Highlights and Prospects of Energy Consumption in Hong Kong

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SUMMARY

Energy is very important to a metropolitan city like Hong Kong and there are a number of problems associated with the use of energy. The supply-side and demand-side energy situations of Hong Kong have been changing rather rapidly over the past years. Different types of energy indicators are available, but each one of them has its own limitations. The aggregate energy intensity figures of Hong Kong compare favorably to other countries and economies. However, availability of end-use data is essential for an accurate understanding of the energy consumption situation. The historical energy consumption trends at disaggregate levels provide useful insights on potential areas for improvement, and thus facilitates formulation of policies and design of initiatives to influence energy consumption of different consuming sectors, and also provides useful data to facilitate estimation of future consumption. With a growing population, overall energy consumption of Hong Kong is expected to rise substantially in the coming decades. The efforts put into energy efficiency and conservation by the Government are well-demonstrated by the various initiatives being or planned to be implemented. Studies are also being undertaken to map out future supply-side scenario.

Keywords: energy indicators, energy end-use, energy consumption trends, energy efficiency and conservation

1. INTRODUCTION

Energy is crucial to the development of modern society. For many industrialized nations and economies, energy policy is a matter of great national/governmental interest.

In year 2000, we paid roughly HK$52 billion[1] (from end-users' side) for all of the final energy consumed within the territory, including electricity, gas and oil products. With the scarcity of flat land within an area of only 1097 square km accommodating the already very high and ever increasing population (with a mid-year population of about 6.8 million in year 2000 and projected to increase to about 9 million in 2029 [1]), we need a great deal of energy resources to create a habitable indoor environment inside the high-rise commercial and residential buildings, and we need a great deal of energy to support our various economic activities and infrastructure machinery.

There are no indigenous energy resources in Hong Kong, we have to rely totally on imported

[1] Excluding indirect taxes.

fuels. Besides large quantities of oil products, we also imported[2] about 6 million tonnes of coal and 2.2 million tonnes of natural gas [2] in year 2000, both for electricity generation (and we imported electricity too). Despite the fact that energy security has not been a very acute problem for Hong Kong, our economy did suffer in times of high oil prices, although not to the extent as great as the industrialized economies[3].

Besides energy security, there is a great deal of concern over the environmental impact of combustion of fossil fuel. Most of our energy comes from combustion of fossil fuels - oil, gas, and coal - that releases a number of by-products such as SOx, NOx, and particulates. All these by-products may to a certain extent affect our health and our environment. Unfortunately, the hilly terrain coupled with the high-rise and compact city formation of Hong Kong does not allow for rapid dispersion of pollutants generated by combustion of fuel, particularly motor fuel.

Another combustion by-product is carbon dioxide, which being a greenhouse gas, is a potential major contributor to global warming. Acknowledging the seriousness of the problem, many countries around the world are taking active measures to cut down their greenhouse gas emissions, particularly the European countries.

Finally, we understand that fossil fuel reserves are finite. We often hear discomforting "predictions" that the fossil fuel reserves will be exhausted in imminent decades. The message cannot be ignored. Here brings in the notion of "inter-generational equity" - are we enjoying our life at the expense of our future generations? We burn fuels which pollute our environment, generate greenhouse gases which warms up our earth, and more importantly, we are using up the earth's precious reserves of fossil fuels thus leaving little for our heirs. So, we must use energy wisely and responsibly.

2. TERMINOLOGY

Before we talk about energy in Hong Kong, there are a few key terms that need to be defined here. First of all, "end-uses" of energy refer to the specific purposes for which energy is finally consumed. Lighting, air-conditioning, cooking, refrigeration, motive power, etc. are all end-uses of energy. The energy consumed by end-uses is known as "final energy", to distinguish it from "primary energy" which is sum total of the energy consumed at end-use level plus energy losses during transformation (e.g. electricity generation) and distribution.

For Hong Kong, electricity, Towngas, LPG, petrol, diesel oil, heavy fuel oil, coal, wood charcoal are different forms (or "carriers") of final energy. For primary energy sources, we have natural gas, imported electricity, coal, naphtha (for Towngas generation), LPG, petrol, diesel oil, heavy fuel oil.

The Hong Kong Energy Statistics produced by the Census and Statistics Department provide quarterly and annual statistical figures for different energy sources. The "Primary Energy Requirements (PER)" and "Final Energy Requirements (FER)" figures are reported in this publication. These are based on import/export data and on data reported by major energy

[2] The figures are referring to "retained imports" rather than total imports.

[3] To cushion Hong Kong's economy from the adverse effects of any shortage of oil supplies which may occur in contingency situations beyond its control, the Government has entered into a voluntary Code of Practice with major oil importing companies and the gas company. Under the voluntary code, these companies will hold a 30-day strategic reserve on gas oil and naphtha.

suppliers, and so are derived using an essentially "top-down" approach. The "Primary Energy Requirements" and "Final Energy Requirements" figures correspond to the "Total Primary Energy Supply (TPES)" and "Total Final Energy Consumption (TFC)" figures respectively which are the terms used in international publications.

Besides PER and FER, the Electrical and Mechanical Services Department also compiles another set of energy consumption data using a bottom-up approach and using data from various statistical sources, surveys and estimations. The energy end-use data are stored in the Hong Kong Energy End-use Database. The Energy End-use Database provides the Government with energy information base and analytical tools for evaluating energy efficiency policies. Although the data are mainly for Government's internal use, a set of "basic" data has been published for public use through the department's web-site (http://www.emsd.gov.hk/). Currently, the Energy End-use Database contains data from the years 1984 to 1998, and will be updated on an year-on-year basis.

The "Total End-use Energy Consumption (TEUC)" figure for each year is obtained by summing the energy consumption of all end-uses in the Energy End-use Database. The scope of the Energy End-use Database is such that TEUC basically includes all final energy consumed by local end-uses of Hong Kong up to the air/sea/land ports, excluding regional and international port-to-port transportation energy consumption. In this way, TEUC reflects solely the "internal" energy consumption of Hong Kong at the end-use level. In this sense, TEUC is complementary to PER and FER in reflecting the energy scene of Hong Kong.

3. WORLD TREND AND OUR POSITION

The world primary energy supply is projected by the International Energy Agency (IEA) [3] to increase by 57% from 1997 to 2020, from 3.60×10^5 PJ [4] to 5.66×10^5 PJ. Oil will remain the dominant fuel in the primary energy mix with a share of 40% in 2020. Natural gas will be the second fastest growing energy source after non-hydro renewables in the global energy mix, with a share of 26% in 2020. The bulk of this increase will come at the expense of nuclear (5%) and coal (24%). Hydro and other renewables' shares will be 2% and 3% respectively. For comparison purpose, the Energy Information Administration of the United States projected the world energy consumption to increase by 59% from 1999 to 2020 [4], broadly consistent with the projection by IEA.

What is our share in this total picture? Here are some figures from the IEA Key World Energy Statistics 2000 Edition [5] which contains reported energy statistics for most economies in the world for the year 1998: In 1998, our population was only 0.11% of world total, our GDP in purchasing power parity (PPP[5]) terms was 0.41% of world total, while our TPES was 0.17% of world total. Of the 134 economies listed in the publication, when arranged in increasing order of the TPES-per-dollar (GDP in PPP terms) figure, we ranked number 6 along with two other economies in the same ranking[6]. That means we have been using energy rather productively, due to the temperate climate and compact formation of our city, relatively low share of industries in our economy, and efficient use of energy.

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[4] PJ = petajoule = 10^{15} joule

[5] Use of PPPs for computation of GDP produces a GDP that has been corrected for differences in price levels between countries or economies.

[6] Those economies with TPES-per-dollar figures lower than Hong Kong are: Bangladesh, Morocco, Myanmar, Uruguay, Yemen.

Another publication which contains detailed energy statistics for APEC economies is the APEC Energy Statistics [5]. Figures 1 and 2 show the comparison between Hong Kong and some other APEC economies in terms of TFC-per-capita and TFC-per-dollar GDP (in PPP terms) for the year 1998, using data from the publication. These figures re-confirm the previous point about our productive use of energy.

4. AGGREGATE ENERGY CONSUMPTION TRENDS

To understand the energy consumption trend of Hong Kong, we first look at Figure 3 which shows the TEUC trend for Hong Kong from 1984 to 1998, in TJ [7], superimposed on which are the population and GDP trends. TEUC basically followed the GDP trend in the 80s and then depart in the 90s. The departure is due to the fact that TEUC does not include the fuel consumed by marine vessels travelling between Hong Kong and nearby ports, which became increasingly significant in the 90s, and also due to the declining industrial activities.

Figure 4 shows the breakdown of TEUC from 1984 to 1998 into energy carrier types. We can see that electricity had been growing almost linearly while gas and oil did not. It is interesting to note that electricity consumption grew almost hand-in-hand with GDP (with an elasticity of about unity).

For 1998, electricity accounted for about 45% of TEUC, Towngas and LPG about 10%, and the rest being other oil products like kerosene, petrol, diesel, and so on.

Looking ahead into the future, Hong Kong is expected to continue to expand in population and in the aggregate economic activities. It is estimated that TEUC will increase roughly by about 26% in the coming decade. As energy demand is directly related to amount of economic and human activities, such kind of projection goes along with it a set of assumptions about economic growth, population growth, and structure of economic activities. It is assumed that the economy will continue to grow, labor productivity will increase (i.e. GDP will grow faster than population), and the structure of the economy will continue to change as it has been doing. The growth rate of electricity is expected to be faster than that of TEUC. In year 2011, the share of electricity in TEUC is estimated to be around 52%.

5. ENERGY CONSUMPTION BY SECTOR AND END-USE

The energy end-use data in the Hong Kong Energy End-use Database are organized in a "sector" - "segment" - "end-use" - "technology" breakdown structure. There are 4 major sectors - Residential, Commercial, Industrial, Transport. Figure 5 shows the trend of each sector within TEUC from 1984 to 1998. Obviously the fastest growing sector is the Commercial Sector while the Industrial Sector has been declining since the late 80s. The share of each sector within TEUC in 1998 were: Residential 17%, Commercial 32%, Industrial 14% and Transport 36%. These percentages are estimated to change to 20%, 36%, 11%, and 32% respectively in 2011.

Figures 6 shows the composition of the Residential Sector, Commercial Sector, and Transport Sector when broken down into the major end-uses, for the year 1998. One may find it inspiring to know that space conditioning accounted for almost one-third of all electricity consumption, and about 15% of TEUC.

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[7] TJ = terajoule = 10^{12} joules

6. SUPPLY-SIDE TRENDS

The major change in the supply side trends came about in electricity generation. Figure 7 shows the evolution of fuel mix for electricity generation (including electricity import in this "fuel mix" picture) for the last decade. We have two electricity supply companies in Hong Kong, the CLP Power Hong Kong Ltd. and the Hongkong Electric Co. Ltd. Historically, the main fuel for electricity generation was initially oil, replaced by coal-fired generation in the late 70's at the Castle Peak Power Stations and then the Lamma Power Station. In the 80's, CLP participated in a joint venture with their Mainland counterpart to invest in the Guangdong Nuclear Power Station at Daya Bay, and a further joint venture was formed to invest in the Guangzhou Pumped Storage Power Station, resulting in net electricity import from 1994[8] onwards. A further development was the use of the much cleaner fuel of natural gas for electricity generation. Starting from 1996[9], natural gas piped from a gas field near the Hainan Province in Southern China has been used for the natural-gas combined-cycle (NGCC) plants in the Black Point Power Station.

One study indicated that total CO_2 emission of Hong Kong in the year 1997 was in fact just a little bit lower than that in 1990, mainly due to import of electricity and use of natural gas for electricity generation.

It is expected that any new power plants to be built in Hong Kong in the coming years will very likely also be of the NGCC type, because of its environmental friendliness and high thermal efficiency.

7. ACTIONS TO INFLUENCE ENERGY SUPPLY AND CONSUMPTION

It is the stated policy of the Government:

- to ensure that the energy needs of the community are met safely, efficiently and at reasonable prices; and
- to minimize the environmental impact of energy production and use and promote the efficient use and conservation of energy.

The Government commissioned in 1997 a study to examine the feasibility of adopting a common carrier system in Hong Kong for transmission and distribution of gas in Hong Kong. The Government aims to map out around 2004 broad institutional, infrastructural and regulatory framework necessary for possible introduction of a natural gas based common carrier system, pending the availability of a secure and reliable source of gas supply.

On the electricity side, the Government commissioned a consultancy study on Interconnection and Competition in the Electricity Supply Sector in Hong Kong in 1998. Following public consultation on the consultancy report, further detailed studies are being undertaken on the routing and timing for construction of the new interconnectors as well as the planning criteria for our electric systems under an increased interconnection scenario. In parallel, options for the post 2008 regulatory regime for our electricity supply sector are being examined.

The ultimate impact of these supply-side activities in the long run would be on the structure and cost of gas and electricity supplies, with resultant benefit to consumers and would

[8] Import in 1993 was of small amount only.
[9] Natural gas consumption in 1995 was of small amount only.

consequently affect the demand and fuel mix at final consumption level.

Regarding Government's efforts on demand-side, the Energy Efficiency Office was established in August 1994 to provide technical expertise to develop and push forward energy efficiency and conservation programmes and schemes which encompass a wide spectrum of activities aimed at designers, consumers, operators and energy users. Up to this moment, such programmes and schemes include:

1) Building energy codes
2) Energy Efficiency Registration Scheme for Buildings
3) Energy Efficiency Labelling Schemes
4) Energy audits for government buildings and Pilot Energy Management Opportunities (EMO) Implementation Programmes
5) Demonstration projects on the application of innovative energy-efficient technologies
6) Studies on the wider use of water-cooled air conditioning systems (WACS)
7) Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers
8) Promotion of energy performance contracting
9) Consultancy Study on Potential Applications of Renewable Energy
10) Demand-side Management Programmes

The above programmes and schemes are targeted at different end-use areas. As shown in Table 1, all those schemes and programmes with private sector involvement are implemented in a voluntary manner. One exception is the Overall Thermal Transfer Value Code implemented by the Buildings Department (which is considered to be one form of building energy code). The possibility of introducing legislation on energy efficiency and conservation is being examined.

Besides above programmes and schemes, the Energy Efficiency Office had established the Hong Kong Energy End-use Database as mentioned above. To take a step further, the Energy Efficiency Office has also commissioned a Consultancy Study on the Development of Energy Consumption Indicators and Benchmarks for Selected Energy Consuming Groups in Hong Kong. Further study on energy efficiency of public transport is also being undertaken.

8. REFERENCES

[1] "Hong Kong Population Projections 2000-2029", Census and Statistics Department, Hong Kong Special Administrative Region
[2] "Hong Kong Energy Statistics Annual Report 2000 Edition", Census and Statistics Department, Hong Kong Special Administrative Region
[3] "World Energy Outlook 2000 Highlights", International Energy Agency
[4] "International Energy Outlook 2001", Energy Information Administration, United States
[5] "IEA Key World Energy Statistics 2000 Edition", International Energy Agency
[6] "APEC Energy Statistics 1998", APEC Secretariat

Table 1: Nature and method of implementation of energy efficiency and conservation initiatives and demand-side management programmes

Initiative	Area of impact	Method of implementation
Overall Thermal Transfer Value Code	Building shells of commercial buildings	Mandatory compliance with the code
Building energy codes for air conditioning, lighting, electrical, lift and escalator installations	Building services installations in buildings covered by the codes	Voluntary compliance with the codes
Energy Efficiency Registration Scheme for Buildings	Same as above	Voluntary participation
Energy Efficiency Labelling Schemes	Appliances and vehicles	Voluntary participation
Energy audits for government buildings, Pilot EMO Implementation Programmes, demonstration projects	Building services installations in government buildings	Government projects
Water-cooled air conditioning systems - Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers	Central or packaged air conditioning systems in non-domestic buildings,	Voluntary implementation by private sector
Water-cooled air conditioning systems - territory-wide and district schemes (currently in consultancy study stage)	Air conditioning systems for non-domestic buildings	(Being studies)
Promotion of energy performance contracting*	Building services installations in buildings	Voluntary implementation
Pilot project to install building-integrated photovoltaic panels in an existing government buildings (part of consultancy study)	Electricity consumption of government buildings concerned	Government project
Demand-side Management Programmes	Mainly lighting and air-conditioning installations in non-residential premises	Voluntary participation

* Currently mainly to non-government organizations.

Fig1 : TFC per Capita for 1998 for Selected APEC Economies

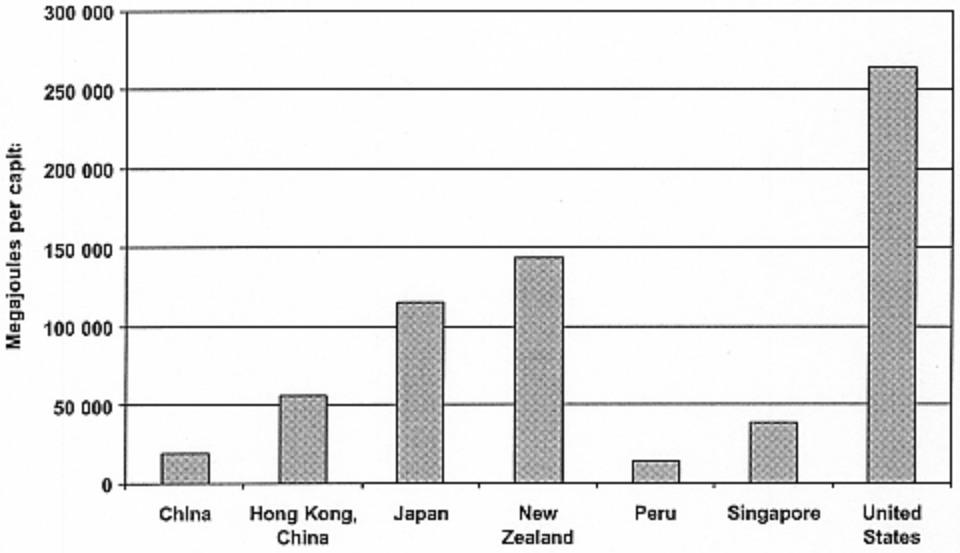


Fig.2 : TFC per Dollar GDP (at 1995 Prices and Using 1995 PPP) for 1998 for Selected APEC Economies

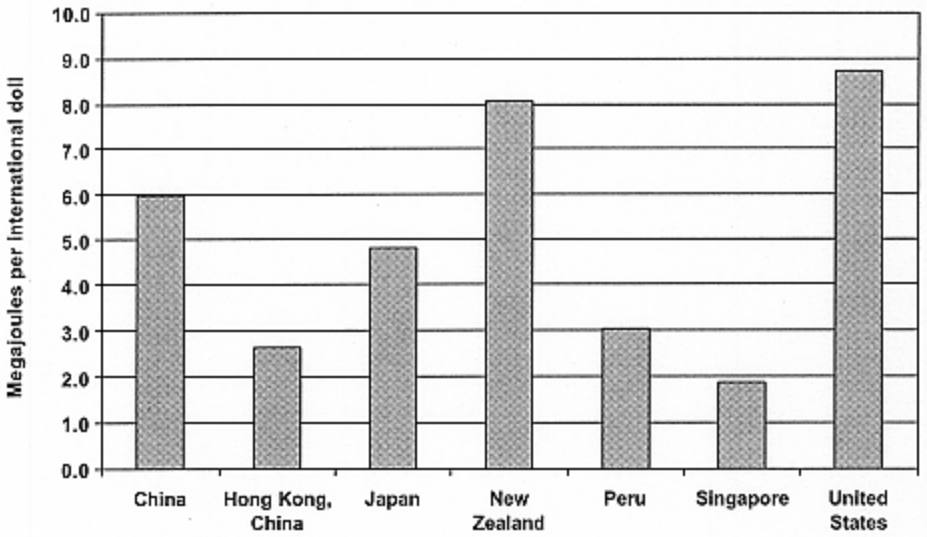


Fig.3 : Total End-use Energy Consumption (TEUC), GDP, Population Trends

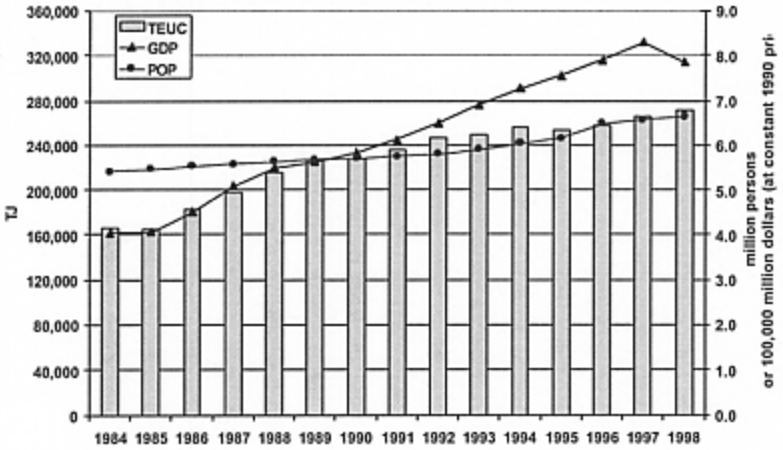


Fig.4 : Composition of TEUC by Energy Carrier Type

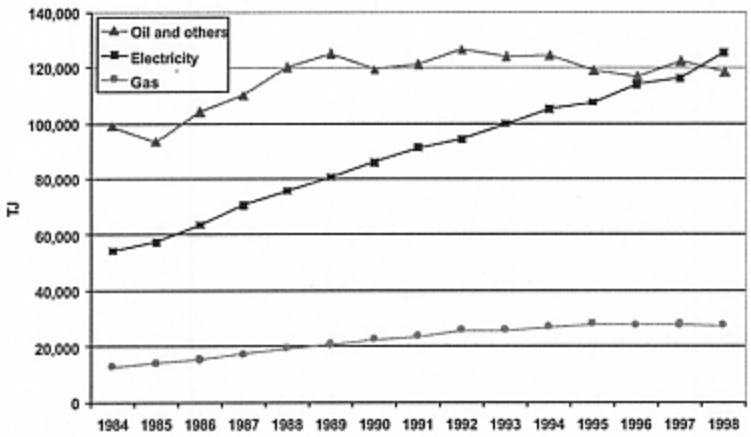


Fig.5 : Contributions to TEUC by Sector

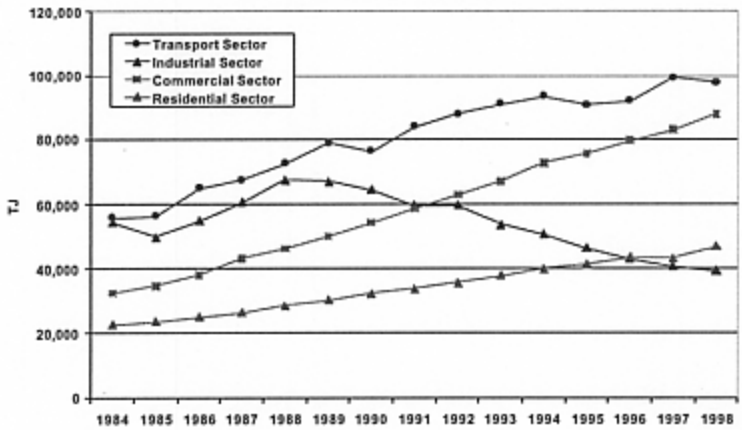
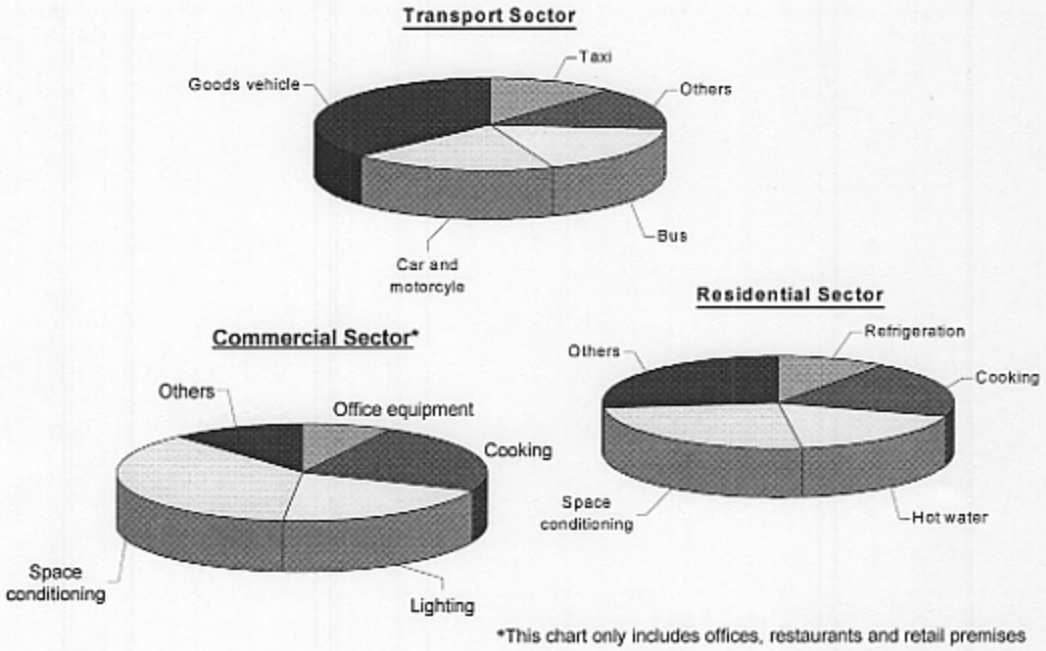


Fig.6 Composition of Sectors by End-uses



*This chart only includes offices, restaurants and retail premises

Fig.7: Mix of Primary Energy Sources for Electricity Supply