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APPLICATION OF LONG RANGE ENERGY ALTERNATIVE PLANNING (LEAP) MODEL FOR THAILAND ENERGY OUTLOOK 2030 : REFERENCE CASE

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ABSTRACT
The total energy consumption in Thailand rise up from 47,806 ktoe to 60,260 in 2004, the energy, the growth of economic make the demand of energy more and more, then we have to have future planning and manage to use the energy efficiently which can prepare support energy crisis of the country. Long range Energy Alternatives Planning (LEAP) is an accounting tools, used to simulated and managed scenario to preparing to support the energy situation in the future. In the case of Business As Usual (BAU) estimated that the overall energy demand rised up from 61,262 ktoe to 254,200 ktoe during 2004 – 2030

KEY WORDS
Long range Energy Alternatives Planning (LEAP), energy planning, scenario management

1. Introduction

The final energy consumption in Thailand had increased at the rate of 8.8 % in 2004, Commercial energy consumption, which comprises petroleum products, natural gas, coal and its products, and electricity, increased of 9.0%, and new & renewable energy increased of 7.8% Almost 60% of the total commercial energy supply in Thailand has been imported 57,714 ktoe, rose for the fifth year in a row at a arte of 12.5% over the previous year,. The total value of energy imported was 560,702 million Baht, an increase of 37.5 %

The changes in energy consumption patterned are affenatural increased based on population growth and demographic changes and the rise of the economic activity and development

2. Methodology

In this study, the current energy situation is created first in staring year (2004), and the energy demand projection in Business As Usual (BAU) scenario for this study is based on historical trend with the assumptions of the growth rate of number of population and number of household for the residential sector, the growth rate of Gross Domestic Product (GDP) from the study of economic growth 2000 – 2016 by Thailand Development Research Institute.

In 2004, Thailand has 64.5 million peoples, there is household amount of 18.9 million household, by in this amount 17.8% live in greater Bangkok. The energy consumption outside Greater Bangkok still use renewable fuel such as firewood, charcoal, and the husk stays very especially the area outside the municipal area, conversely, the energy consumption in greater Bangkok will stress to using the electricity and LPG whereas using renewable energy in a little quantity

In case of the business of usual expected to the amount of Thailand people still tends to increase but happen in the rate that is down because of the birth control and the value that like modern in the requirement in conceiving are down

Table 1
Thcted by two parameters, which are the e projection of Thailand people 2000 – 2030 [6]

year	Population (million people)	year	Population (million people)
2005	65.13	2018	69.84
2006	65.59	2019	70.10
2007	66.04	2020	70.34
2008	66.47	2021	70.58
2009	66.88	2022	70.80
2010	67.27	2023	71.01
2011	67.64	2024	71.21
2012	68.00	2025	71.40
2013	68.34	2026	71.59
2014	68.67	2027	71.76
2015	68.98	2028	71.92
2016	69.28	2029	72.08
2017	69.57	2030	72.23

The population projections for Thailand will suppose to have 70.34 million peoples in 2020 and from anticipation assessment that will have 72.23 million

peoples increase to are a person in 2030. The character of a family tend that will the single family more and more by suppose household size will quietly until have member amount about 3 persons per the household in the rate that is down about -1% per year until 2007, -0.6% per year during 2008 - 2016, and quietly is down with -0.3% per year until B.E. 2030. The proportion of population found that the residence people in Greater Bangkok have the proportion increase a little look like the linear, in order that suppose in the future the proportion will aforementioned should still increase in the rate originally by will have the proportion increases to are 18.3% in 2030

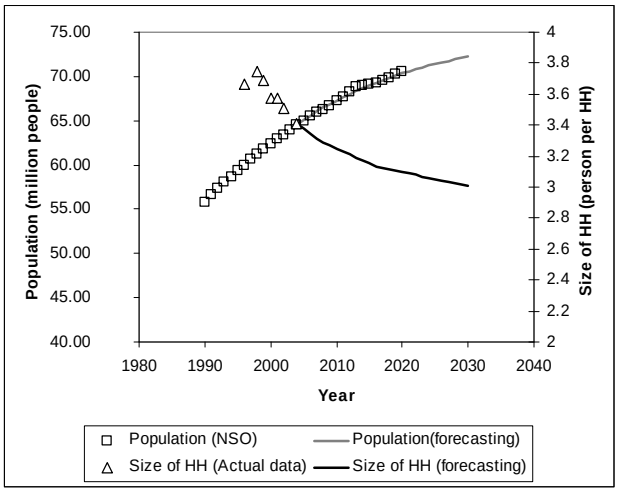

Figure 1. Population projection in BAU case [6]

The long ranged Energy Alternative Planning (LEAP) model has been developed by the Stockholm Environment Institute (SEI) Boston centre [8] and used to evaluate energy development policies. The concept of LEAP in an end-used driven scenario analysis. Additionally, the model includes the technologies and environmental database (TED) to estimate environmental emissions of the energy utilization. The LEAP model framework is disaggregated in a hierarchical tree structure of four levels; sector, sub sector, end used and device. The model contains two main modules: Energy module and TED module. In the energy demand module, the energy intensity values along with the type of fuel used in each device are required to estimated the energy requirements at sector, sub-sector, and end used level. The emission factors of different pollutants in the TED module are linked to the device level to appraise the environmental emission from the energy utilization during the planning horizon. The model requires data for at least the base year and the future years. Then, the future energy demand and emissions are estimated for the other years by interpolation, extrapolation or the growth rate changes methods. In this study, the current energy satiation is created in the starting year and the BAU scenario can be developed assuming a contribution of current trends.

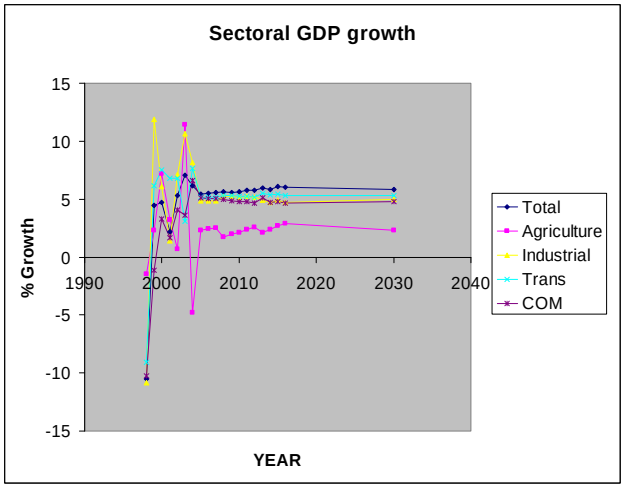

Figure 2. The growth rate of Gross Domestic Product [8]

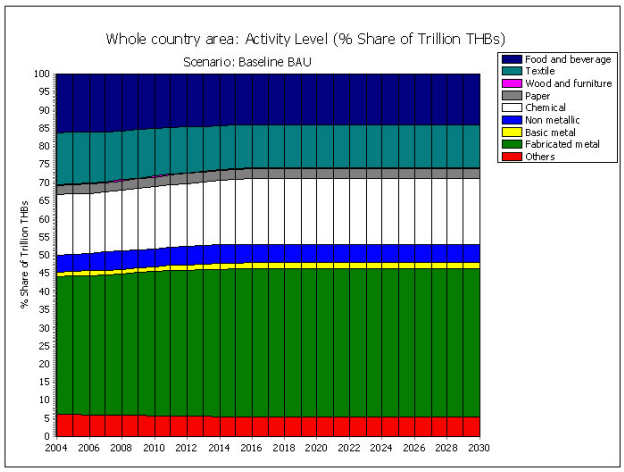

Figure 3. The percentage share of GDP in the industrial sub-sector

Input data for the LEAP model are number of household, population, Gross domestic product of Thailand and growth rate change in economic sector and sub-sector. The number of households is calculated base on data from the Department of provincial Administration, Ministry of Interior, The National Statistical Office (NSO) and The National Economic and Social Development Board (NESBD). The data required for LEAP model include the base year (2004) and any future years. By using the historical data and the function such as interpolation or growth rate method, the energy demand projection can be estimated for the other years from 2004 to 2030.

3. Results and discussion

In 2004, the household sector consumed energy 8,801 ktoe and accounted for 14.4 % of the final energy consumption for the whole country. Energy consumed in this sector comprised new & renewable energy such as charcoal, wood, and etc about 64.2%, electricity 23.9%, and petroleum product such as LPG, kerosene of about 11.9%.

The energy demand projection in the business in the business as usual case for this study based on the historical trend with the assumptions from the annual growth rate of household are using the current population statistics and the model estimate the population in year 2003 - 2016 and household amount for seek the relation and build the model will about household amount in the future.

The energy consumption behavior will in the future, suppose the household in greater Bangkok will should tend to use high efficiency electrical equipment while the household in the provincial should have using electricity per household , for the cooking suppose kind firewood and charcoal fuel should replacement with using LPG increase especially in provincial area

The Assumption of energy consumption in Transportation sector are LPG and NG are consumed only by Public land, Bio-diesel is consumed only by Private land and Share of gasoline and gasohol consumption are proportion to the total consumption in private and public land. In addition the current data for transportation sector shown in Table 3

Table 2
Annual growth rate of Energy intensity classified by type of fuels

Type of fuels	Greater Bangkok area	Provincial area
Electricity	-0.1%	+0.4
LPG)	+1.6% (2005-2014)	+2.7% (2005-2014)
	+1.4% (2015-2030)	+2.5% (2015-2030)
Kerosene	unchanging	unchanging
Wood	unchanging	-1.6%
Charcoal	unchanging	+0.8%
Paddy husk	unchanging	unchanging

The government has the aim encourages using natural gas, decrease using oil gasoline and the diesel in the overall image of 10 % countries within year 2010 enhance are 15 % within year 2015 and 20% within 2020 [5] by emphasize the target group such as because will make expenses in changing can pay back fast.

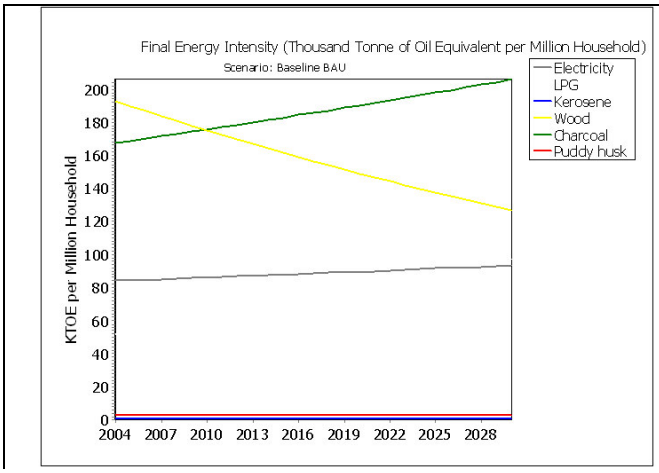

Figure 4. Final Energy Intensity 2004 – 2030 in the household sector

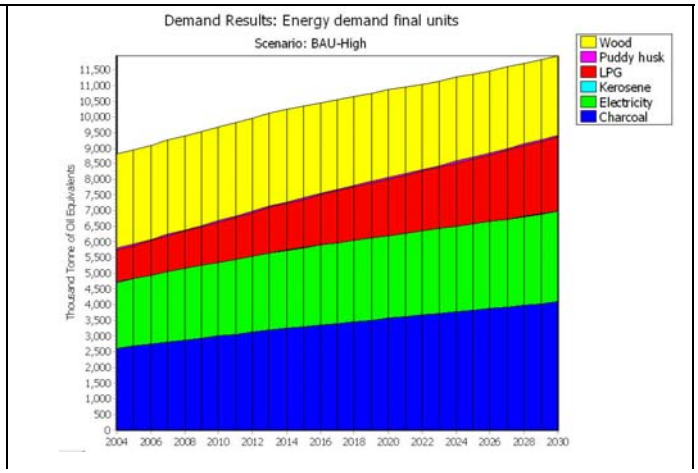

Figure 5. Estimated energy demand 2004 – 2030 in the household sector

Table 3
Current data for transportation sector (unit : ktoe)

Mode	% share	Electricity	LPG	NG	Jet Fuel	Gasoline	Gasohol	Diesel	Biodiesel	Fuel oil	Total
Private land	67.9					4,858	39	10,590	2		15,489
Public land	10.0		263	27		714	6	1,271			2281
Rail	0.4	4						87			91
Water	6.5							157		1326	1,483
Air	15.2				3,467						3,467

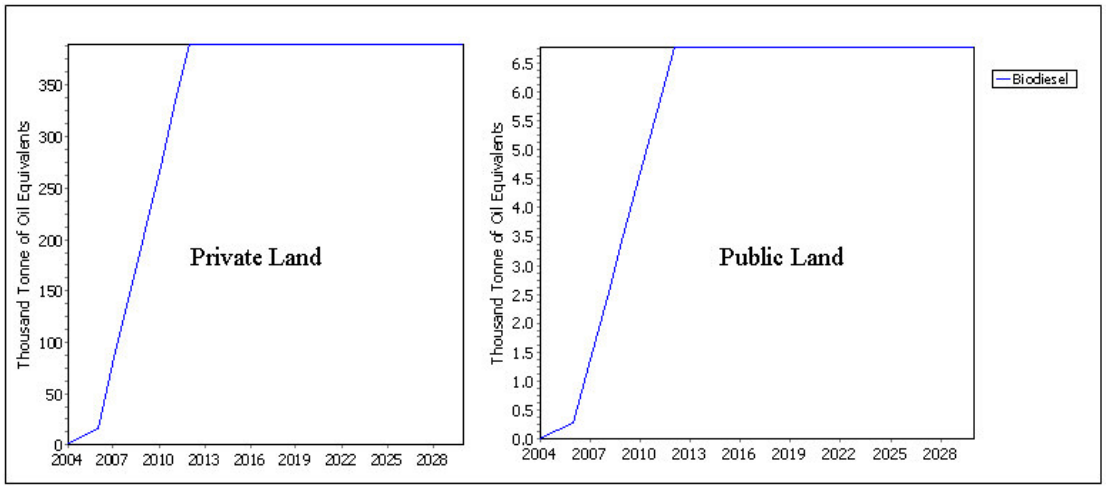

Figure 6. Future trend of Biodiesel consumption in Transportation sector

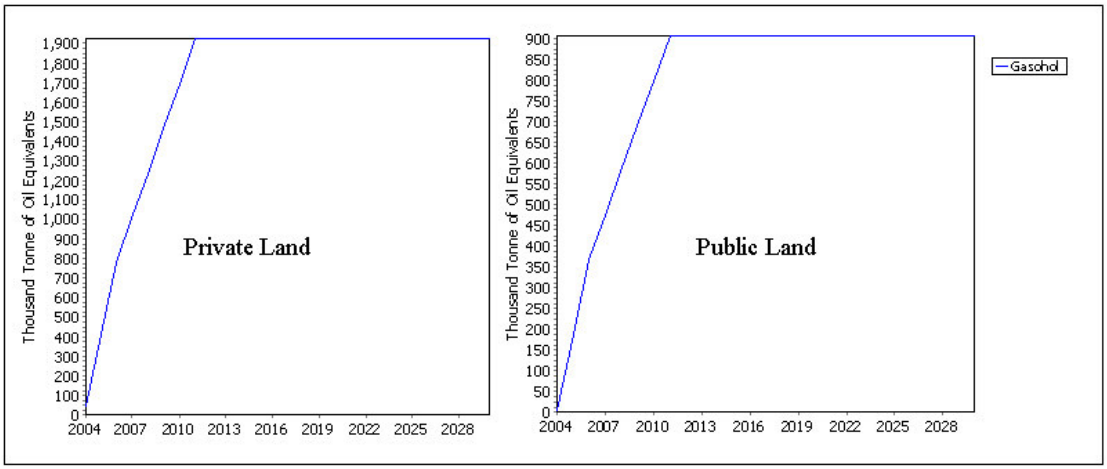

Figure 7. Future trend of gasohol consumption in Transportation sector

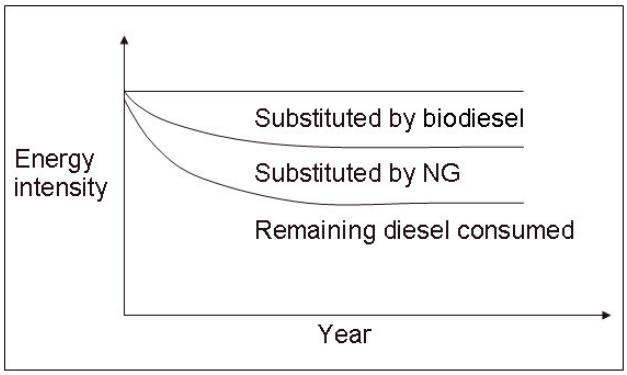

Figure 8. Future trend of Energy intensity in Transportation sector

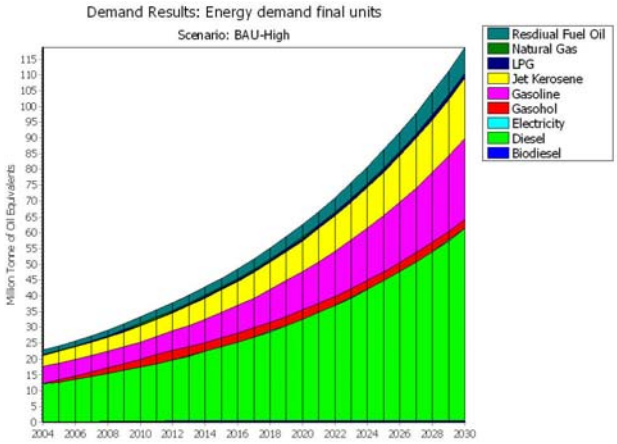

Figure 9. Estimated energy demand 2004 – 2030 in the transportation sector

The policies of the natural gas for the vehicle aims to decrease 10 % using gasoline (about 3 million liter per day) aimed to 219,000 automobiles that uses gasoline oil within year 2010, and decrease using 10 percentage of diesel by 281,000 automobiles in 2010 [5]

This assumption, In 2008 have using natural gas 220 cubic foot per day which replacement of gasoline and diesel of 2,200 million liter/year and equal to the lead can reach crude oil import of about 41,100 million baht per year, In 2010 will have 50,000 car uses natural gas,

80,000 million baht per year, can economize fuel value has 60,000 million baht per year [5]

Energy consumption in manufacturing sector in 2004 was 21,961 ktoe and account for 35.9% of the final energy consumption of the whole country. The manufacturing sector is the largest electricity consumption sector shared about 20.2 % of the energy consumption in this sector. However, coal and petroleum products are main fuel types used in industry with the proportions of fossil fuels (petroleum product and natural gas) and renewable energy of 59.1% and 20.1 % of the total energy consumption in 2004

Table 4
Current account of energy intensity in manufacturing sector (unit : ktoe)

	Anthracite	Bituminus	Coke	Other	Lignite	Total
	227	2544	42	1376	1729	
Food					30	30
Textile					62	62
Wood						
Paper	57					407
Chemical	57	717	12			786
Non metallic	57	1824	2	1147	1274	4303
Basic metallic	57	3	28	29		317
Fabricate metallic						
other					13	13

	Wood	Paddy husk	Baggase	Total
	884	1306	2949	
Food	278	1266	2949	4493
Textile				
Wood	10			10
Paper				
Chemical	109			109
Non metallic	217	40		257
Basic metallic				
Fabricate metallic				
other	270			270

Shares of fuels in sub-sector are based on equipments used in each sub-sector and anthracite equally is equally consumed in each sub-sector while the future trends of energy intensity in sub-sector of manufacturing sector are show in table following

Table 5
Future trend of energy intensity in manufacturing sector (growth rate per year)

	Food	Textile	Wood	Paper	Chemical	Non metallic	Basic metallic	Fabricate metallic	other
Electricity	-0.5%	-0.7%	n/a	-0.4%	-0.3%	n/a	n/a	n/a	-0.4%
Non electricity	-0.1%	-0.1%	n/a	-0.1%	-0.1%	n/a	n/a	n/a	-0.1%

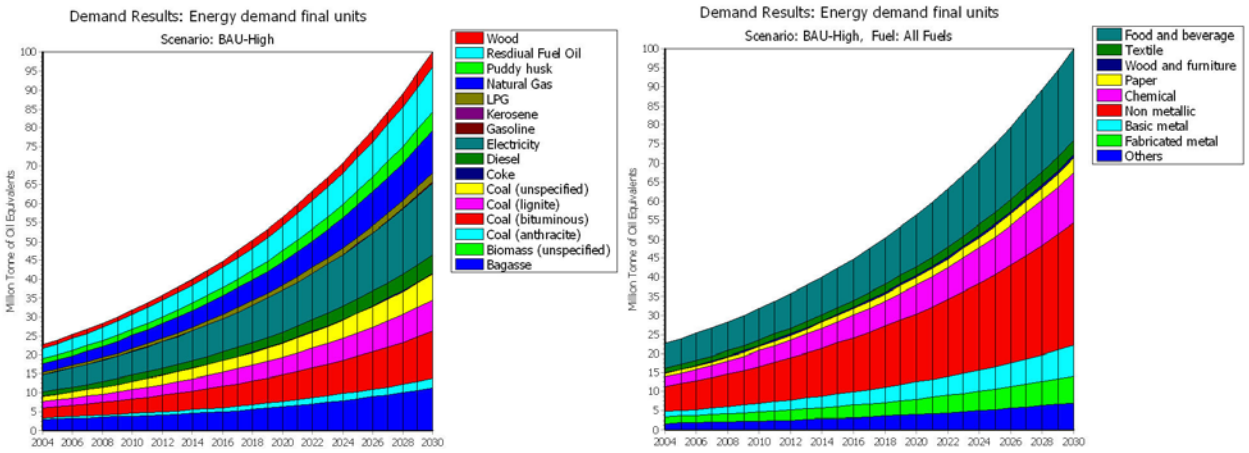

Figure 10. Estimated energy demand 2004 – 2030 in the industrial sector and energy demand classified by sub-sector

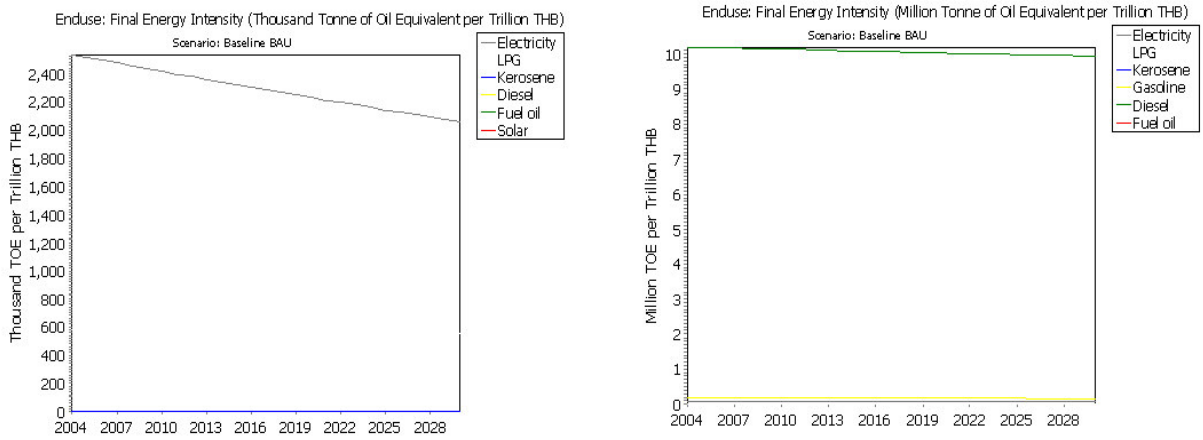

Figure 11. Future trend of energy intensity for Commercial sector (left) and Agricultural sector (right)

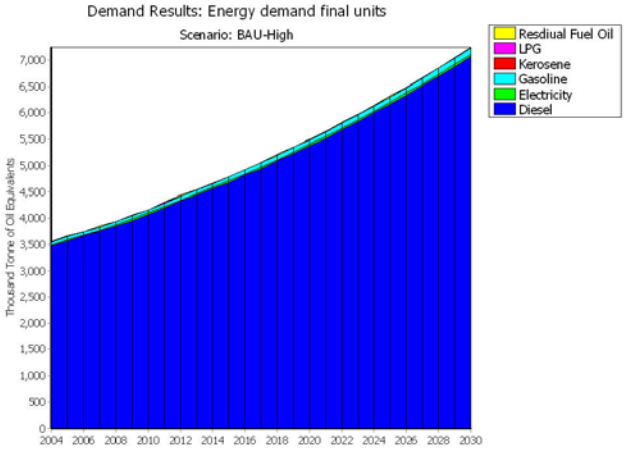

Figure 12. Estimated energy demand 2004 – 2030 in the commercial sector

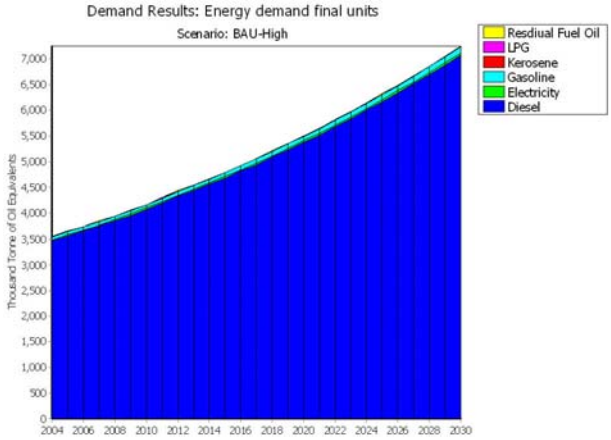

Figure 13. Estimated energy demand 2004 – 2030 in the Agricultural sector

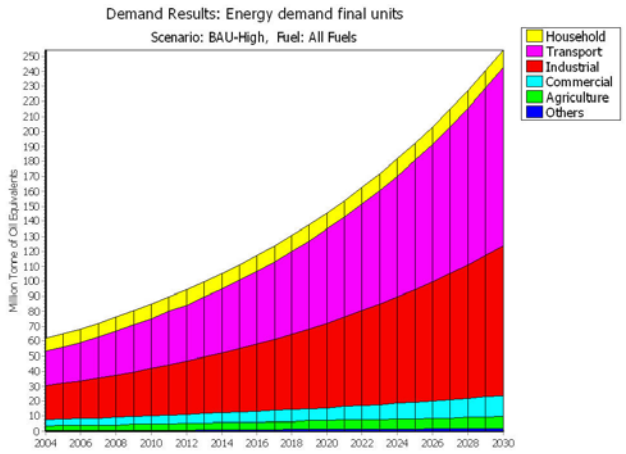

Figure 14. Estimated energy demand 2004 – 2030 in the overall sector

4. Conclusion

Base case of Thailand energy consumption patterned was mainly affected by Gross Domestic Product (GDP). Moreover, the household sector was affected by the number of household and number of population, the result of simulated by LEAP accounting tool to estimated the overall energy demand rised up from 61,262 ktoe to 254,200 ktoe during 2004 – 2030 Thus, Royal Thai government has to overcome barriers in the measure to reduced energy demand or energy efficiency measurement. This BAU scenario also helps in base case of Thailand energy situation for long term strategic or scenario planning and response to threat of energy crisis.

Acknowledgement

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