A STUDY ON THE ELECTRICAL ENERGY CONSUMPTION CHARACTERISTIC OF URBAN HOUSEHOLD IN KLANG VALLEY, MALAYSIA

BY

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ABSTRACT

Is Malaysian used too much of electrical energy, especially by household in urban area? The aim of this research is to investigate the current pattern and characteristic of Malaysia urban household electrical energy consumption. In year 2005, a research on the Malaysia urban household electricity consumption was carried out and found that the consumption rate is 2204 kWh/year. Based on those findings, a projection was done for year 2010 with a projected consumption of 3707 kWh/year or 68% increment within 5 years. All 14 items of electrical appliances are expected to increase in consumption especially air conditioner day time, which is expected to increase about 7 times from 54 kWh/ year to 369 kWh/ year. However, air conditioner night time was expected to take the lead in total consumption with 871 kWh/year or about ¼ of a household consumption. The hypothesis of this research is the urban household electrical energy consumption has direct relationship with the standard of living. Household with higher income will consume more electrical energy than the lower income household. The methodology of this research is by conducting case studies on 30 houses within Klang Valley to find out the current electricity consumption. 3 types of houses were chosen - bungalow, terrace house and condominium from various townships within Klang Valley. 30 randomly pick up samples were: 21 samples of terrace houses, 7 from condominium and 2 from bungalows. To enable comparison with the projected scenario, similar 14 items of electrical appliances includes refrigerator, rice cooker, water heater, washing machine, dryer, iron, fan, television, radio, air conditioner night time, air conditioner day time, lighting, vacuum cleaner and computers were selected for this study. No addition or new appliances are considered to maintain consistency. General information of the household such as household income, type of house, house built-up area and household size were collected as a measurement to the standard of living. A comprehensive study was carried out on the daily electricity consumption, trend and habit of electricity usage, and the relationship between lifestyle and electricity consumption. The average yearly electrical energy consumption collected from 30 samples is 6876 kWh/year for year 2011 or 3169 kWh higher than the projection of 3707 kWh/year. In comparison to the consumption in year 2005 of 2204 kWh/year, there is an increment of 4672 kWh/year or 200% of increment within six years. When analysing the above increment relate to style of living, the study found that the electricity consumption rate has direct relationship with the standard of living. The higher the standard of living, electrical energy consumption of the household will be higher.The above tremendous increment reflected the electricity consumption in Malaysia, especially in urban area has grown in a very fast pace beyond the projected scenario. This definitely will trigger the alarm of energy crisis in Malaysia. Green technologies are required to be introduced into house design, either passive approach or active approach to reduce the electrical energy consumption.

ملخص

هل الماليزيون يستعملون الكثير من الطاقة الكهربائية لا سيما في المناطق الحضرية؟ إن هدف هذا البحث هو التحقيق في النموذج الحالي وماهية استهلاك الطاقة الكهربائية من قبل الماليزيين في المناطق الحضرية. لقد أجري بحث عام ٢٠٠٥ حول استهلاك الماليزيين في المدن للطاقة الكهربائية حيث توصل البحث إلى أن نسبة الاستهلاك بلغ ٢٢٠٤ كيلوواط في السنة. واستناداً إلى هذه الأرقام بلغ حجم التخمينات حول نسبة الاستهلاك المستقبلي ٣٧٠٧ كيلو واط في العام أي زيادة قدرها ٦٨% في غضون خمس سنوات. ومن المتوقع أن يزيد حجم استهلاك استعمال جميع ١٤ الأجهزة الكهربائية خاصة أجهزة مكيفات الهواء خلال النهار حيث يتوقع أن يزيد الاستعمال سبعة أضعاف تقريباً أي من ٥٤ كيلوواط إلى ٣٦٩ كيلوواط في العام. أما استعمال المكيفات في أوقات الليل فيتوقع أن يبلغ حجمه ٨٧١ كيلوواط في العام أي أنه سيشكل ¼ من مجموع الاستهلاك الأسري للكهرباء. أن فرضية هذا البحث تبين أن هناك علاقة مباشرة بين حجم الدخل الأسري وبين استعمال الأسر الماليزية للكهرباء. فكلما زاد الدخل الأسري زاد حجم استعمال الطاقة الكهربائية أكثر من الأسر منخفضة الدخل. تتضمن منهجية هذا البحث إجراء حالات دراسية على ٣٠ بيتاً في منطقة (Klang Valley) لمعرفة الاستهلاك الحالي للكهرباء. وتم اختيار ثلاثة أنواع من البيوت: البيوت الكبيرة، والبيوت الصغيرة وأخيراً الشقق وذلك في مختلف القطاعات السكنية في منطقة (Klang Valley). وكانت نتيجة العينات العشوائية للثلاثون بيتاً: ٢١ بيتاً صغيراً وسبعة شقق وبيتين كبيرين. وعلى سبيل المقارنة مع التخمينات، قامت الدراسة باختيار ١٤ من الأجهزة الكهربائية المتشابهة وهي الثلاجة، وطاهي الرز، وسخان الماء، وغسالة الملابس، والمجففة، والمكواة، والمروحة والتلفزيون والراديو مكيفات الهواء المستعملة في الليل ومكيفات الهواء المستعملة خلال النهار، والإضاءات، والمكنسة الكهربائية والكومبيوتر. ولم يتم إضافة أي جهاز آخر للمحافظة على نسق هذه الدراسة. كما تم جمع معلومات عامة مثل دخل الأسرة، ونوع البيت، مساحة بناء البيت وعدد أفراد الأسرة كمؤشر لقياس المستوى المعيشي. أجريت دراسة شاملة حول الاستهلاك اليومي للكهرباء، واستعمال الكهرباء باعتباره عادة وكذلك العلاقة بين أسلوب الحياة واستهلاك الكهرباء. إن معدل الاستهلاك السنوي للكهرباء من الخلال ٣٠ العينات بلغ ٦٨٧٦ كيلوواط لعام ٢٠١١ أي زيادة قدرها ٣١٦٩ كيلوواط قياساً بالرقم التخميني البالغ ٣٧٠٧ كيلواط في العام. أما مقارنة بحجم استهلاك الكهرباء عام ٢٠٠٥ والبالغ ٢٢٠٤ كيلوواط فهناك ارتفاع بلغ حجمه ٤٦٧٢ كيلواط في العام أي زيادة قردها ٢٠٠% في غضون ستة أعوام. وعند تحليل الزيادة أعلاه المتعلق بأسلوب الحياة وجدت الدراسة أن لنسبة استهلاك الكهرباء علاقة مباشرة مع المستوى المعيشي. فمع زيادة مستوى الحياة يرتفع حجم استهلاك للكهرباء من قبل الأسر. وتعكس النتائج أعلاه ارتفاع حجم استهلاك الكهرباء من قبل الأسر الماليزية لا سيما في المدن وبوتيرة سريعة متعدية التخمينات الأولية. ويعد هذا انذار بحدوث أزمة طاقة في ماليزيا. لذلك يقتضي الأمر التعرف على التكنولوجيا الخضراء وإشراكها في تصميم البيوت أما بالطريقة الإيجابية أو السلبية من أجل تقليل استهلاك الطاقة الكربائية.

ABSTRAK

Adakah rakyat Malaysia mengguna terlalu banyak tenaga elektrik, terutamanya rumah tangga di kawasan bandar? Tujuan penyelidikan ini ialah untuk mengkaji corak dan cirri-ciri penggunaan elektrik masa kini dalam rumah tangga di bandar Malaysia. Pada tahun 2005, satu kajian mengenai penggunaan elektrik oleh rumah tangga di bandar Malaysia telah dijalankan dan mendapati kadar penggunaan adalah 2204 kWj/tahun. Berdasarkan penemuan kajian tersebut, satu unjuran untuk tahun 2010 telah dibuat dan medapati ramalan penggunaan ialah 3707 kWj/tahun atau 68% penambahan dalam 5 tahun. Kesemua 14 jenis alat-alat elektrik diramalkan peningkatan dalam penggunaan elektrik terutamanya pendingin udara masa siang, dimana dijangkakan bertambah sebanyak 7 kali penggunaan dari 54 kWj/tahun ke 369 kWj/tahun. Bagaimanapun, pendingin udara masa malam adalah dijangka mendahului jumlah penggunaan dengan 871 kWj/tahun atau lebih kurang ¼ penggunaan rumah tangga. Hipotesis penyelidikan ini ialah penggunaan tenaga elektrik rumah tangga di kawasan bandar mempunyai hubungan secara langsung dengan taraf hidup. Rumah tangga berpendapatan tinggi akan mengguna lebih tenaga elektrik dibanding dengan rumah tangga berpendapatan rendah.Metodologi penyelidikan ini ialah melalui kajian kes terhadap 30 buah rumah dalam Lembah Klang untuk mengetahui penggunaan elektrik masa kini. 3 jenis rumah telah dipilih – rumah banglo, rumah teres dan pangsapuri daripada beberapa bandar dalam Lembah Klang. Daripada 30 sampel yang dipilih secara rawak: 21 sampel ialah rumah teres, 7 sampel pangsapuri dan 2 sampel rumah banglo. Untuk membolehkan perbandingan dengan keadaan ramalan, 14 jenis alat-alat elektrik yang sama termasuk peti sejuk, periuk nasi, pemanas air, mesin cuci baju, pengering rambut, seterika, kipas, televisyen, radio, pendingin udara masa malam, pendingin udara masa siang, lampu, pembersih vakum dan computer telah dipilih untuk penyelidikan ini. Tiada tambahan atau alat elektrik baru dipertimbangkan untuk mengekalkan ketekalan.Maklumat am rumah tangga seperti pendapatan rumah tangga, jenis rumah, keluasan rumah dan saiz rumah tangga telah dikumpul sebagai pengukuran taraf hidup. Satu kajian terperinci terhadap penggunaan elektrik harian, arah aliran dan tabiat penggunaan elektrik, dan hubungan antara taraf hidup dan penggunaan elektrik telah dijalankan. Purata penggunaan tenaga elektrik tahunan yang telah dikumpul dari 30 sampel itu ialah 6876 kWj/tahun untuk tahun 2011. Dari keputusan analisa, ia menunjukkan penggunaan sebenar adalah lebih tinggi dari ramalan yang dibuat pada tahun 2005. Jika dibandingkan dengan penggunaan pada tahun 2005 yang tercatat 2204 kWj/tahun, sebanyak 4672 kWj/tahun telah ditambah atau sebanyak 200% telah bertambah dalam enam tahun. Apabila menganalisa penambahan di atas berhubung dengan taraf hidup, kajian mendapati bahawa kadar penggunaan elektrik mempunyai hubungan secara langsung dengan taraf hidup. Semakin tinggi taraf hidup, semakin banyak penggunaan elektrik.Peningkatan yang besar tersebut menunjukkan penggunaan elektrik di Malaysia, terutamanya dalam kawasan bandar telah menumbuh dengan pesatnya dan melebihi keadaan ramalan. Ini semestinya mencetuskan penggera krisis tenaga di Malaysia. Teknologi hijau perlu diperkenalkan dalam rekabentuk rumah, samada pendekatan aktif atau pasif, untuk mengurangkan penggunaan elektrik.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Building Services Engineering.

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Muhammad Abu Eusuf
Main Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Building Services Engineering.

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Dean, Kulliyyah of Architecture &
Environmental Design

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Ng Wai Tuck

Signature …… Date ……..

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Affirmed by Ng Wai Tuck

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Signature Date

To my wife Poh Moi for her continuous love, support and inspiration.

To my daughter, Jie Yi and my son, Jia Hua for their lovely smile, unconditional love and understanding

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LIST OF ABBREVIATIONS

BTU	British Thermal Unit
Cetdem	Centre for Environment, Technology and Development Malaysia
GHG	Green House Gases
GNI	Grosss National Income
GWh	Gigawatt hour
GWP	Global Warming Potential
IEE	The Institution of Electrical Engineers
kWh	kilowatt hour
kWh/yr	kilowatt hour/ year
LCD	Liquid crystal display
LED	Light emitting diode
PJ	Petajoule
RM	Ringgit Malaysia
sq.ft.	square foot
TOE	Tonne of Oil Equivalent
TNB	Tenaga National Bhd

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Malaysia faces many challenges in the era of globalisation on its quest to achieve developed nation status. Sustainable development of the energy sector is a pivotal factor to maintain economic competitiveness and progress. The structural shift of Malaysia's economy from one of agriculture to industrialization since independence has brought about an improved standard of living among Malaysians especially for those who are staying in urban area, such as Kuala Lumpur, Pulau Pinang and Johor Bharu. World Development Indicator released by The World Bank (2011) indicated an impressive economic growth achieved by Malaysia from year 1980 to 2009 with Gross National Income (GNI) per capita in Purchasing Power Parity Dollars (PPP$) of $2,250 in 1980 to $13,710 in 2009 has further boosted the confidence of Malaysians for better economic performance in the future if it continues to sustain its competitiveness. Vision 2020, created to achieve the ambition of becoming an industrialized nation, has raised Malaysia's aspiration of comfort and safety to a drive for affluence. One of the indicators of increasing affluence enjoyed by Malaysians is the ownership and usage of electrical appliances.

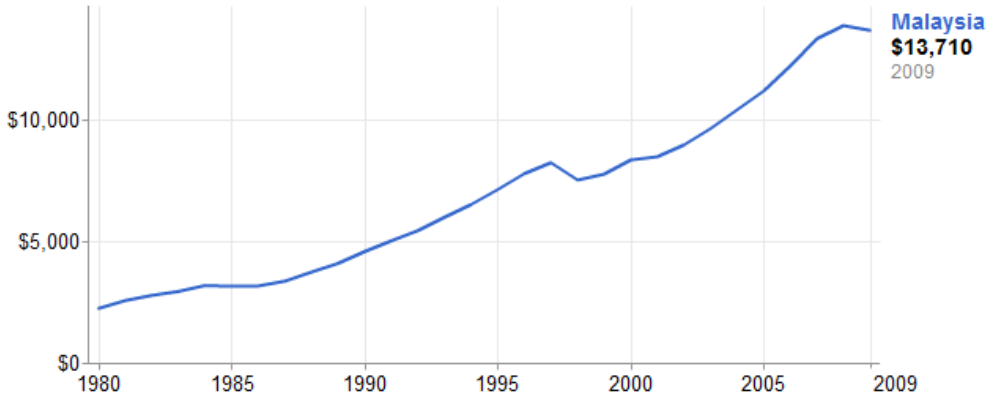

Figure 1.1: Malaysia GNI per capita in purchasing power parity dollars (PPP$)
Source: The World Bank (2011)

With the higher income per capita, the ownership and usage of electrical appliances by Malaysians were also increase. Othman and Ong (1995) reported almost every household (97.0 percent) owns at least one television set. Whereas in 1984, only 79 percent of households in Peninsular Malaysia owned a television set.

The increment on the ownership of electrical appliances will directly influence the electrical power consumption of the Malaysian household. In year 2005, CK Tang in his research with the title '*Energy Efficiency in Residential Sector*', developed a projected reference scenario of Malaysia household electricity consumption in 2010 and 2020. The reference scenario was developed based on the household growth scenario and household income distribution scenario of Malaysia.

The detail of the reference scenario was shown in Table 1.1. From the projection, the ownership of each appliance was increased from year 2005 to 2010 and 2020, for example, the ownership of refrigerator was estimated to increase from 58% in year 2005 to 93% in 2010 and ownership of computer was estimated to increase from 50% in year 2005 to 93% in 2010.

Table 1.1
Reference Scenario of Electricity Consumption Malaysia

	Year 2005		Year 2010		Year 2020	
ITEM	**Average per household kWh/year**	**Estimate % of household using item**	**Average per household kWh/year**	**Estimate % of household using item**	**Average per household kWh/year**	**Estimate % of household using item**
Refrigerator	530	58%	760	93%	1222	93%
Rice Cooker	125	67%	156	93%	218	93%
Water Heater	278	45%	435	77%	748	77%
Washing Machine	272	45%	425	77%	732	77%
Dryer	2	4%	16	12%	42	12%
Iron	58	67%	72	93%	100	93%
Fan	86	67%	108	93%	151	93%
Television	58	67%	73	93%	102	93%
Radio	49	67%	61	93%	85	93%
Air Conditioner night time	419	38%	871	77%	1774	77%
Air Conditioner day time	54	4%	369	12%	999	12%
Lighting	233	67%	291	93%	407	93%
Vacuum Cleaner	5	38%	11	77%	22	77%
Computers	34	50%	60	93%	112	93%
Total (%-Average)	2204	49%	3707	77%	6714	77%

Source: CK Tang (2005)

Due to the increment on the ownership of electrical appliances, the total electricity consumption will also increase from 2204 kWh/yr in 2005 to 3707 kWh/yr in 2010 with growing rate of 68%. Furthermore, the consumption will increase to 6714 kWh/yr in 2020 which is about triple of consumption in compare to year 2005.

1.1 BACKGROUND OF STUDY

Malaysia has about 6.4 millions household in year 2010 (Department of Statistics Malaysia, 2010). In a micro context, any changes on the household electricity energy consumption have direct impacts to Malaysia national energy challenge and national

energy policy. If we enlarge the issue to the macro level as a global issue, the changes of electricity consumption of individual household will also change the global energy consumption.

1.1.1 The Global Energy Challenges

The global population has more than doubled since 1950 of 2.5 billion and is expected to increase by 33% by 2050 to 9.3 billion (World Population Prospects, 2010). The current global population in 2011 as estimated by United Nation is about 7 billion. To support economic growth, the world will need vast amounts of extra energy. The challenge is to meet the rising demand in economically, environmentally and socially responsible ways, including dealing with greenhouse gas emissions.

Shell (2012) in the article titled '*The energy challenge*' commented that the world faces three hard truths in meeting the energy challenge.

Firstly, demand for energy is growing rapidly, as countries including China and India enter the most energy-intensive phase of economic development.

Secondly, supplies of easily accessible oil and natural gas are unlikely to keep up with demand after 2015. The world will have to use energy more efficiently and increase its use of other sources of energy. This means more renewable like solar, wind and bio-fuels, more nuclear energy, more coal, and more oil and natural gas from difficult to reach locations or unconventional sources like oil sands.

Thirdly, as a result Carbon Dioxide (CO_2) emissions from energy, responsible for more than half of man-made Green House Gas (GHG) emissions are set to rise, even as concerns about climate change grow.

Global environmental issues, such as climate change and deforestation, have emerged as new challenges to people throughout the world. Many countries with aims

to become a low-carbon society through green growth achieved via green technologies and green industries which enhance eco-efficiency while minimizing adverse environmental impacts.

1.1.2 Malaysia National Energy Policy

As posted in the webpage of Ministry of Energy, Green Technology and Water, Malaysia, the Malaysia National Energy Policy has three main objectives. The three principal energy objectives of Malaysia are instrumental in guiding the future energy sector development. They are as follow:-

i. The Supply Objective

   To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country.

ii. The Utilization Objective

   To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption.

iii. The Environmental Objective

   To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

For supply, the main aim is to extend the life of domestic resources and diversify away from oil to promote other energy forms. Utilization depends heavily on the industry and consumers to integrate energy efficiency programmes and develop demand-side initiatives to curb consumption. Energy and the environment are linked

at every level, thus the requirement for mandatory assessments to address negative impacts.

To date the Government's approach to realize the second objective on utilization is to rely heavily on the energy industry and consumers to exercise efficiency in energy production, transportation, conversion, utilization and consumption through the implementation of awareness programmes. Demand side management initiatives by the utilities, particularly through tariff incentives, have had some impact on efficient utilization and consumption.

Government initiatives to encourage co-generation are also aimed at promoting an efficient method for generating heat energy and electricity from a single energy source. This also contributes to a reduction in the costs of conversion.

To enhance the level of achievement of the Utilisation Objective, the market approach needs to be supplemented by the regulatory approach. Towards this end, the energy efficiency regulation is currently being formulated and it will be focusing on designation of large consumers, appointment of energy managers and equipment labelling.

The Government is conscious of the need to work with the industry to promote energy efficiency in order to reduce inefficient and wasteful use of energy in industrial facilities. Towards this end, a number of industrial energy efficiency initiatives are being planned and these include energy auditing program, energy service companies support programme and technology demonstration programme.

1.1.3 Energy challenges in Malaysia

Malaysia faces many challenges in the era of globalisation on its quest to achieve developed nation status. Sustainable development of the energy sector is a pivotal

factor to maintain economic competitiveness and progress. For more than 20 years, Malaysia has successfully diversified its energy consumption by taking advantage of domestic energy resources such as oil and natural gas.

Malaysia has a good mix of energy resources; oil, natural gas, coal and renewable energies such as hydro power electricity, biomass, and solar. Instead of electricity generation, these most popular types of energy those being used in Malaysia widely are also important in various fields such as transportations, industries, residential and commercials, and also being exported to some countries.

The world oil crisis in the 1970s powerfully illustrated that concerns over resource scarcity were justified. The situation exposed the vulnerability of the energy supply and the over-dependence on oil as a fuel. These conditions lead to the necessity for the diversification of energy fuel resources. Thus, this era triggered the development of energy-related legislation and policies to address energy requirements.

Danida (2005) reported in the report with title 'Energy Outlook of Malaysia' for Economic Planning Unit Malaysia and Ministry of Energy, Water and Communications, Malaysia said that: The main challenges Malaysia facing is the projected growth in fuel demand will require significant imports to meet the final energy demand in 2020. Furthermore, the projected fuel mix will also significantly increase Green House Gas emissions, both in real terms and in terms of emission factor – the latter particularly for the power sector. The reference scenario of the development in energy demand by sector and energy supply by fuel in Malaysia is shown in

Figure 1.2 and Figure 1.3. The reference scenario was developed to project the energy supply and demand from year 2003 until 2020.

The main observations from the Reference Scenario are:

- The energy supply will double up from 58 Million Tonnes of Oil Equivalent (TOE) in 2003 to 125 Million TOE in 2020
- However, the final energy demand will increase almost threefold, from 33.9 Million TOE in 2003 to 83.5 Million TOE in 2020, which is much more higher than the supply

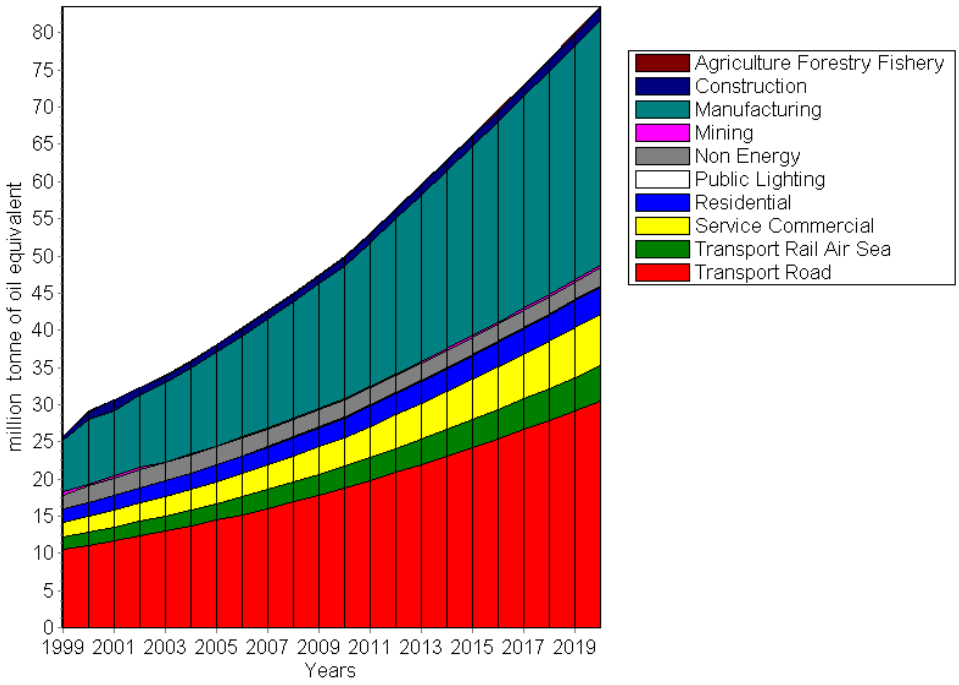

Figure 1.2: Final energy demand by sector–Reference Scenario
Source: Danida (2005)