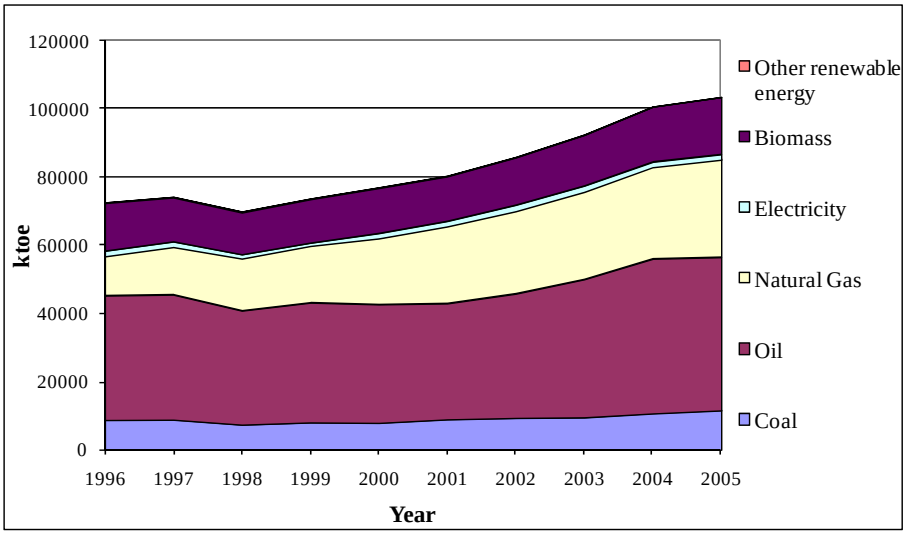


Figure 1.1: Primary Energy Consumption of Thailand from 1996 to 2005
Source: IEA, 2007

Sectoral energy consumption during the ten years starting from year 1996 is shown in Figure 1.2

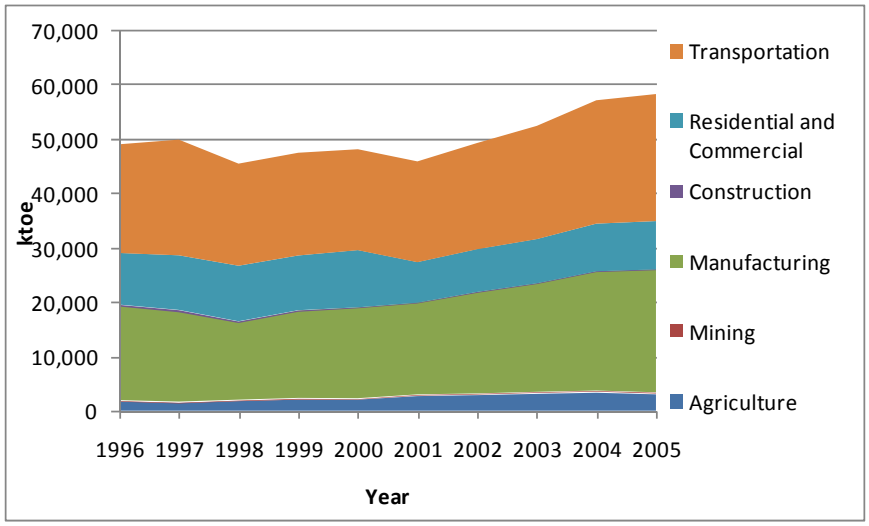


Figure 1.2: Sectoral Final Energy Consumption

(Source: DEDE, 2001-2005)

Transport sector, which is predominantly oil based, is the highest energy consuming sector of Thai economy. Manufacturing sector is the second largest contributor to the total final energy demand of the country. This sector shows the largest change of energy consumption among all the economic sectors. Household and commercial sector is the third next significant energy consuming sector of the economy. The final energy consumption from household and commercial sector shows the least change during 1996-2005.

The total demand for energy has been growing at an average rate of 2% per annum during 1996-2005 and the trend is expected to continue in future. Already, Thailand imports more that 45% of its primary energy demand. These energy imports accounted for 12% of GDP of Thailand and accounted for 18.6% of total export earnings. With resent hikes of oil prices, situation would be more vulnerable in future. In this backdrop, national level energy security analysis is a timely important study for the context of Thailand. Apart from the national level, household level energy security is also an important issue because of the effects of changes in energy supply and prices on household sector's shift to the use and affordability of modern fuels on one hand and the effect of the growing shift of the household sector to modern fossil fuels, which are mostly imported.

1.2 Objective of the Study

The overall objective of the study covers an analysis of energy security of Thailand from both national and household level perspectives. This includes the analysis of various energy security threats and impacts of energy security improvement measures from the above perspectives. The specific objectives of the study are as follows:

- At the national level, the specific objectives are to analyse:
    1. the threats to energy security of Thailand;
    2. different measures/strategies for energy security; and
    3. the impacts of measures to improve energy security

- At the household level, the specific objective are to analyse:
    1. the threats to energy security at the household level;
    2. key measures in the household sector to improve the energy security; and
    3. the impacts of the measures/strategies on energy security

1.3 Country Selection

Thailand is a middle income country and is one of the fastest growing economies in South East Asia (6.1% of average annual economic growth during 1981-2004 (BoT, 2007)). Associated with this economic growth, energy demand has increased steadily over the last few decades in Thailand. As shown in Table 1.1, during 2002-2006, the total primary energy supply increased at an average annual growth rate of 5.4% and the total final energy demand rose at an average growth rate of 4.6%. In 2006 the total amount spent for energy imports represented about 12% of the GDP (DEDE, 2006). Thailand has depended on energy imports for more than 45% of its primary energy supply throughout the period during 2002 to 2006 and these imports represent an ever increasing percentage of its GDP. Ensuring security of energy supply by reducing dependence on energy imports is therefore a major issue for Thai policy makers to address.

Table 1.1: Total energy consumed and imported in Thailand (1994-2006)

Year	1994	2002	2003	2004	2005	2006	AAGR (2002-2006), %
Total Primary Energy Supply (TPES), ktoe	63,938	85,854	92,491	100,495	103,302	105,762	5.38
Net Energy Import, ktoe	27,423	39,262	43,368	49,326	48,351	48,438	5.60
Final Energy Demand, ktoe	43,940	52,979	56,289	61,262	62,397	63,257	4.57
Share of net import in TPES, %	42.8	45.7	46.9	49.1	46.8	45.8	

Source: DEDE (2006)

Though Thailand has fairly high economic growth and its status is that of a middle income country, the traditional use of biomass in the country is relatively high. In 2005, in the residential sector, biomass (fuel wood, charcoal and rice husk) accounted for 60% of the total final energy consumption with a total of more than 11.0 mega tonnes of biomass consumed (Table 1.2).

Table 1.2: Household Energy Consumption by Type of Energy, ktoe

Year	2004	2005	2006
LPG	1040	1303	1304
Kerosene	6	6	6
Electricity	2108	2182	2301
Fuel wood	2766	2706	2578
Charcoal	2408	2698	2807
Paddy husk	42	38	38

Source: DEDE (2004, 2005, 2006)

Table 1.2 shows energy consumption in household sector by types of energy. Electricity, LPG and charcoal consumption has increased over the time. Fuel wood and paddy husk consumption shows slight drop over the time. Shifting from traditional fuels to modern fuels would make the household sector ever more dependent on imported fuels. The expenditure on fuels may rise with rapidly increasing prices of modern fuels.

Thailand has implemented measures to improve the efficiency of energy use since 1992 with the adoption of the Energy Conservation and Promotion (ENCON) Act. A study on Thai experience in energy efficiency improvement programs and its implications for energy security and the lessons that can be learned would be timely and interesting with the growing concern for energy security.

1.4 Structure of the Report

This report is organized as follows: Chapter 2 presents the methodology used in the study and also gives definitions of relevant energy security indices. Socio-economic background of Thailand is described Chapter 3. The national level analysis of energy security including threats to national level energy security, measures of improving the national level energy security, role of energy efficiency and renewable energy for the improvement of national level energy security are discussed in Chapter 4. The issues of household level energy security, threats to the energy security at that level, measures to enhance the security (such as enhancing energy efficiency and promotion of renewable energy) are described in the Chapter 5. Finally, conclusions as well as suggestions and recommendations for the next phase of the study are presented.

Chapter 2

Methodology

The national level analysis is carried out considering various energy security indices, in order to capture different aspects of energy security. The analysis of national level energy security covers the following aspects for which the relevant indicators are described as follows:

- Energy Import Dependency

  It is measured by Net Energy Import Ratio (NEIR):

$$NEIR = \frac{NEI}{DS + NEI}$$

  where, *NEI* is the net energy import to the country during the considered period of time
  DS is domestic supply of energy

- Diversification of energy sources

1. It is measured by Shannon-Wienier Index (SWI) (Grubb et al., 2006)

$$SWI = -\sum_i S_i \times Ln(S_i)$$

   Where, S_i is the share of fuel i in total primary energy supply (TPES).
   Note that a higher value of SWI implies a more diversified energy resource mix.

   The diversification of energy sources is also measured by Herfindhal-Hirshman Index (HHI) (Grubb et al., 2006)

$$HHI = \sum_i S_i^2$$

   where, Si = S_i is the share of fuel *i* in TPES. Note that a lower value of HHI means higher level of diversification in energy supply mix.

- Depletion of energy reserves of different fossil fuels and their rate of depletion.

  It is measured through:
  Reserve to production ratio (R/P ratio) = Estimated reserves / Current annual extraction

- Economic implications of energy imports

  It is assessed through the use of the following indicators:
  Vulnerability index 1 = Expenditure on energy imports / GDP
  Vulnerability index 2 = Expenditure on energy imports / Total export earnings

The household sector analysis considers the differences in energy use pattern between rural and urban, as well as poor and non-poor households. Energy statistics related to the household sector is used for this analysis. The household sector analysis includes the use of the following indices:

- Household expenditure on energy in different regions
- Household expenditure on different fuels
- Household energy expenditure by different income groups
- Access to electricity
- Fuels used for cooking

The study is based on the data available on energy and economic statistics of Thailand. Analyses of the key measures undertaken by the government of Thailand are carried out based on the information in various national reports and publications. The main data sources are annual publications of Department of Alternative Energy and Energy Efficiency (DEDE) Thailand. These publications include “Thailand Energy Situation”, “Oil in Thailand” and “Electric Power in Thailand”. Apart from the main data sources, statistics from Energy Planning and Policy Office (EPPO), Department of Energy Development and Promotion (DEDP), National, Statistics Office (NSO), IEA as well as reports of different research projects at AIT are also used.

Chapter 3

Socio Economic and Energy Profile of Thailand

3.1 Main socio-economic factors

At present, Thailand has the population of 66 million people and a land area of over 513 million km^2 (which means a population density of 127 per km^2) (MOI, 2007). Of this, around 20 million people live in the municipal area and 46 million people in the non-municipal area. Life expectancy is estimated at 68.2 years for male and 75.1 years for female; the infant mortality rate is at 7.6. Overall, the rates of crude birth and death per 1000 people are 10.85 and 6.76 respectively and the natural growth rate is at 0.41 per 1000 people (NSO, 2007a). The Thai population in the year 2000 was 60.6 million and in 2009, the value is 67 million. Therefore, over the last 9 years, the average annual growth rate of population is around 1.1 per cent (NSO, 2000; NSO, 2009). By 2015, it is expected that the population of the country will reach 70 million people (NESDB, 2007). The labour force proportion rate in the country is about 73 per cent, with 97.9 per cent employment rate (NSO, 2007b). The literacy rate in is 98.1 per cent (MOEd, 2007). There are around 19.6 million households in Thailand, with an approximate of 3.4 persons per household (MOI, 2007). In terms of migration, the North-eastern region of Thailand (also the poorest and the most populated) has seen the largest number of people moving out of the area. This is followed by the Central, Northern and the Southern regions respectively (NSO, 2007a).

The overall GDP in 2006 was $US 193.85 billion. The average annual growth rate of GDP since 1996 is estimated to be around 2.25 per cent. The levels of inflation in Thailand are shown to be increasing over the years. In 2003, the general consumer price index was valued at 101.8; this has increased to 114.4 in 2006 (2002 = 100) (MOC, 2007). The main parameters for this rising inflation can be seen in the forms of food and energy costs. The CPI values for these two broad categories of commodities in 2006 are estimated at 138.2 and 156 respectively (MOC, 2007).

Rice is a major export commodity of Thailand. The major types of industries in the country include agro-processing, weaving and electronics. The country is well endowed with natural resources including limestone, gypsum, glass sand, tin, marble, and natural gas. Tourism is a huge industry in Thailand. Over the period between the years 2004-2006, the country has recorded an average of 12.4 million tourists per year. Between the years 2005-2006, the number of tourists has grown by 19.5 per cent (TAT, 2007). On average, each tourist spend around 3890.1 Baht per day ($US 111.15/day) and the 10 year average income from the tourist industry is estimated at $US 8.3 billion per year (TAT, 2007).

3.2 Overview of the household sector

As of 2006, there were in total 19,582,845 households in Thailand, 6,853,996 (35%) of which were located in urban areas and 12,728,849 (65%) in rural areas (NSO, 2006). The average number of people per household was 3.4 at the national level, 3.2 in the urban areas and 3.6 in the rural areas. The lowest average household size was found in urban areas of the

Northern region (3.0 persons/household), whereas the highest average household size was found in rural areas of the Southern region (3.8 persons/household), (NSO, 2006).
The average monthly income per household in Thailand is estimated to be around US$ 508.2[1] (NSO, 2007a). The levels of income are however not evenly distributed across different regions. For example, in Bangkok and its vicinity, the average monthly income is significantly higher than the rest of Thailand at $US 945.4 per household. By contrast, the average monthly household income in the Northern and North-eastern regions of Thailand (where the primary occupation in the area is in the agricultural sector) is estimated at $US 375.6 and 337.6 respectively (NSO, 2007a). The ratio of household expenditure to income in Greater Bangkok is 73.1% while it is in the range of 79.7 to 87.3% in other regions.

In Thailand, the poverty line is set by the National Economic and Social Development Board (NESDB). For 2004, the poverty line was set at 1,242 Baht/person/month (US$30.8/person/month) (NESDB, 2007). Based on an average household size and the number of population in each region, the percentage of poor households can be estimated as presented in Table 3.1

Table 3.1: Estimated share of poor households in different regions (%)

Region	Urban Areas	Rural Areas	Total
Greater Bangkok	1	-	1
Central	4.7	6.9	6.2
North	8.4	18.4	16.1
Northeast	11.2	18.2	16.8
South	4.8	8.5	7.5
Whole Country	4.6	13.9	11

Note: Estimation based on data from NSO (2005) and NESDB (2007)

3.3 Thailand Energy Situation

3.3.1 Total Primary Energy Supply

In 2005, total primary energy supply in Thailand is estimated at 100,037 ktoe, an increase of 3.1 per cent from the previous year (2004). This is slightly lower than the 10 years average (since 2005) at 4.5 per cent. Exception for 1998, the country has consistently seen an increase in its total primary energy supply, ranging from 3 to 10 per cent per year (IEA, 2007).

[1] Exchange rate: 1 US$ = 35 Thai Baht (at 2007)

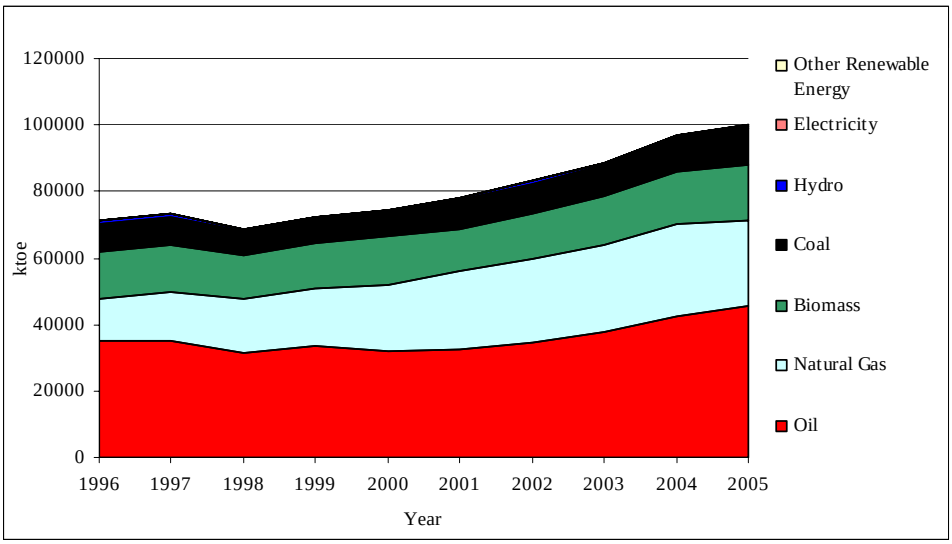


Figure 3.1: Total Primary Energy Supply in Thailand 1996-2005 (ktoe)

Source: IEA (2007)

Looking into share of different supply sources, it can be seen from Figure 3.1 that oil has always held the largest share, followed by natural gas, biomass, coal, hydro, electricity import and other renewable respectively. Oil consumption in 2005 was 45,544 ktoe (a 6.8% increase from the 2004 value). The average annual growth rate (AAGR) of total primary energy supply during 1996-2005 was 2.8 per cent but the period between the years 1996-2000 has experienced a steady decline in energy supply (5 years average at – 1.4%). On the other hand, natural gas supply has seen a continuous increase throughout 1996-2004. In 1996, its supply was estimated at 12650.06 ktoe, which increased to 27,380.71 ktoe by 2004. The AAGR of the natural gas supply was 7.7 per cent during 1996-2005. For coal, it can be seen in Table 3.2 that its supply has been growing over the period of 10 years between 1996-2005 (at AAGR of 5.4%). Recently, the supply of lignite has been decreasing due to depletion of local mine. However, the supply of imported coal such as Bituminous has been increasing. Between 2005-2006, the supply of imported coal has increased by 33.9 per cent (DEDE, 2006). Recently, due to the low supply of water, hydropower has been on a decline, with the electricity output falling from 642.51 ktoe (7472 GWh) in 2002 to 499 ktoe (5803 GWh) in 2005. By contrast, the supply from imported electricity has been increasing significantly over the same period of time. In 2005, imported electricity in Thailand (e.g. from LAO PDR and Malaysia) reached 325 ktoe (3780 GWh), as compared to 187.74 ktoe (2183 GWh) in 2004. Biomass experienced an AAGR of its supply by 1.8 per cent over the period of 10 years between the years 1996-2005. This reflects a slow increase from 13,980.18 ktoe in 1996 to 16,514 ktoe in 2005. The supply of other forms of renewable energy has remained stagnated over years. In 2005, their total supply was estimated at 2 ktoe.

Table 3.2: Total Primary Supply 1996-2005 (ktoe)

Fuel Type	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Coal	8776.77	8710.51	6926.32	7315.71	7503.48	8614.53	8986.2	9399.52	10377.28	11235
Oil	35164.24	34955.82	31679.13	33398.24	31943.48	32565.07	34847.12	37634.87	42639.46	45544
Natural Gas	12650.06	14855.18	16027.71	17317.75	20093.99	23339.25	24952.12	26232.2	27380.71	25918
Hydro	631.24	619.2	445.222	303.924	518.236	542.058	642.506	627.714	519.44	499
Electricity	61.576	55.212	126.42	178.536	238.478	224.804	218.354	187.738	259.376	325
Other Renewable Energy	1.719	1.719	1.719	1.719	1.719	1.719	1.719	1.719	1.719	2
Biomass	13806.79	13971.52	13326.97	13830.33	14270.62	12908.61	13692.17	14679.51	15892.65	16514
Total Primary Energy Supply	71092.4	73169.15	68533.48	72346.21	74570.01	78196.04	83340.18	88763.27	97070.63	100037

Source: IEA (2007)

3.3.2 Final Fuel Consumption by Fuel Types

Total Final consumption (TFC) was growing at an AAGR of 2.9% during 1996-2006 (Figure 3.2). Thailand experienced an economic crisis in 1997-98 which resulted in a reduction in TFC during the period. A steady growth in TFC has been taking place thereafter (Figure 3.2). Petroleum products accounts for the largest share during 1996-2006. However, during the period, the share of petroleum products has decreased from 58% of TFC in 1996 to 50% in 2006. In the same period, the share of electricity in TFC has increased from 14% to 18%. The share of natural gas also increased from 2% to 5% during the period. Biomass and coal/lignite have a small increment (less than 1%) during the period.

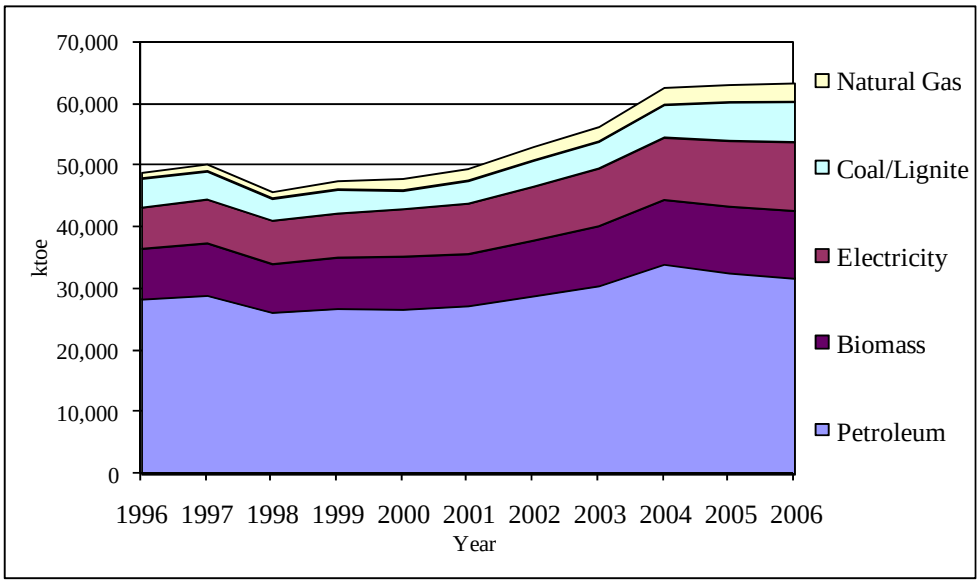


Figure 3.2: Total Final Energy Consumption during 1996-2006, ktoe

Source: EPPO, 2008
* Biomass includes Fuel wood, Charcoal, Paddy husk and Baggase

3.3.3 Energy Consumption in the Economic Sectors

In 1996, the transport sector accounted for the largest share (41%) in TFC followed by the industrial sector (36%), residential and commercial sector (19%) and agriculture sector (4%) in 1996 (Table 3.3). However, the share of the transport sector has decreased to 36% by 2006 and the share of the industrial sector has increased to 37% by 2006. The share of residential

and commercial sector also increased to 21% and that of agriculture sector increased by 1% by 2006. The AAGRs of these sectors show that the agriculture sector has been growing with 7.26% in the past decade (1996-2006) followed by the residential and commercial sector (3.36%), industrial sector (3.18%) and transportation sector (1.52%).

Table 3.3: Total Fuel Consumption by economic sector (ktoe)

Sector	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agriculture	1,786	1,493	1,880	2,160	2,161	2,847	3,032	3,308	3,520	3,207	3,312
Residential and Commercial	9,543	10,092	10,253	10,114	10,551	10,920	11,377	11,799	12,667	12,779	13,249
Industrial	17,827	17,146	14,685	16,434	16,975	17,143	18,934	20,255	22,263	22,918	23,711
Transportation	20,094	21,399	18,856	18,991	18,652	18,632	19,636	20,927	22,812	23,491	22,985
Total	49,250	50,130	45,674	47,699	48,339	49,542	52,979	56,289	61,262	62,395	63,257

Source: DEDE, 2007

3.3.4 Power Generation by Fuel Type

The power generation in the country is steadily increasing with AAGR of 5.34% during 1996-2006. The power generation is heavily based on fossil fuel and is heavily dominated by natural gas throughout the period. The share of natural gas in power generation increased from 41.5% to 66.5% during 1996-2006. The share of petroleum products (fuel oil and diesel) in power generation has decreased significantly, i.e., from 29.1% to 5.6% during the period. The share of coal and lignite has also decreased from 20% to 17.2% during the period. The share of hydro has decreased from 8.2% to 5.6% during the period. However, the share of imported electricity has increased from 0.9% to 3.6% and the share of others (biomass) increased from 0.2% to 1.5% during the same period (Figure 3.3).

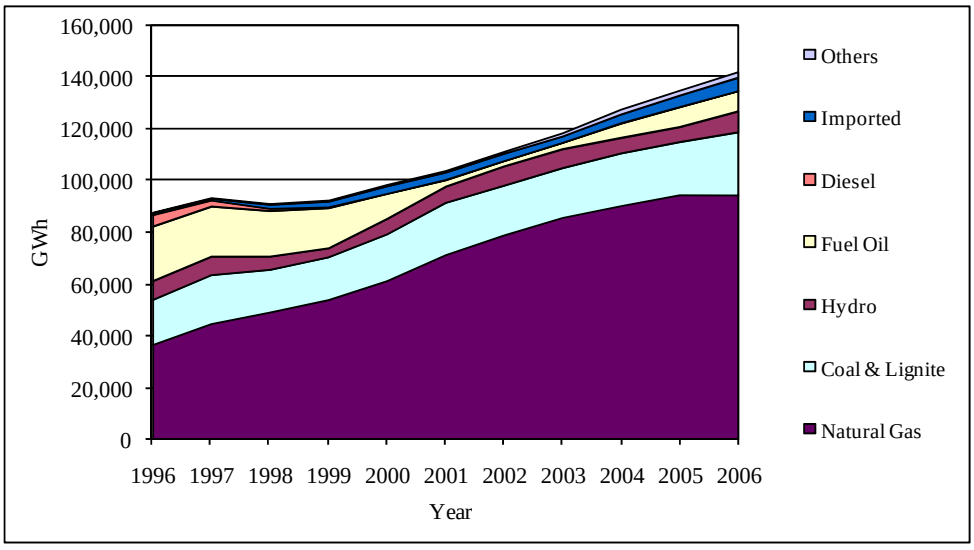


Figure 3.3: Power generation mix by fuel types during 1996-2006

Source: EPPO, 2008, DEDE, 2007

Chapter 4

Threats to Energy Security at National Level, Measures to Enhance Energy Security and their Impacts

As a rapid developing economy with not much indigenous energy resources, high level of imported energy dependency, the issue of national level energy security is of utmost importance for Thailand in the face of fast rising fossil fuel prices, especially oil prices. This chapter discusses the energy security issues in Thailand, different measures to improve energy security and their impacts.

4.1 Threats to Energy Security

4.1.1 Import Dependency

The high level of energy import dependency is a major issue of concern and makes Thailand vulnerable to disruption in international energy supply and/or substantial rises in prices of imported energy. As shown in Table 4.1, imported energy accounted for about 46% of total primary energy supply in the country in 2006. Demand for the imported energy shows an annual average growth of 5.5% during 2002-2006.

Table 4.1: Primary Energy Supply from 2002 to 2006

	Unit	**2002**	**2003**	**2004**	**2005**	**2006**
Total Primary Energy Supply	ktoe	84,489	92,491	100,495	103,302	105,762
Domestic Primary Energy Production	ktoe	45,227	48,149	50,140	53,640	55376
Net Primary Energy Import	ktoe	39,262	43,368	49,326	48,351	48,438
NEIR	%	46.5	46.9	49.1	46.8	45.8

Source: DEDE, 2006

Electricity Imports

Thailand imports electricity from Laos and Malaysia. In 2006, total electricity imported was 440 ktoe, this is an increase of 16.7% compared to the previous year, and accounted for 3% of the total electricity supply and 0.7% of the total energy imports. Since 2002, the average percentage of imports of electricity accounts for 2.5% of total annual electricity supply.

Natural Gas Import

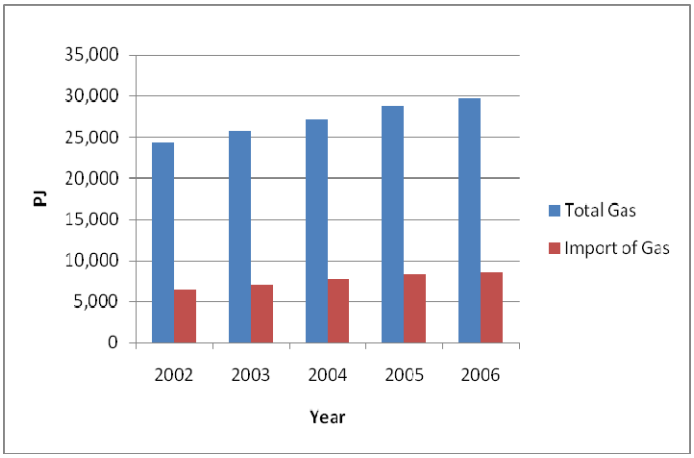


Figure 4.1: Gas Imports form 2002 to 2006

Source: DEDE, 2006a

Though indigenous natural gas plays the predominant role in natural gas supply in the country, the growth rate of import of natural gas exceeds over the growth rate of total natural gas supply in the country. The import of natural gas has AAGR of 7% during 2002-2006, whereas the total natural gas supply in the country has AAGR of 5% in the same period. The imported natural gas met 22% of the total gas requirements in 2006 (Figure 4.1), which is 14.4% (8,484 ktoe) of the total commercial energy imported in 2006.

4.1.2 Economic Significance of Energy Imports

The value of total imports was about 919,144 million Baht in 2006 and it was an increase of 17% compared to the same in 2005. In 2006, oil, gas, coal and electricity accounted for 89%, 8%, 2% and 1% respectively of total energy import costs. The variation of vulnerability indices are given in the Table 4.2. Both vulnerability indices are increased during the period of 2002 to 2006. This is an alarming energy security threat to Thailand.

Table 4.2: Estimations of Vulnerability Indices form 2002 to 2006

Year	2002	2003	2004	2005	2006
GDP (Million Baht)	5450600	5917400	6489800	7087700	7813100
Export Earrings (Million Baht)	2923941	3326015	3922432	4436676	4938508
Expenditure on Energy Imports (Million Baht)	360189	432956	592148	785976	919144
VI-1 (%)	6.6	7.3	9.1	11.1	11.8
VI-2 (%)	12.3	13.0	15.1	17.7	18.6

Sources: NSO, 2007a and DEDE, 2006

Growing demand for the imported energy commodities is a major cause of increased expenditure on energy imports. Another major cause is the increase of price of energy commodities in the international market. Figure 4.2 shows the increase of price of importing energy commodities from 2002 to 2006.

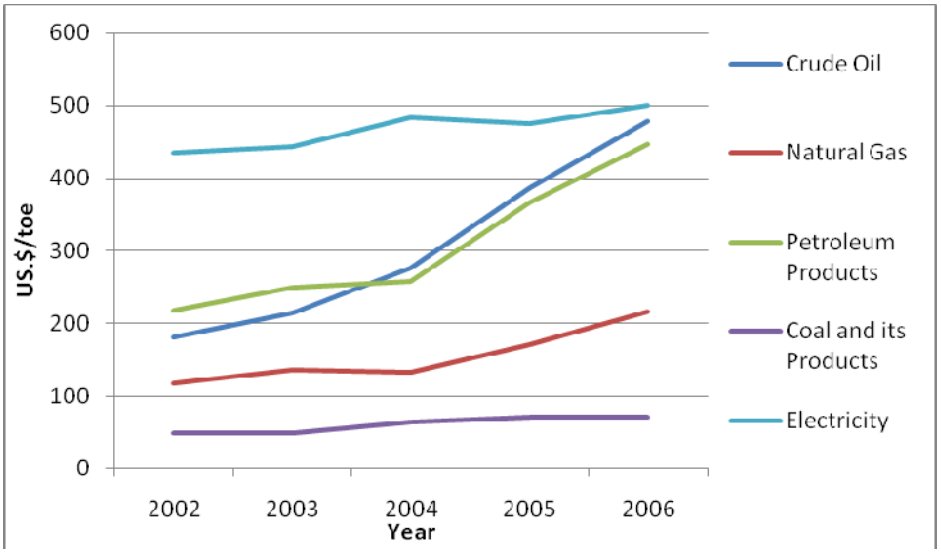


Figure 4.2: Variation of Import Prices

Source: DEDE, 2006a

4.1.3 Energy Source Diversification

Thailand's primary energy supply system is more diversified compared to many other developing countries. Coal, petroleum, natural gas, fuel wood and agricultural residue are the main primary energy types supplied during the past five years. Diversification of primary energy supply shows slight improvement during the period of last five years. Figure 4.3 shows the variation of Shannon Weiner Index (SWI) and Herfindhal-Hirshman Index (HHI) which are used as indices for the measurement of diversification of energy sources. Higher the index value of SWI explains better diversification of energy sources. HHI shows the opposite variation with the variation of diversification (i.e., a higher value of HHI implies the lower level of diversification). Even though Grubb et. al.,2006 explains that SWI and HHI give consistent results for diversification, our estimations of the two indicators show inconsistent results for some periods. This can be noticed particularly from the increases of both SWI and HHI in year 2006 compared to year 2005. (Figure 4.3): i.e., the change in SWI here means a higher diversification, while the opposite is indicated by the change in HHI.

Figure 4.3: Diversification of Energy Sources

4.1.3 Energy Reserves

Table 4.3 presents the energy reserves in Thailand. It covers all the fossil fuel and domestic hydro potential of Thailand. The low level of domestic oil reserve poses a threat to the long term energy supply security given the high share of oil in total energy consumption in the country.

Table 4.3: Fossil Fuel Reserves

	Unit	Proven Reserves	Probable Reserves	Possible Reserves	Total
Crude Oil	Million bbl	192	119	76	387
Condensate	Million bbl	261	293	158	712
Natural	bcf	10743	11598	9555	31896
Lignite	Million tons				2,870
Domestic	Hydro Potential (MW)				15,112

Source: DEDE, 2006

Crude Oil

The average crude oil production in 2006 was 128,890 barrels per day (bpd). This is an increase of 12.8% compared to the crude oil production in year 2005. If we assume the same rate of production and all the reserves as estimated in Table 4.3, the resulting reserve to production ratio would be 4.1 years. This is one of the major threats to the existing primary energy supply mix. With uncertainties involved in assumptions, the reserve to production ratio can be considerably lower than 4.1 years.

Condensate

The average rate of production of condensate increased by 8.3% in 2006 compared to the production level in 2005. In 2006, the average rate of production of condensate was 75,252

bpd. Based on the current average rate of production and total reserves, it is estimated that reserve to production ratio of condensate is about 9.5 years.

Natural Gas

Natural gas is one of the major domestic primary energy resources in 2006. In 2006, the average rate of production of natural gas was 2,356 MMscfd. This is an increase of 2.9% compared to the average rate of production in year 2005. The estimated reserve to production ratio is 12.5 years. Compared to crude oil, natural gas has a significantly higher reserve to production ratio.

Lignite

Anthracite, Bituminous, Coke and Lignite are the main types of coal used in Thailand in 2006. Lignite is the only domestically produced type of coal and its recorded production was 5307 ktoe in 2006. The average rate of production of lignite in 2006 was 52,058 tons per day, which is a decrease of 8.9% compared to the previous year. Lignite has the highest reserve to production ratio (about 100 years) compared to all the fossil fuels produced in Thailand (Nilkuha, 2000).

Hydro Power

Total estimated theoretical hydro power potential of Thailand is 15,112 MW. However, the installed hydropower capacity is about 3,500MW, which contributed to 1,801 ktoe of electrical energy supply during 2006.

Other Renewable Energy Sources

The theoretical wind potential of Thailand is 150,000 MW of fair wind sites of 6-7m/s of wind speeds, 2,990 MW of good wind sites of 7-8m/s of wind speeds and 52 MW of very good wind sites of wind speeds of 8.9m/s (Australian Business Council for Sustainable Energy, 2005). However, only few sites have been developed. These installations supplied 0.7 ktoe energy in 2004 (Greacen, 2004). The country's annual biomass production is about 47.3 kt. Biomass and biogass projects supplied 222 ktoe energy during 2004. There are several solar PV plants operating in Thailand. These projects supplied 1.2 ktoe to the national grid in 2004 (Greacen, 2004). There is also one geothermal plant of 300kW operating in the country (Australian Business Council for Sustainable Energy, 2005).

The future energy import dependency values under four predefined scenarios, namely, TA1 (Global market scenario), TA2 (Dual track), TB1 (Sufficiency economy), TB2 (Local stewardship) are as shown in the Figure 4.4 (Shrestha et al. 2007). Here, the four Scenaris are defined as below.

TA1

Economy: GDP growth rate of 7.5% per year during 2000–2020 and 5.5% per year during 2021–2050
Demography: low population growth rate of 0.02% per year
Life style: high per capita appliance ownership in households, car ownership and mobility
Technology: energy efficiency improvement of 0.3% per year

TA2
Economy: GDP growth rate of 6% per year during 2000–2020 and 5% per year during 2021–2050
Demography: high population growth rate of 0.74% per year
Life style: medium per capita appliance ownership in households
Technology: energy efficiency improvement of 0.2% per year

TB1
Economy: GDP growth rate of 6.5% per year during 2000–2020 and 5.5% per year during 2021–2050
Demography: low population growth rate of 0.02% per year
Life style: medium per capita appliance ownership in households and use of public transport
Technology: energy efficiency improvement of 0.4% per year

TB2
Economy: GDP growth rate of 4% per year during 2000–2020 and 3.5% per year during 2021–2050
Demography: medium population growth rate of 0.39% per year
Life style: low per capita appliance ownership in households and use of more public transport
Technology: energy efficiency improvement of 0.1% per year (Shrestha et al. 2007).

It is to be noted that even under the sufficiency economy and local stewardship scenarios, the expected energy import dependency would be as high as 80% by 2050. This means that growing energy import dependency would pose a higher level of vulnerability to both energy supply disruptions and energy price rise in the future energy system of Thailand. According to Shrestha et al., (2007), the two largest primary energy sources expected to be used for the electricity generation are coal and natural gas followed by renewable energy sources.

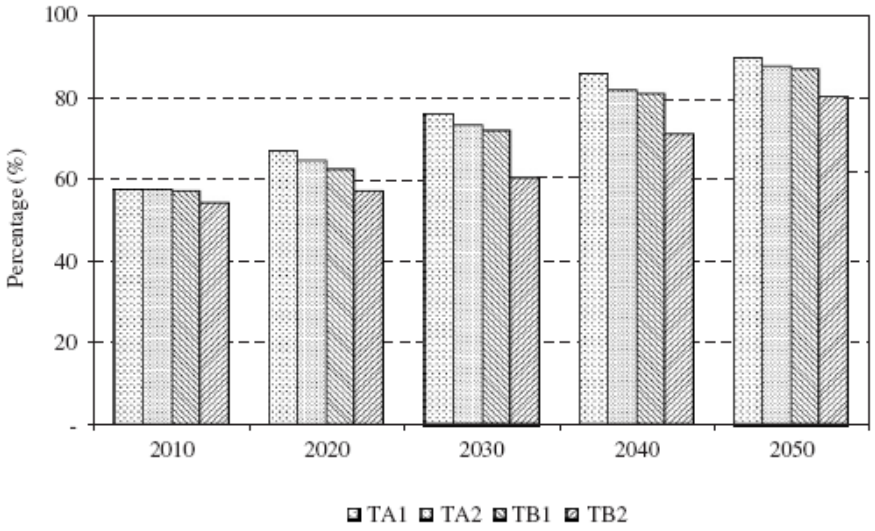


Figure 4.4: Energy Import Dependency under Selected Scenarios

(Source: Shrestha et al., 2007)

Prachumchon (2007) has estimated the expected electricity demand growth of Thailand under three different scenarios, namely, low economic growth rate, medium economic growth rate and target economic growth rate. According to the study, the annual average electricity demand growth rates are 6.2%, 9.9% and 11.5% under the low, medium and target economic growth scenarios respectively. The demand is expected to increase to 38.7 GW by 2020. According to Prachumchon (2007), even in the low economic grow rate scenario, electrical energy demand is expected to be doubled approximately by 2020. This means that a significant increase in the amount of coal and natural gas demand can be expected in the electricity generation sector. High dependence on imported fossil fuels would not only increase the country's economic and social vulnerability to supply disruptions and price rises, but would also result in higher emissions of local pollutants and green house gases.

4.2 Measures to Enhance Energy Security and Their Impacts

The government Thailand has formulated an energy policy in 2001(Government Policy Thailand, February 2001). It includes the following sub policies:

- Promotion of the combined use of energy by further developing the use and exploitation of Thailand's natural gas, which is a domestic resource, as the country's major source of energy.

- Promotion of the efficient procurement and use of alternative energy sources by expediting the survey, development and procurement of alternative energy sources as well as by promoting research and development on innovative energy sources for the purpose of energy conservation.

- Emphasis on energy management to increase the competitiveness of Thailand's production sector and to enhance the stability of energy prices through appropriate monetary, fiscal and managerial measures.

These polices are expected to help reduce energy import dependency and hence improve long term energy security.

At present, the energy challenges for Thailand comprise the supply side energy security and reduction of impact of soaring oil prices. Equally important is the reduction of dependency on imported energy. This could be done by improving the energy efficiency and maximizing the utilization of available renewable energy resources. With this it is expected that the subsequent reduction of environmental impact from the energy use and production. However, development of appropriate Renewable Energy Technologies (RETs) must be ensured in order to reduce the cost of renewable energy as much as possible. On the demand side, improvement of efficiency of energy use is of prime importance.

There are many different policies, plans and programs implemented in Thailand in order to improve the energy security of the country. Energy efficiency improvement is one of the focussed areas. Towards that end, activities on energy conservation, efficiency improvement in industries and research and development are under implementation. These programs are explained in the next sub chapter. Apart from the energy efficiency improvement, there are

several renewable energy promotion programs. Renewable based electricity generation is promoted through the Small Power Producer (SSP) buy back tariff. Small hydro, biomass and biogas projects are the main beneficiaries of this program. The program of promoting biofuel in transport sector is another main renewable energy promotion program. The renewable energy programs are discussed in more detail under different sections of this chapter. Energy Security improvements due to proposed nuclear plants is discussed in Section 4.2.6. The proposed ASEAN Power Grid and ASEAN Gas Pipeline projects are also expected to improve the energy security of Thailand. The details of these two projects are discussed in Section 4.2.7.

A number of policy initiatives which are implemented are, namely:

1. Renewable Energy Policy Cabinet Resolution on Sept. 2, 2003
2. National Agenda Cabinet Resolution on June 8, 2004 - regarding electricity production, the utilization of biomass has been sought through the Energy Conservation Act and the Announcement for the Purchase of Power from Small Power Producers, made by EGAT in March 1992. Under this new framework, 22 applicants were proposed to sell biomass-generated power to the grid, with a total capacity of 229 MW.
3. Country action plan for promoting new and renewable energy technologies -Thailand had a five-year plan (1997-2001) for promoting new and renewable energy technologies that called Demonstration and Promotion of Alternative Energy Production and Utilization Plan (DPAEPU Plan). The objective of the plan was to substitute imported oil about 23,000 tons of crude oil equivalent and reduce emission of carbon dioxide (CO2) by 160,000 tons by the year 2001. Programs under the DPAEPU Plan were as follows:

- Energy from solid waste and industrial waste plans with a total budget of 162 million Baht
- Solar energy plans with a total budget of 441 million Baht (1997 to 2001)
- Hydropower plans with a total budget of 4,190 million Baht (1997 to 2001).
- Coal utilization plans, a cooperation project that Thai government participate 6 million Baht budget,
- Capacity Building in Formulating Harmonised Policy Instruments for the Promotion of Renewable Energy and Energy Efficiency in the ASEAN Member Countries (2005)

4.2.1 Energy Efficiency

The Energy Conservation Promotion Act 2535 (1992) was enacted to mandate the production and use of energy efficiently and economically, to promote the production and use of energy efficient machinery and equipment. The Energy Conservation and Promotion Fund (ECPF) was established under this Act. The fund is contributed by the tax collected from fuels and other sources. This Act targets three groups, i.e. designated factories, designated buildings and producers or distributors of energy equipment and machinery. As an extension to the Energy Development and Promotion Act 1992, the Royal Decree on Regulated Energy 1993 has been announced, which states that the electrical energy generated from combined source with a total installed capacity of up to 200 kVA and over should follow the energy Act. The implementation of this Act is under the authority of the Minister of Science, Technology, and Environment through the announcement of the Department of Energy Development and

Promotion on Possession of Electricity Generator. The latter was followed by the Royal Decree on Designated Buildings (1995) and other relevant ministerial regulations effective since 12 December 1995. The Royal Decree on Designated Factories and other relevant ministerial regulations were announced and have been effective since 17 July 1997.

Industries liaison program

NEPO is the agency responsible for this program. The purpose of this program is to enhance the capacity of the industrial sector to produce energy-efficient and renewable energy based equipments in Thailand by providing technical and financial support to establish a market. In general, the following services are considered under the program:

- Assistance and financial support for market expansion for energy-efficient or renewable energy equipment in Thailand. The following areas of support are envisaged:

- Market research and formulation of a marketing plan
- Public relation activities for energy-efficient material or equipment
- Support for the producer/distributor to reduce his price to the consumer
- Support to the users of energy-efficient equipment

- Execution of activities within the scope of an equipment-labeling program.
- Support to centres for the dissemination of information on energy conservation, such as the Thailand Energy Conservation Centre, and for establishing centres.
- Communications, training and incentives to appropriate service industry firms to ensure that they become proficient in installing equipment in a manner that guarantees efficient operation, and also to encourage them to make efficiency improvements a part of their service and maintenance business.
- Support for demonstration projects of energy conservation technologies in buildings and factories.
- Dissemination of general technical information about technological options and ideas developed elsewhere (energy database).

Research and development program

This program aims at the development of new or the improvement of existing technologies, including small-scale demonstration projects and information dissemination by publications and workshops. NEPO is the agency responsible for this program. The fundable R&D projects could include:

- General and policy studies e.g., studies on energy saving potential in different sectors and for specific technologies; optimal strategies for market-introduction of energy-efficient and renewable energy technologies; training needs; know how transfer.
- R&D on energy-efficient and renewable energy technologies e.g., small-scale cogeneration, absorption cooling; energy-efficient process-equipment (e.g., kilns, ovens); solar heating and drying.

- Transfer and adaptation to Thailand conditions of proven technologies from elsewhere, including collaboration on joint research with institutions abroad.
- Information dissemination of results of (applied) research, through small-scale demonstration projects, workshops and seminars, conferences, publications, brochures etc.

4.2.2 Renewable Energy Promotion

Exploitable potentials of renewable energy (except large hydro) are given in Table 4.4. Various strategies have been developed in order to harness renewable energy. Setting renewable energy targets is one of the strategies to promote renewable energy effectively. The government takes the cue on the amount of electricity consumed in 2003 (Figure 4.5), from which the contribution of renewable energy in electricity production amounts to 0.5 per cent only. It is projected, then, that by 2011 a total of at least 8 per cent of renewable energy will share the burden of electricity production through the aid of Renewable Portfolio Standard (RPS), Research and Development (R&D), incentives and other facilities. However RPS is not being pursued actively at present. Instead the most resent strategy is to promote renewable energy based power generation by giving incentives in terms of favourable buyback rates for small power producers (SPPs) and very small power producers (VSSP).

Table 4.4: Renewable Energy Potential of Thailand

Renewable Energy	Approximate Energy Potential
Biomass	7000 MW
Solar	5000 MW
Small hydropower	700 MW

Source: Greacen (2004)

In the total electricity supply, with the aid of RPS could generate a total of 437 MW based on combined sources of solar, wind, municipal solid waste, biomass and hydropower. In contrast to the RPS, incentive policies could encourage a projected supply of 1,093 MW. Through various incentive mechanisms, it is estimated that heat could share 3,700 ktoe, bio-fuel with 3,100 ktoe, Ethanol with 3 million litres/day and bio-diesel with 8 million litres/day (Figure 4.6b) (Sajjakulnukit, 2007).

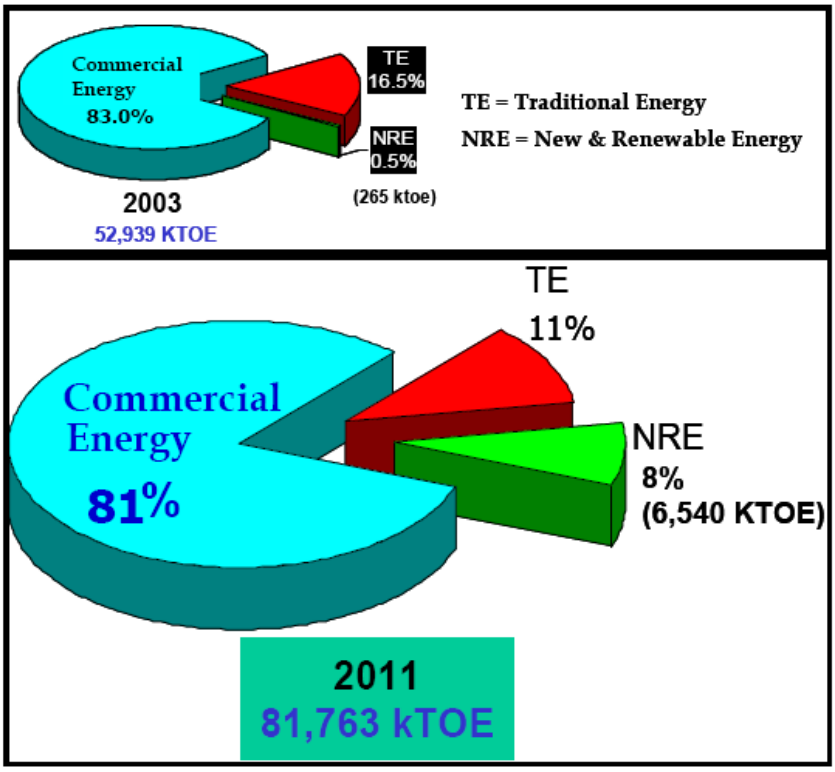


Figure 4.5: Thailand's distribution of energy consumption in 2003 (a); and projections in 2011 (b).

Source: Sajjakulnukit, (2007)

4.2.3 Small Power Producer (SPP) Tariffs

The SPP scheme was introduced in March 1992 immediately following the amendment of the EGAT Act. Its purpose is to promote private participation in the power sector development.

The objectives of purchasing electricity from SPPs were:

- To reduce the financial burden on the government of electricity generation and distribution;
- To encourage participation by private producers in electricity generation;
- To promote the use of indigenous by-product energy sources and renewable energies for electricity generation;
- To promote the more efficient use of primary energy. The source of SPP generation must be from:

- Non-conventional energy such as wind, solar and mini-hydropower energy;
- Waste or by-products from agricultural and industrial activities;
- Co-generation using natural gas or petroleum products under a number of conditions.

Investment policies

The government has embarked on a comprehensive Energy Conservation (ENCON) Program, adopting the Energy Conservation and Promotion Act in 1992. One of the main objectives of the ENCON Program is to promote the development and use of renewable energy sources, through Voluntary Programs. The handling of Voluntary Programs will be contracted out by the National Energy Policy Office (NEPO) to organizations such as municipalities, university institutions, research facilities, non-profit organizations, religious organizations and other approved groups. There are two types of financial support for the implementation of Voluntary Programs: Support for the Project Implementing Organization, or "contract owner", for the operational cost for management and administration. This is to entice them to invest in the use of renewable energy technology or invest in energy-conserving equipment.

Renewable energy and rural industries program

A special sub-program has been created for small rural industries. Rural industries under the energy conservation program are manufacturing facilities located in non-urban areas. Opportunities to improve energy efficiency include not only energy conservation alone but also measures like fuel substitution and application of renewable energy technologies, or technologies to use renewable energy sources more efficiently. A typical example of use of renewable energy in large-scale industries is the burning of agro-industrial waste products like sugarcane baggase and rice husks. This fuel substitution can be combined with energy efficient technologies, like cogeneration or the use of energy efficient process equipment. This program would also focus on the introduction and dissemination of renewable technologies, which use and/or produce renewable energy. Included are full-scale demonstration projects of proven technologies and promotion on outputs of research projects, with emphasis on non-industrial applications. NEPO is the agency responsible for this program.

4.2.4 Alternative Transport Fuel Promotion

Domestic production of biofuels is one of the options to reduce the dependency on petroleum imports. In Thailand, ethanol production from molasses was reported since 1985. Gradually it was developed as an alternative fuel supplying industry (MTEC Bioenergy Research Group, 2007). In 2006, the production capacities of ethanol and pure biodiesel were 1.155 million litres/day and 0.06 million litres/day respectively (Sajjakulnukit B, 2005). Both ethanol and pure biodiesel are produced through cultivated energy plantations. Ethanol is produced using molasses (by-product of sugarcane) and cassava. Blendings of 10% ethanol with gasoline and 10% biodiesel with diesel are known as E10 and B10 respectively. At present Biodiesel and Gasohol (i.e., Ethanol and Gasoline blend) are available for use by vehicles. Thai government plans to increase the production capacity of ethanol to 3 million litres/day by 2011 and that of biodiesel to 8.5 million litres/day by 2012. With those production rates E10 and B10 would replace the total demands of gasoline and diesel (Gonsalves, 2006).

The Gasohol promotion plan in the country consists of the following two phases (Sajjakulnukit B, 2005):

Phase I (2004-2006)

- Ethanol production capacity should increase to 1.155 million liters/day by 2006.
- Stop using methyl tertiary butyl ether (MTBE) in unleaded gasoline.
- Develop specifications for Gasohol 95 (5% blend of ethanol with gasoline) and perform emission tests on engines running on it.
- Formulate policies on the use of gasohol in high-performance vehicles
- Request government vehicles to use Gasohol
- Mandate that all of government vehicles to use gasohol

In 2007, there were ethanol production plants with total installed capacity of 955,000 litres/day. Twelve more plants were under construction with total installed capacity of 1,970,000 litres/day. Gasohol production in that year was 3.94 million litres/day (i.e., 3.52 million litres/day of Gasohol 95 and 0.42 million litres/day of Gasohol 91). There were 3,504 Gasohol service stations operating as of March 2007 (Sajjakulnukit B, 2007).

Phase II (2007-2012)

- Ethanol production is to increase to 3.0 million liters/day by 2011.
- Gasoline consumption would be replaced totally by Gasohol 95 by 2012.

The Biodiesel promotion plan consists of the following activities (Sajjakulnukit B, 2005):

- Promotion of community based biodiesel plants (2005-2006)
- Commercial scale biodiesel use (after 2006)
- Introducing B5 (5% biodiesel with diesel) in some areas in the South and Bangkok, and expanding throughout the country in 2011.
- Research and Development on palm and Jatropha Curcas plantations

4.2.5 Biomass Power Generation

Initially ENCON supported biomass development by giving externality cost subsidy of not more than 0.009 cent/kWh. During 1995–2004, the energy conservation (ENCON) fund financed (giving subsidy) 15 biomass projects and 21 biogas projects involving total investment of 2,125 million Baht and 1,320 million Baht respectively. However, the distribution of the fund was uneven. Few large projects took a substantial share of the ENCON fund. For example, the largest biomass project alone received a subsidy of 2,060 million Baht. Initially, 43 proposals for SPP projects were received. The total capacity proposed was 775 MW. The ENCON fund committee approved only 17 projects with total

installed capacity of 335 MW in 2002. Out of the 17 projects, fourteen were biomass projects with total installed capacity of 279 MW. However, before contract granting, every project (both biomass and biogases) must be agreed upon by local communities residing within the radius of 5 km from the plant through the public hearing. Several projects were opposed by local communities. Approved projects consist of a project fuelled by rubber wood (20 MW) and rest were bagasse and rice husk based.

4.2.6 Nuclear Energy Plan

According to EGAT (2007), the nuclear power option is proposed in the Power Development Plan 2007-2021 of Thailand beginning 2020/21. It is proposed to install nuclear plants with a capacity of 4,000 MW to cope with the looming power shortage. The first of these nuclear power plants is expected to start operation in 2020-2021(Kritayakirana K, 2007).

> Security of Fuel Supply
> From a national perspective, the security of future fuel supply is a major factor in assessing its sustainability. The abundance of naturally occurring uranium makes nuclear power attractive to an energy security standpoint. At present, the current usage of uranium is about 66,500 tU/yr. Thus the world's present measured resources of uranium (4.7 Mt) to be used in conventional reactors, are enough to last for 70 years. This represents a high level of assured resources.
>
> Stable Fuel Price
> A long-term advantage of nuclear power over fossil fuels is the low impact on fuel price increase, since a large proportion of those costs is in the capital cost of the plant. This insensitivity to fuel price fluctuations will help stabilize the electricity tariff
>
> EGAT, 2007

4.2.7 ASEAN Power Grid an Gas Pipe Line

The ASEAN 2020 Vision adopted in 1997 by the heads of state of ASEAN countries at the 2nd ASEAN Informal summit held in Kuala Lumpur envisioned an energy-interconnected South East Asia through the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline Projects (AMEM, 2004). The proposed power grid linking ASEAN member countries would provide greater diversification of energy sources.

A Master Plan for the power grid was prepared with funds from the Norwegian government and the Asian Development Bank. The Plan recommends a series of long-distance transmission lines and transformer stations linking Thailand's existing national grid with future large hydro dams on the upper Mekong (Yunnan), Mekong tributaries (Lao PDR and Vietnam), and the Salween River (Burma). Representatives of the Greater Mekong Sub region (GMS) countries endorsed the Plan in Rangoon (Burma) in October 2002 at the ADB-sponsored GMS Electric Power Forum (Ryder, 2003).

It is estimated that the ten countries of ASEAN have a total of 22 billion barrels of oil, 227 trillion cubic feet of natural gas, 46 billion tons of coal, 234 gigawatts of hydropower and 20

gigawatts of geothermal capacity (AMEM, 2004). With the high level of natural resources of neighbours such as natural gas reserves and hydro power potential Thailand would benefit from ASEAN power grid project and gas pipe line project.

4.3 Summary

At the national level, the major threats to Thai energy security are:

- The import of primary energy, which stands at about 46% of the total primary energy consumption. This has remained at this level, and is expected to rise in the future. Natural gas imports are 14.4% of the total natural gas consumption, while about 2.5% of the total electricity consumption is imported. The growth rate of natural gas consumption exceeds the growth rate of total natural gas supply.
- Diversification of primary energy supply shows slight improvements during the last five years. The Shannon Weiner index is about 1.65.
- In term of energy resources, Thailand has some reserves of coal (lignite) and natural gas. The estimated reserve to production ratio for natural gas is 12.5 years while the corresponding figure for lignite is about 100 years.
- Based on the analysis by Shrestha et. al. (2007), the future main primary energy sources which are expected to be used for the electricity generation are coal and natural gas.

The measures undertaken to address the threats could be listed as follows:

- Energy Efficiency: The Energy Conservation Promotion Act 2535 (1992) and the Energy Conservation and Promotion Fund (ECPF). These target designated factories, designated buildings and producers or distributors of energy equipment and machinery.
- Research and Development: The National Energy Policy Office (now the Energy Planning and Policy Office) funds R and D on policy studies, energy-efficient and renewable energy technologies, Transfer and adaptation to Thailand conditions of proven technologies from elsewhere, and information dissemination
- A current strategy to promote renewable energy based power generation is to give incentives in terms of favourable buyback rates for small power producers (SPPs) and very small power producers (VSSP)
- Incentives to Small Scale Power Producers for electricity generation and promotion of renewable energy technologies, especially, biomass/biofuels, solid waste and solar electricity.
- Even though the biofuels in Thailand have a long history, current biofuel promotion program started in 2004 and has clearly formulated tasks and targets. It is intended to reduce the dependence on imported oil.
- Nuclear technology is now included as an option for electricity generation with 4,000 MW of nuclear power plant capacity to be installed by 2020/21 with the primary objective of improving fuel supply security and stable electricity price and hence improving the energy security.
- Thailand has taken initiatives to promote biomass energy use. Even though the biomass promotion program has some problems such as uneven distribution of benefit among beneficiaries, it has supported to develop many biomass projects in the country.

Chapter 5

Threats to Energy Security at Household Level, Measures to Enhance Energy Security and their Impacts

5.1 Threats to Energy Security

Increasing expenditure on energy commodities over the years as a percentage of total household income can be a measure of threat to energy security at the household level. Figure 5.1 presents the trend of average energy expenditure by households and its share in total household expenditure during 1986-2006. As can be seen from the figure, there has been an increasing trend not only of the absolute level of energy expenditure but also of the share of energy in total household expenditure over time in Thailand. With the rapidly increasing petroleum product prices, one can expect households to have an even higher energy expenditure and higher share of energy in their total expenditure over time.

According to NSO (2006), nationwide average monthly energy expenditure in 2006 is estimated at 1434 Baht (US$41), which constitutes around 10 per cent of total household expenditure -- a significant increase from 6.1 per cent in 1996. In addition, the energy expenditure varies among different regions of Thailand, ranging from 1,005 Baht in the North-eastern region to 2,412 Baht in Bangkok (NSO, 2006). It is possible to interpret this as a reflection of the uneven economic development in different regions. Bangkok and its vicinity are the most well off areas with the average monthly income of 33,088 Baht per household, followed by Central, Southern, Northern and North-eastern regions respectively (NSO, 2006).

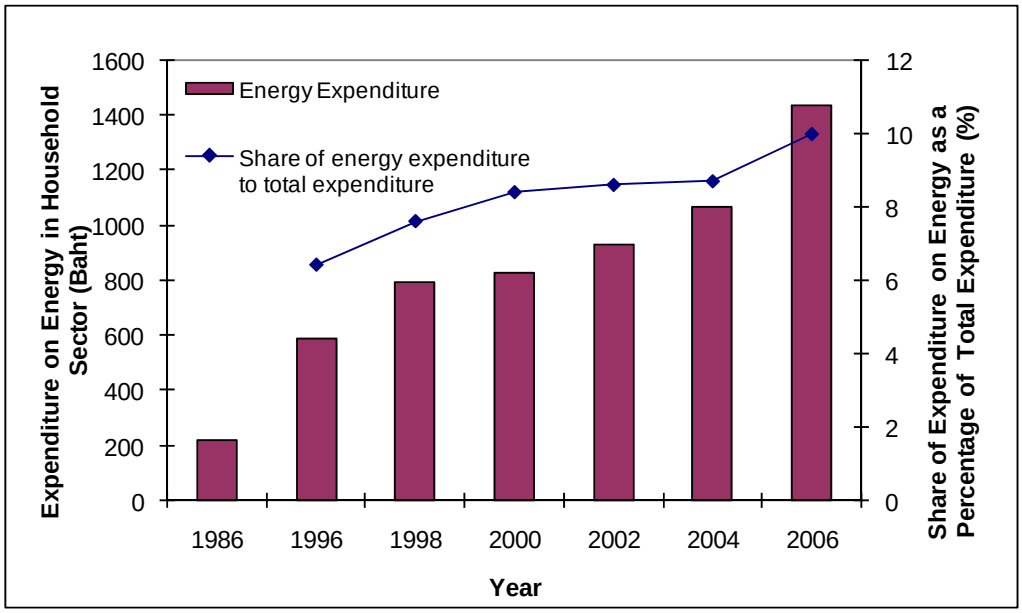


Figure 5.1: Trend of Energy Expenditure and Its Share of Total Expenditure during 1986- 2006

Source: NSO (1986, 1996-2006)

Table 5.1: Average Monthly Income, Total Expenditure and Energy Expenditure per Household by Region

	Whole Kingdom	Region				
		Greater Bangkok	Central	North	Northeast	South
Total Income (Baht)	17,787	33,088	19,279	13,146	11,815	18,668
Total Expenditures (Baht)	14,311	24,194	15,373	11,185	10,316	15,260
Energy Consumption Expenditures (Baht)	1,434	2,412	1,577	1,112	1,005	1,570
As Percentage of Total Income	8.1	7.3	8.2	8.5	8.5	8.4
As Percentage of Total Expenditure	10	10	10.3	9.9	9.7	10.3

Source: NSO (2006)

In Thailand, urban and rural areas are segregated as 'municipal' and 'non-municipal'. Currently, 30 per cent of the population live in urban area and the rest 70% live in rural area under this definition. Table 5.2 shows that on average urban households' monthly spending on energy commodities is Baht 2,018, which is much higher than that of their rural counterparts (Baht 1,163). With the exception of fuel wood and charcoal, which are common in the rural North and Northeast, the expenditures on energy commodities are generally higher among urban population. At present, there are around 1.5 million rural-urban migrants per year (not including unregistered population) (NSO, 2006). The rising urban population increases the energy demand in the residential sector further (due to normally higher per capita energy consumption of the urban households) and would thus further raise the level of dependency on fossil fuels both at the household and national levels.

Table 5.2: Average Monthly Expenditure on Energy Per Household by Type of Energy, Region and Area (Baht)

Type of energy	Whole Kingdom		Greater Bangkok		Central		North		Northeast		South	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Total Energy Expenditure	2,018	1,163	2,461	2,121	1,757	1,507	1,535	1,005	1,637	882	1,829	1,479
Gasoline	854	475	1,100	887	680	573	636	402	637	362	749	676
Diesel	383	272	335	498	412	398	350	221	451	189	469	346
Grease and lubricating oil	69	37	81	59	61	50	61	35	49	24	69	51
LPG for transport	3	1	4	11	3	3	1	0	0	0	0	0
LPG for cooking and others	74	61	76	77	73	78	66	58	74	44	81	89
Electricity	622	266	863	587	520	380	391	225	387	190	457	301
Charcoal and wood	13	51	2	2	8	25	30	64	39	73	4	16

Source: NSO (2006)

With the current state of the international oil market, it is also a worrying prospect that the petroleum products account for the major share (62.9% or around Baht 1,017 per month) in

nationwide household energy expenditure in Thailand. Further, most of this consumption in 2006 (41.5% or 596 Baht) is spent on gasoline, while 21.4 per cent (Baht 307) is spent on diesel. There is not much of a substitute for gasoline and diesel for the transportation purpose. LPG use for transport is still very low in the household sector and the promotion of NGV for transport is too recent to have a significant impact (Figure 5.2) (NSO, 2006).

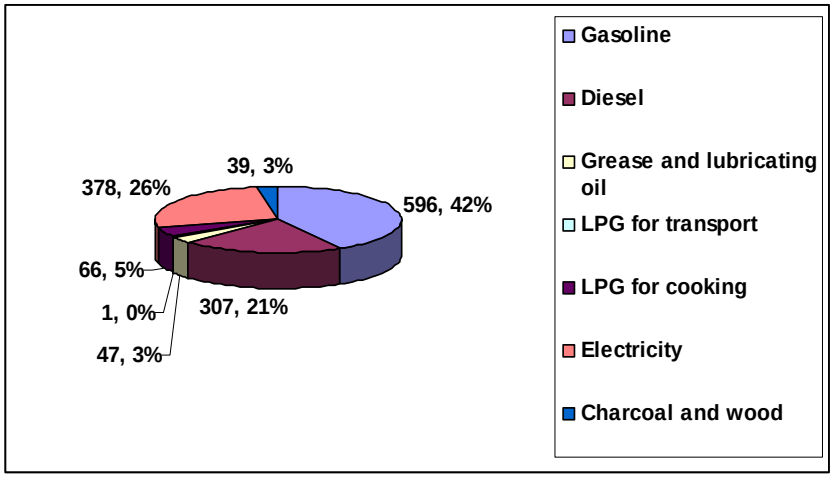


Figure 5.2: Average Monthly Energy Consumption per Household by Type of Energy Commodity in 2006.

Source: NSO (2006)

Monthly spending on electricity has been increasing over the years (from Baht 57.1 in 1986 to Baht 378 in 2006). This increase has, however, been less rapid than that of the petroleum products. Expenditures on other types of energy have remained virtually the same over the years (Figure 5.3).

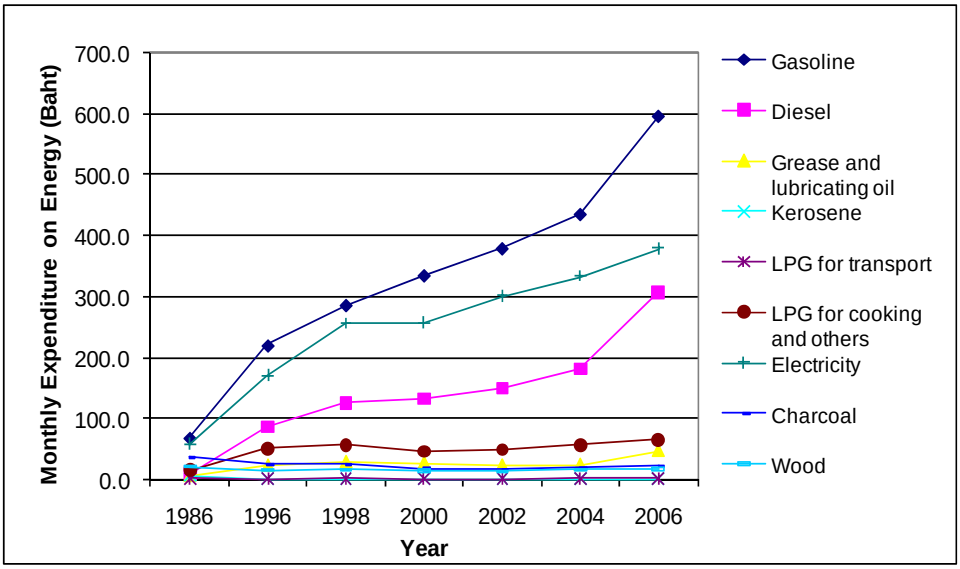


Figure 5.3: Comparison of average household energy expenditure in 1986-2006.

Source: NSO (1986, 1996-2006)

In terms of the shares of energy expenditure to total household expenditure, it can be seen in Figure 5.4 that gasoline and diesel together account for the highest share increasing from 51.7 per cent in 1996 to 62.9 per cent in 2006. The share of electricity in total expenditure was 28.8 per cent in 1996 and it decreased to 26.4 per cent in 2006 (31.2% in 2004). The shares of LPG and biomass have experienced a slow decline over the years at household level.

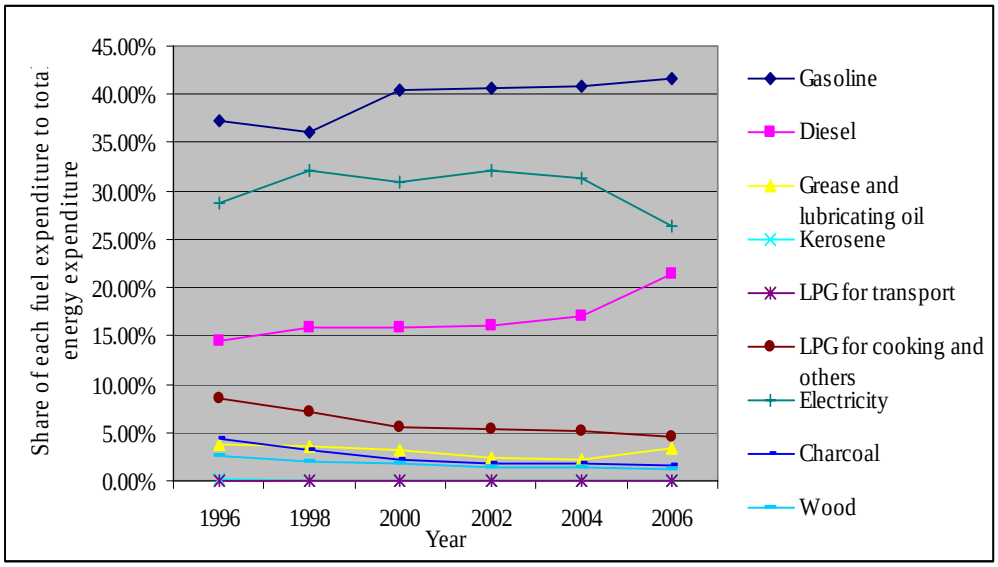
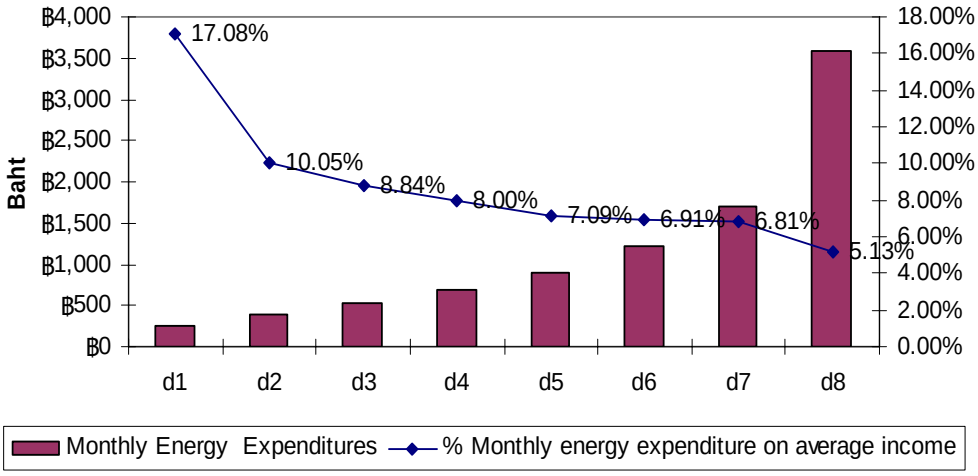


Figure 5.4: Share of fuel expenditure to total energy expenditure, 1996-2006.
Source: NSO (2005b)

Overall, as can be expected, the energy expenditure of high income group on modern energy is higher than that of the low income group. Also, the expenditure of low income group on traditional energy (wood and charcoal) is more than that of high income group. In 2004, monthly energy expenditure ranged from 256 Baht for the lowest income group (d1) to 3,593 Baht for the highest income group (d8) (NSO, 2004). The share of monthly energy expenditure to the average monthly income is lower for higher income groups, e.g. 17 per cent for d1 group and only 5 per cent for d8 group (see figure 5.5). This implies that the lower income groups are much more likely to be affected by changes in price of energy commodities than the higher income groups.



Item	D1	d2	d3	d4	D5	D6	d7	d8
Description	Less than 3,000	3,000-4,999	5,000-6,999	7,000-9,999	10,000-14,999	15,000-19,999	20,000-29,999	30,000 and over

Figure 5.5: Average energy expenditure per income level in 2004 (Baht per month)
Source: NSO (2004)

On the other hand, persons earning less than 3000 Baht per month (which is the lowest income group) live in 5.1% of the total households of the country, while persons earning greater than 100,000 Baht per month (which corresponds to the highest income group) live in 15.1% of the total households. Figure 5.5 also shows that households earning less than 10,000 Baht per capita per month, (the first four listed in the figure) account for 43% of the total number of households. This means that, for 43% of the households, the average energy expenditure is on or above 8% of household income.

Cooking energy sources (i.e., fuel wood, charcoal, and LPG) account for 17.8 per cent of total household expenditure on energy for lowest income group as compared to less than 3.1 per cent for the highest income group (NSO, 2006).

Thai households are characterised by a high level of access to electricity. In 2005, at country level, 72,494 villages (97.4% of total villages) and 16,100,825 households (84.7% of total households) had access to grid electricity (DEDE, 2006b). The access to grid electricity per region is given in Table 5.3 below. However, the official household data suggests that the actual level of access to electricity is higher than the level of access to the grid. Indeed, the report on nationwide household survey in 2004 shows the percentage of household having access to electricity to be 98.9%.

Table 5.3: Access to Grid Electricity

Region	Number of Villages	Percentage of total number of villages	Number of households (thousands)	Percentage of total number of households
MEA Area[a]	725	100	2,518	85.7
Central	15,737	99.5	3,671	82
North	16,385	99.7	3,092	82
Northeast	31,073	96.2	4,709	88
South	8,574	93.5	2,112,056	85
Whole Country	**72,494**	**97.4**	**16,101**	**84.7**

[a] In Thailand, two public utilities distribute electricity, namely the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). MEA distributes electricity in Bangkok Metropolis, Nonthaburi and Samut Prakan and PEA elsewhere in the country.
Source: DEDE (2006b)

DEDE (2006b) presents the ownership rates of electrical light bulbs and TV to be 98.6% and 94% respectively (Table 5.4). The difference between these data and the grid connection data can be explained by two factors: firstly, the Thai Government has put a lot of effort to electrify remote households through off-grid schemes, solar photovoltaic battery charging stations and solar home systems in particular (Shrestha et al., 2007). Secondly, in poor urban areas, some unregistered households living on squat land get electricity connection from their neighbours (Martin et al., 2007).

Table 5.4: Percentage of Households Reporting Ownership of Selected Durable Goods in Thailand.

Durable goods	Total	Household size				Average no. of items per reported household
		1-2 person	3-4 persons	5-7 persons	8 persons or more	
Cook Stove - gas	73.8	64	78.9	78.5	81.3	1
Cook Stove - electric	11.6	12.6	10.7	11.8	11.6	1
Microwave Ovens	11.2	9.3	11.9	12.8	15	1
Electric Pot	58.2	49.2	61	66.3	73.8	1
Refrigerator	82.1	73.4	86.5	86.3	87.7	1.1
Electric Iron	77.9	66.5	82.6	86.2	85.3	1
Cooking Pot, Electric	85.8	80.3	88.5	88.6	90.2	1.1
Electric Fan	95.8	94.3	96.7	96.3	96.1	2.3
Radio	60.8	56.7	62.3	63.8	67.1	1.1
Television	94	88.7	96.5	97.2	97.3	1.3
Video	68	53.4	74.2	78.2	79	1.1
Washing Machine	42.8	31	47.4	51.7	53.5	1
Air Conditioner	11.2	9.5	11.8	12.6	14.4	1.6
Water Boiler	9.4	7.8	10.1	10.5	11.6	1.2
Home Computer	14.7	8.9	17.5	18.2	18.3	1.1
Fluorescence	98.4	97.9	98.6	98.9	99.3	5.3
Incandescence	13.8	11.6	14.6	15.7	15.5	5.2
Compact Fluorescence Lamp	8.5	6.9	9	9.7	12.2	3.5
Private car	9.2	7	9.6	11.7	15.3	1.2
Pick-up, Van	18.1	10.7	20.7	24.4	28.6	1.1
Other Mini Truck	14.2	7.5	16.2	20.8	17.9	1.1
Motor Boat	0.7	0.3	0.9	0.9	1.6	1.2
Motorcycle	70.6	51.9	78.3	83.9	89.5	1.4

Source: NSO (2006)

As can be seen from Table 5.5, the average urban household consumption level was almost constant for both the poor and non-poor households over the recent years.

Table 5.5: Electricity consumption by Households of Bangkok Metropolis, Nonthaburi

Year	Average monthly electricity consumption, kWh	
	Poor households[+]	Non-poor households
2002	91.05	408.81
2003	88.64	412.03
2004	89.79	411.71
2005	88.88	409.51

[*]The figures in the table are calculated from MEA (2008).
[+]Here, we have considered the households consuming electricity below 150 kWh per month as the "poor" and those consuming more than 150kWh per month as the non-poor.

The main regulatory change of household electricity tariff came into effect at the beginning of the year 2000. Both service charge and the unit charge were changed. This tariff change introduced two consumer groups based on their average consumption rate (higher and lower to 150kWh). Unit charges for consumption blocks below 25 kWh were almost doubled for the customers, whose monthly consumption level did not exceed 150 kWh. The comparison of two tariffs is given in the Table 5.6. It should be noted that the monthly service charge for the customers with monthly consumption up to 150 kWh was substantially lower than that for those consuming above 150 kWh. Furthermore, the unit charge for customers consuming up to 150 kWh was also significantly lower (almost half) than that for customers with consumption level above 150 kWh if the actual monthly consumption level was below 26 kWh. The change in tariff structure also favors the low poor households whose consumption level is low.

Table 5.6: Electricity Tariff for Households

Electricity Consumption-on	Consumption not exceeding 150 kWh per month ("Reduced Tariff")				Consumption exceeding 150 kWh per month ("Standard Tariff")	
	1997-1999 December		January 2000-Present		January 2000-Present	
Unit (kWh)	Service Charge	Unit Price	Service Charge	Unit Price	Service Charge	Unit Price
	Baht/Month	Baht/ Unit	Baht/Month	Baht/ Unit	Baht/Month	Baht/ Unit
1 - 5	4.96	0	8.19	0	40.9	1.8047
6 - 15		0.7124		1.3576		1.8047
16 - 25		0.8993		1.5445		1.8047
26 - 35		1.1516		1.7968		1.8047
36 - 100		1.5348		2.1800		2.1800
101 - 150		1.6282		2.2734		2.2734
151 - 400		2.1329		2.7781		2.7781
>= 401		2.4226		2.9780		2.9780

Source: MEA (2008)

Looking at households' dependence on traditional fuels, it can be seen that cooking energy sources (fuel wood and charcoal) accounted for more than 13% of the household energy

expenditure of the lowest income group as compared to less than 1% in the case of the highest income group (Figure 5.6). LPG is, however, the most popular fuel for cooking used by 57.5% of the total number of households at the country level (16.9% for wood and 15.9% for charcoal) (NSO, 2006). As shown in Table 5.7, the share of biomass use for cooking is high in some parts of the country, especially in North-eastern region of Thailand.

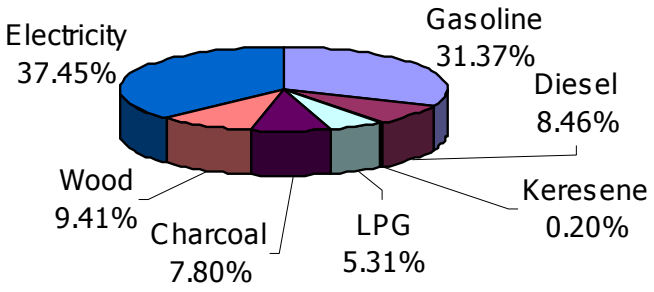


Figure 5.6: Share of Expenditure on Energy in the Lowest Income Group, 2004
Source: NSO (2004)

Table 5.7: Main Fuel Used for Cooking (% of households)

Region	Charcoal	Wood	Kerosene	LPG	Electricity	Other	No cooking
Greater Bangkok	2.5	0.3	0.2	67.2	13.3	0.2	16.3
Central	11.5	3.5	0.2	75.8	3.1	0.1	30.0
North	19.4	23.2	0.1	51.4	1.9	0.1	3.9
Northeast	26.8	34.9	0.1	35.1	1.2	0.1	1.8
South	6.9	3.7	0.6	82.9	2.3	-	3.5
Whole Country	**15.9**	**16.9**	**0.2**	**57.5**	**3.8**	**0.1**	**5.6**

Source: NSO (2005a)

Furthermore, an attempt to understand Thailand's future energy requirement was made in a study using the bottom up modeling framework based on a cost minimum linear programming approach (AIM/Enduse model) (Shrestha et al., 2007). The core assumptions used in this study are based on Thailand being more and more integrated into global markets. The GDP here would grow by 7.5 per cent per year during the first 20 years (2000-2020) and by 5.5 per cent per year for the remaining years (2021-2050) reflecting the possible slowdown of country's economic growth. Easy access to global technology market is expected, and thus significant improvement in the efficiency of end-use devices (i.e. an average rate of 0.3% per year) is considered here. In the demographic front, the country's average annual population growth is low (0.02%) due to low total fertility rate based on the United Nations low variant population projection over the study period (UN, 2009). However, the urbanization rate would double (62%) in 2050 due to migration from rural to urban areas and transformation of big villages into cities.

Based on these assumptions, the study found that the final energy demand in Thailand is expected to increase significantly. However, the main driving forces come from the industrial and transport sectors, follow by the commercial sector, with the residential and agricultural sectors lagging behind. Focusing on the residential sector, it is expected that final energy demand here will only increase gradually from 8 Mtoe in 2000 to 10, 13 and 17 Mtoe in 2010, 2030 and 2050 respectively (Table 5.8). Although this is significantly lower than the increases in other sectors, it is important to remember that the assumptions used here is based on there being faster transition of the economy towards industry- and commerce-based economy.

Table 5.8: Expected Sectoral Final Energy Demand in Thailand 2000-2050 (Mtoe)

	2000	**2010**	**2030**	**2050**
Agricultural	2	2	4	4
Commercial	3	5	20	56
Industry	18	33	88	197
Residential	8	10	13	17
Transport	18	32	71	176
Total	49	82	197	450

Source: Shrestha et al. (2007)

5.2 Measures to enhance energy security and their impacts

Measures at the household sector in Thailand that also has potential to enhance energy security mainly include energy conservation activities i.e., Demand Side Management (DSM) and Energy Conservation Program (ENCON)

Demand Side Management (DSM) Program: In 1993, EGAT established the DSM office with to objective of managing the timing and the amount of electricity demand by increasing energy efficiency. From the result of the initial two years implementation of the DMS pilot program, estimation was made on the potential savings in long-term from DSM program, which includes the conservation, load management and attitude creation programs. Table 5.9 shows estimates of the effects of DSM program in Thailand in terms of saving on peak capacity and electricity consumption.

Table 5.9: First DSM long-term master plan in Thailand

Period	Total DSM Saving at Generation Level	
	Peak Capacity (MW)	Energy (GWh)
1993-1996	221	1,189
1997-2001	1,641	3,846
2002-2006	3,525	9,670
2007-2011	6,706	22,177

*Note: Accumulated to the years end of each period
Source: DSM and IRP (2004)

In September 1998, the program resulted in reductions of 468 MW of peak demand, 2,194 GWh of electricity generation and 1.64 million tons of CO_2 emission (NEPO, 1997). There are six main activity plan areas, namely, residential, commercial, industrial, air-conditioner control test, education, and evaluation and surveys. The first three areas focus on energy efficient appliances, particularly lighting equipment, high-efficiency refrigerators and air-conditioners. Some achievements of the implementation of energy conservation activities are shown below:

1. Lighting
    - Energy Efficient Fluorescent Lamp Program 36 and 18 W in September 1993.
    - A pilot Lighting Retrofit Program in the Royal Project Foundation.
    - "Million Hearts Million Lights" Program to utilize compact fluorescent lamps (CFL) instead of incandescent lamps.
    - Energy Efficient Ballast Program inviting manufacturers to produce energy efficient ballast. Campaigning was first focused on producing energy efficient ballast named as 'Safety Ballast No. 5'.
    - Low-Income Fluorescent Program promotes the utilization of fluorescent tube instead of incandescent lamps among low-income people.

2. Refrigeration and air conditioning
    - Energy Efficient Refrigerator Program, It persuaded the five manufacturers of refrigerators in Thai market to have refrigerators tested for efficiency rating labelling.
    - Energy Efficient Air-Conditioner Program: It persuaded local manufacturers and importers to have split-type air-conditioners tested.
    - Appliance Testing Laboratory Program: That is, testing energy efficiency of refrigerators and air-conditioners in the Thai Industrial Standard Institute (TISI).
    - Free interest loan of 10,000 Baht from EGAT for the purchase of every of energy efficient No.5 labeled air conditioners from May to July 2002.
    - Air Conditioning Cleaning and Checking Program, Thai Jointly Save Energy in collaboration with the Office of Vocational Educational Commission in April and June 2003.

3. Reduction of the thermal transfer in the building
    - Utilisation of thermal transfer reduction material in building, such as micro fiber insulation, ceramic coating utilization, reflective aluminum installation, and windows film.

4. Other programs
    - Attitude Creation Program creates awareness of energy conservation and energy efficient utilization
    - Low Efficiency Buy-Back Program transforms operation and early retirement of low efficiency appliances utilized in the system and also puts pressures on manufacturers to produce only high efficiency appliance.
    - Creating a permanent public awareness by Green Learning Room program

- Customer-Oriented Program Design and Public-Private Sector Partnership by doing pilot project at government building.

The ENCON program: The program was established on 3 August 1994 with the objective of promoting energy efficiency, energy conservation, sustainable use of natural resources, and protection of environment under the Department of Energy Development and Promotion (DEDP) and the Ministry of Science, Technology and Environment (MOSTE). The main tasks of the ENCON program are to set guidelines, criteria, condition and priorities for the ENCON allocation fund. Demonstration, promotion, research and development in the energy conservation project basically are the objectives of this program. Two government agencies have been given the task of implementing this program, which is mainly divided into three major sub programs, i.e.: compulsory program, voluntary program and complementary program as given in Table 5.10.

Table 5.10: Sub-programs under ENCON

Programs		
Compulsory Program	Voluntary Program	Complementary Program
Government Buildings Existing Designated Factories and Buildings Factories and Buildings under Designing or Construction Public Awareness Campaign	Promotion of Renewable Energy Utilisation Promotion of SPPs using renewable energy Industrial Liaison Research and Development Existing Non-Designated Factories and Buildings	Human Resource Development Public Awareness Campaign Management and Monitoring
Implementing Agencies		
Department of Energy Development and Promotion	National Energy Policy Office	National Energy Policy Office

Source: EPPO (2005)

5.2.1 Enhancing energy efficiency

According to the Department of Alternative Energy Development and Efficiency (DEDE), formerly known as Department of Alternative Energy Development and Promotion (DEDP), energy efficiency in residential sector can be attained through combination of the following five tools/activities:

- Standards & Regulations – The number of designated facilities that will be covered is approximately 1,800 buildings and 2,600 factories. These facilities shall implement the Energy Management Standard as well as the Building Code.

- Financial Incentives - this covers the program on low interest loans, tax incentives and the promotion of energy-efficient houses. The "Low Interest Loan" includes budget allocation from ECP Fund to banks, loan approval by banks and technical assistance by DEDE with the following key conditions:

  - Loan amount < 1.2 million USD/project
  - Interest less than 4% (fixed rate)
  - Repayment in 7 years

  As of the 2005, the government's initial US$ 50 million allocated loan has been used up. On average, an investment of US$ 0.8 million is required per project with an

average payback period of 2.4 years. The succeeding phase will have co-funding with private banks. The tax incentives, on the other hand, could be Cost-Based (With Revenue Department), Performance-Based (Pilot Project) or Incentive through Board of Investment (BOI). The cost-based incentive allows 25 per cent tax break for the investment in EE projects which result in efficiency improvement. This is applicable for the first 50 million Baht of total investment cost (US$ 1.25 million) which is spread for over 5 years. The performance-based tax deduction is equivalent to 100% of achieved energy savings with a maximum allowable of 2 million Baht (US$ 50,000) per facility. Pre- and post-audit is necessary for this scheme. Finally, the incentive through the BOI covers tax exemptions on import duties and corporate taxes on any investments on energy conservation and renewable energy production. This includes investments on high-efficiency or renewable energy equipment, solar PV manufacturing or energy service company (ESCO). This incentive lasts for a maximum of 8 years. The promotion of energy-efficient houses explores various models with a focus on design of the roofing, walls, flooring, ceiling, openings, sunshade equipment, ventilation, natural light utilization and the shape and location of the house.

- Awareness Raising – this entails efforts on public relations. One scheme is the "Best Practice Competition" which could bring about people's participation. Focus is given on various methodologies of housekeeping measures for over 100 factories and 50 buildings. Saving of 5-10 per cent is expected with a corresponding simple payback of 2.5 years.

- Technical Assistance – this includes projects like workshop and training, free energy audit and consulting, technology demonstration and promotion of ESCOs.

- Information Service – this includes directory of technology providers, database of energy experts, and energy display centre.

5.2.2 Promotion of Renewable Energy

Although the utilization of renewable energy is still limited compared to conventional fossil fuels, it has increased significantly over the years.

Table 5.11: Status of PV installation in household and related sector of Thailand

PV System	Installed Capacity (MW)
Solar Home systems	18.26
Battery charging	2.17
Telecommunication	1.51
Grid-connected systems	1.26
Water pumping	1.14
Miscellaneous	0.13
Total	24.47

Source: DEDE (2005).

First of all, biomass has long been the major indigenous energy source in Thailand, accounting for 17.4 per cent of total final energy consumption in 2006 (EPPO, 2008). A major portion of this (75%) comes from fuel wood and charcoal, which play a role as principal cooking fuels in rural areas. The average production of this biomass is about 380 stocks per *ra*i (1 hectare = 6.25 *rai*) or 22 m^3 per *rai* per year. The total production of fuel wood is approximately 22 Mt or 36.7 million m^3, of which 25 per cent comes from deforestation (DEDP, 2001).

Table 5.12: Number of solar cell households in Thailand, 2005

Locations	Northern zone 1	Northern zone 2 and 3	Central	Southern zone 1 and 3	Southern zone 2
Household - Target	32,663	33,547	21,815	20,853	20,045
Household - Completed	7,432	12,233	4,019	9,362	0
% Completed	22.75	36.47	18.42	44.9	0

Source: DEDE (2005)

Located near the equator, Thailand is suited for implementing solar thermal and solar PV installation systems. The first PV systems were installed in 1976 for communication equipment. The installations are mostly done in residential rather than in commercial sector. Approximately, a total of 50,000 m^2 of flat plate collectors have been installed on commercial buildings, hospitals and private residences. It is envisaged that future PV applications will be promoted among urban people by appropriate financial incentives. This will shift the PV market from publicly funded applications in rural areas and utility application to a private/consumer market. Tables 5.11 and 5.12 show the accumulated capacity and the number of households with solar cells respectively. In terms of solar thermal status in Thailand, its capacity is expanding at a rate of some 3000-3500 m^2 of solar water heaters per year. The current solar water heating market is limited to the upper-income residential (and commercial sector), which is dominated by imports from Australia.

In the earlier years, small hydropower generator systems were installed mainly in the Northern part of Thailand (beyond the national electrical grid) since 1964. The installation works in Thailand are under the authority of Department of Alternative Energy Development and Efficiency (DEDE), formerly known as Department of Energy Development and Promotion (DEDP), and Provincial Electricity Authority (PEA). Since 1980, DEDP has installed and is involved in 25 mini-hydropower plants with capacities ranging from 200 kW to 6 MW with a total capacity of 132 MW. In addition, there are also many village-level small hydropower generation stations built by the DEDP. The PEA operates three small hydropower generation stations of which the total capacity is 3.8 MW. The plan is to implement five more plants to increase the generation capacity to 18 MW (DEDE, 2005). Between the years 1982 to 2001, it is estimated that there were 59 units of small hydroelectric projects in Thailand (Table 5.13)

Table 5.13: Micro-hydropower installation by province (1982-2001)

ıe Hong Son
mpang
achuap Kirikan
k
urce: Greacen, Chris (2004)

Mae Hong Son	2
Lampang	4
Prachuap Kirikan	1
Tak	1

Source: Greacen (2004)

5.3 Summary

At household level, the major threats to Thai energy security are:

- The share of household expenditure on energy commodities in total household income has been increasing over the years. The share of monthly energy expenditure to the average monthly income is lower for higher income groups, e.g. 17% for d1 group and only 5% for d8 group.
- With the current state of the international oil market, it is a worrying prospect that the petroleum products have the major share of nationwide household energy expenditure in Thailand (62.9% or around Baht 1,017 per month in 2006).
- The rising urban population increases the energy demand in the residential sector further (due to normally higher per capita energy consumption of the urban households) and thus further raises the level of dependency on fossil fuels both at the household and national levels.
- The level of energy consumption shows a positive relation with the level income in Thailand, with the average household income shown to be growing every year.
- High ownership of energy consuming devices has been reported in the household sector.
- In 2006, cooking energy sources (i.e., fuel wood, charcoal, and LPG) account for 17.8 per cent of total household expenditure on energy of lowest income group as compared to less than 3.1 per cent of the highest income group (NSO, 2006). In the same year, based on the information from National Statistical Office (NSO,2006), the traditional fuels for cooking (fuel wood and charcoal) accounted for over 13 per cent of the household energy expenditure in the lowest income group as compared to less than 1 per cent in the case in the highest income group.
- LPG is the most popular fuel for cooking used by 57.5 per cent of the total number of households at the country level while 16.9% are found to use fuel wood and 15.9% use charcoal.

The measures undertaken to address the threats to energy security are listed as follows:

- Initial measures to enhance energy security at the household sector in Thailand have mainly been in the form of energy conservation activities e.g. DSM program enacted in 1992, and the ENCON program, 1994.

- The strategy to increase energy efficiency in the household sector, as proposed by DEDE, has focused on 5 tools/activities: standards and regulations, financial incentives, awareness raising, technical assistance and information service.
- In the past, promotion of renewable energy in the household sector has mostly been in the rural area to increase access to electricity. It is envisaged that future applications will be promoted among urban people by appropriate financial incentives (e.g. with PV and solar water heating).

Chapter 6
Conclusions and Recommendations for Further Study

6.1 Energy Security at National Level

Several national level energy security aspects are considered under this study. Energy import dependency, economic significance of energy imports, diversification of energy sources, depletion of reserves and effect of current demand growth are discussed under national level analysis. At the national level, the major threats to Thai energy security are:

- The import of primary energy, which currently stands at about 46% of the total primary energy consumption. This has remained at this level, and is expected to rise in the future. Natural gas imports are 14.4% of the total natural gas consumption, while about 2.5% of the total electricity consumption is imported. The growth rate of natural gas exceeds the growth rate of total natural gas supply.
- Diversification of primary energy supply shows slight improvements during the last five years. The Shannon Weiner index is about 1.65.
- In term of energy resources, Thailand has some reserves of coal (lignite), natural gas and a small amount of oil reserve. The estimated reserve to production ratio for oil is 4.1 years while it is 12.5 years for natural gas and 100 years for lignite.
- The future main primary energy sources which are expected to be used for the electricity generation are coal and natural gas.

The measures undertaken to address the threats could be listed as follows:

- Energy Efficiency: The Energy Conservation Promotion Act 2535 (1992) and the Energy Conservation and Promotion Fund (ECPF). These target designated factories, designated buildings and producers or distributors of energy equipment and machinery.
- Research and Development: The National Energy Policy Office (now the Energy Planning and Policy Office) funds R and D on policy studies, energy-efficient and renewable energy technologies, Transfer and adaptation to Thailand conditions of proven technologies from elsewhere, and information dissemination.
- A current strategy to promote renewable energy based power generation is to give incentives in terms of favourable buyback rates for small power producers (SPPs) and very small power producers (VSSP).
- Incentives to Small Scale Power Producers for electricity generation and promotion of renewable energy technologies, especially, biomass/biofuels, solid waste and solar electricity.

6.2 Energy Security at Household Level

At household level, the major threats to Thai energy security can be listed as follows:

- The share of household expenditure on energy commodities in total household income has been increasing over the years.
- The share of monthly energy expenditure to the average monthly income is lower for higher income groups, e.g. 17 per cent for income group earning Baht 3,000 or below per month and only 5 per cent for income group earning Baht 30,000 and above per month.
- With the current state of the international oil market, it is a worrying prospect that the petroleum products have the major share of nationwide household energy expenditure in Thailand (62.9% or around Baht 1,017 per month in 2006).
- The rising urban population increases the energy demand in the residential sector further (due to normally higher per capita energy consumption of the urban households) and thus further raises the level of dependency on fossil fuels both at the household and national levels.
- The level of energy consumption shows a positive relation with the level income in Thailand. The average monthly income of household in Thailand has grown from Baht 10,779 in 1996 to Baht 17,787 in 2006. Accordingly, household consumption is also rising in the country.
- High ownership of energy consuming devices has been reported in the household sector.
- As analysed in the section 5.1, based on the information from the National Statistical Office (NSO, 2006), cooking energy sources (i.e., fuel wood, charcoal, and LPG) account for 17.8 per cent of total household expenditure on energy of lowest income group as compared to less than 3.1 per cent of the highest income group (NSO, 2006). Traditional fuels for cooking (fuel wood and charcoal) accounted for over 13 per cent of the household energy expenditure in the lowest income group as compared to less than 1 per cent in the case in the highest income group.
- LPG is the most popular fuel for cooking used by 57.5 per cent of the total number of households at the country level while 16.9% are found to use fuel wood and 15.9% use charcoal.

The measures undertaken to address the threats to energy security are listed as follows:

- Initial measures to enhance energy security at the household sector in Thailand have mainly been in the form of energy conservation activities e.g. DSM program enacted in 1992, and ENCON program, 1994.
- Strategy to increase energy efficiency in the household sector, as proposed by DEDE, has focused on 5 tools/activities: standards and regulations, financial incentives, awareness raising, technical assistance and information service.
- In the past, promotion of renewable energy in the household sector has mostly been in the rural area to increase access to electricity. It is envisaged that future applications will be promoted among urban people by appropriate financial incentives (e.g. with PV and solar water heating).

6.3 Limitation and Scope for Further Studies

The threats to energy security to the poor and non poor households are extremely important in the face of rising oil prices. However, available data are not adequate to carry out analysis of the likely effects of rising energy prices on the affordability and likely fuel choice of different categories of households with significant changes in energy prices..

Also interesting is to analyze the effects of growing prices of modern fuels, for example, the possible movement of households down the energy ladder. This requires significant resources and efforts to gather necessary household level data as the first step.

The effects of different measures to improve energy security both at the household and national levels would require statistical analysis and/or energy system modelling.

These tasks could be undertaken in a further study on the energy security theme.

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