1990-2000 Greenhouse Gas Emissions in the Hong Kong Special Administrative Region

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ABSTRACT

The greenhouse gases emitted in the Hong Kong Special Administrative Region are mostly carbon dioxide produced by energy consumption activities. More than half of the emission came from power generation. Transport was the next biggest greenhouse gas producer. Until the recent regional economic downturn, Hong Kong has enjoyed uninterrupted growth for decades. Despite the increasing energy demand that accompanied the economic growth, greenhouse gas emission was significantly reduced by the changes took place in the local generation and supply of electricity. These include using natural gas, instead of coal, in the new power plant and importing electricity from the Mainland China. As a result, Hong Kong's emission in 2000 was comparable with its 1990 level, a difficult goal for many countries. The per capita emission in Hong Kong is also among the lowest in the developed economies. It is interesting to note that the growth in power demand in Hong Kong tracked its economic performance reasonably well, except for 1998 when negative GDP growth was recorded. The greenhouse gas emission, though mainly driven by power generation, did not appear to form any simple correlation with either power demand or GDP because of the said changes.

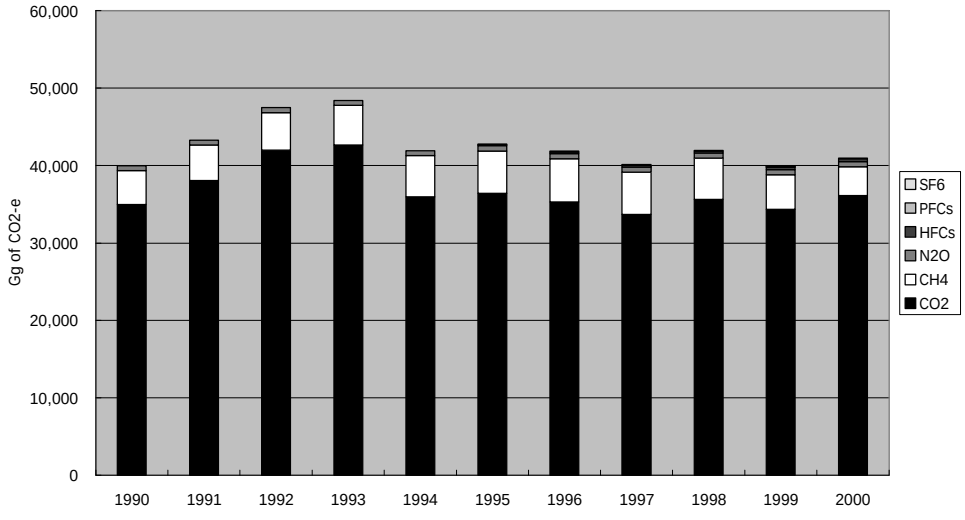
INTRODUCTION

The 1992 United Nations Framework Convention on Climate Change underscored the general consensus that the greenhouse gases emitted by human activities play a key role in determining the global climate. In the last decade, the international community has made a substantial effort in an attempt to avert adverse climate change. The Hong Kong Special Administrative Region (HKSAR), being a responsible economy, is committed to contribute towards this collective effort. The Environmental Protection Department (EPD) commissioned a related study[1] in 1998 which compiled, among others, a greenhouse gas emission inventory covering 1990 to 1997. After the study was completed recently, the EPD took up the task of updating the inventory and improving the emission estimating method. The HKSAR greenhouse gas emission inventory for 1990-2000 was just completed in late 2001.

EMISSION OVERVIEW

Figure 1 showed the emissions from 1990-2000. The Global Warming Potentials (GWP) of different gases were taken into account to produce the weighted totals in units of carbon dioxide equivalent (CO_2-e). During this period, more than 80% of the total emission were carbon dioxide; around 10% were methane; less than 2% were nitrous oxide. Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride were only accounted for from 1995. Their amounts were very small compared with the other gases.

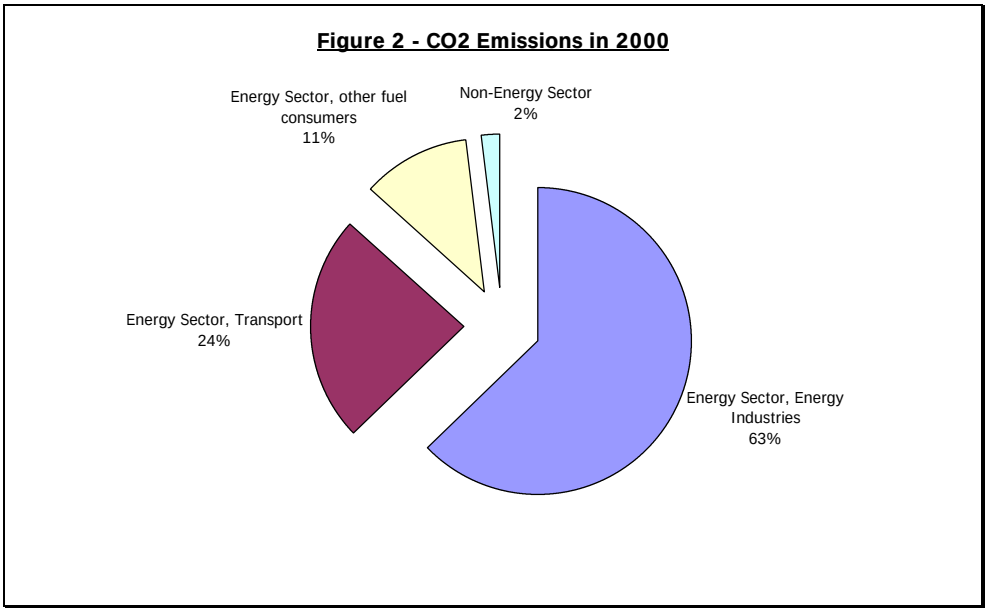
Figure 1 - GWP Weighted Greenhouse Gas Emissions



The total emission in 1990 was around 40,000 Gg of CO_2-e, rising steadily to near 50,000 Gg in 1993. From 1994 onwards, the total emission was much reduced, hovering around the 1990 level. The 2000 emission was only 2.5% higher than 1990, a reduction level not easily achieved by the industrialized economies. The underlying reasons for the emission reduction would be discussed later.

Carbon Dioxide

About 98% of the carbon dioxide came from fuel combustion which is classified under the Energy sector in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. The relative contributions in the year 2000 were shown in Figure 2. The largest emitters were the Energy Industries. They were mostly power companies with town gas production playing a very minor role. In fact, more than half of the total greenhouse gas emission in the HKSAR was produced by the generation activities. The next biggest carbon dioxide contributor was Transport. The commercial, industrial and domestic fuel consumption made up the rest of the Energy sector. The remaining 2% were produced by industrial processes and waste incineration.



Methane

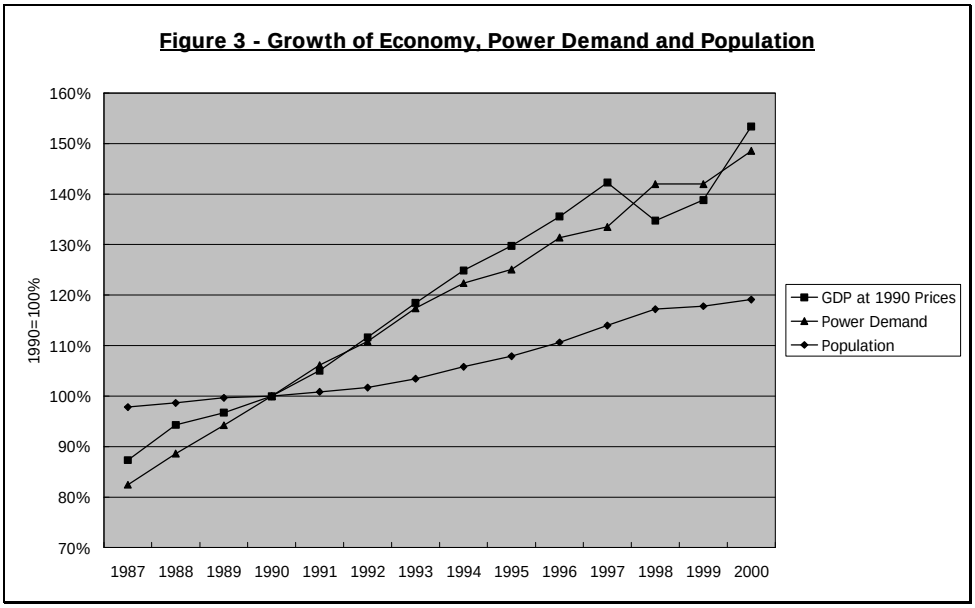
Almost all the methane came from local landfills. Taking the GWP into account, methane represented about 10% of the total greenhouse gas emission in Hong Kong throughout the period. The amount has been reducing in the past few years because the landfill gas was collected for use on- and off-site as well as being flared.

Other Greenhouse Gases

Nitrous oxide, HFCs, PFCs and sulphur hexafluoride emissions were relatively small compared to carbon dioxide and methane. Transport-related combustion was the major source of nitrous oxide. HFCs and PFCs were mostly used in air-conditioning and refrigeration appliances. Power companies used sulphur hexafluoride as insulating gas in their transmission and distribution equipment. Emissions of the halocarbons were associated with their applications.

EMISSIONS AND SOCIETY DEVELOPMENT

Until the recent economic downturn, Hong Kong has enjoyed uninterrupted growth for more than three decades. The gross domestic product (GDP) in 2000 was more than 50% higher than 1990. The population has also increased by nearly 20% over the same period. Growing with such development was the demand for energy of which the key form is electricity. Figure 3 showed the changes in GDP, power demand and population since the late 1980s. Until recently, the growths in GDP and power demand were very similar. The next section would discuss the recent emission trend and how it was related to power demand.



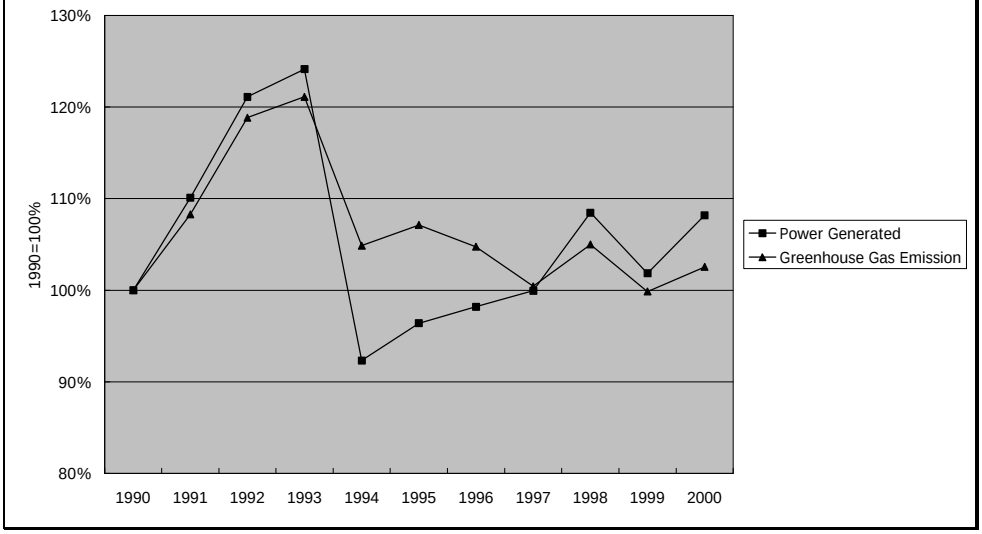
Despite the 50% increase in power demand, the HKSAR managed to keep its 2000 emissions to a level comparable with its 1990 emissions as shown in Figure 1. The reasons are linked to two major changes, both related to power supply.

Up to 1993, Hong Kong's electricity demand was satisfied by local output, mostly from coal-fired facilities. In late 1993, a nuclear power station nearby in Mainland China began production. From it Hong Kong imported substantial amount of electricity - about one-fifth of the local demand in the year that followed. The effect could be clearly seen in Figures 1 and 4 where the emission dropped significantly in 1994.

In 1995, a new local power station came on line. The natural gas it used has lower carbon per unit energy content compared with coal. In addition, the combined cycle gas turbines in the new station have better efficiency than the old coal-fired units. The latter were being displaced gradually. The full effect of the new station became evident in 1997 when the commissioning period was over.

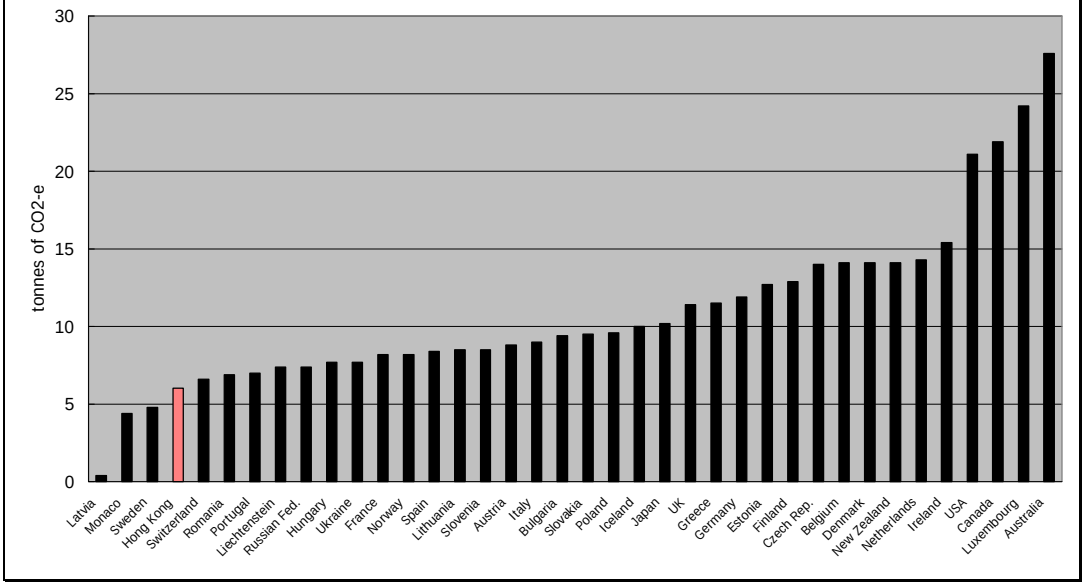
The post-1993 increase in electricity demand would have caused more emission had it not for the power import and the new gas-fired plant. The amount of power generated is a reasonable indicator for greenhouse gas emission, as shown in Figure 4. Apart from the transitional period between 1995 and 1997 when the new plant was brought on line gradually, the emission trend and the power generation trend were very similar.

Figure 4 - Emission and Power Generation



Hong Kong's emission in 2000 was 6 tonnes of CO_2-e per capita. It was among the lowest compared with the industrialized countries[2] as shown in Figure 5.

Figure 5 - Industrialized Countries per Capita Emissions

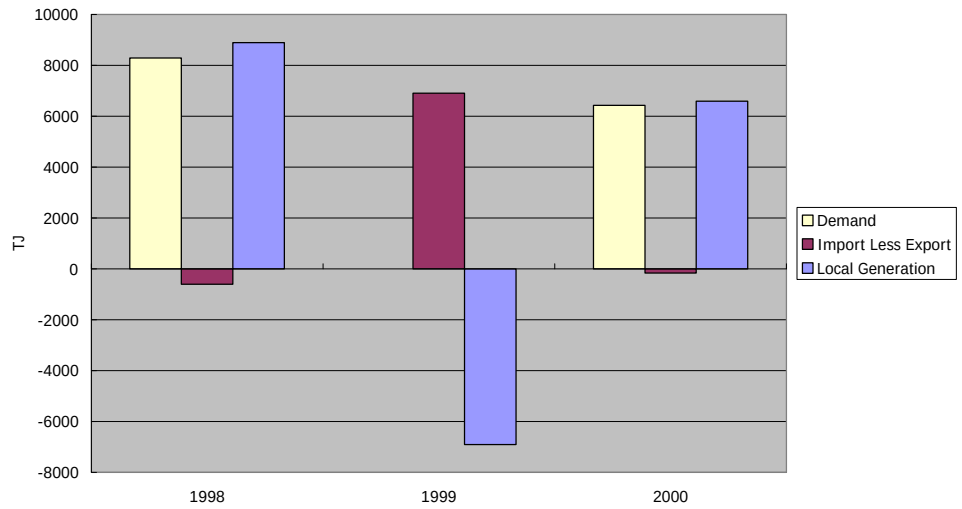


The HKSAR is densely populated with on average nearly 6,200 residents/km^2. The relatively shorter travelling distance and smaller activity area are likely to need less energy to support the functioning of the society, leading to low per capita emission. Nonetheless, the population density is only a simplistic way of explaining the per capita emission since other factors such as the presence of heavy industry, agriculture activities and non-fossil fuel power sources need to be taken into consideration.

TREND OF RECENT EMISSION

Hong Kong's greenhouse gas emissions were mostly driven by power generation as shown in Figure 4. The power was generated merely in response to demand. The power demand to some extent was linked to the economic performance as seen in Figure 3 but it is not within the scope of this paper to explore their relationship. Nonetheless, comparing the Figures 3 and 4, it is obvious that, apart from the monotonous increase at the beginning, the emission did not form any simple relationship with the economic performance or power demand. This was expected for the transitional period between 1993 to 1997 when new power supply sources were introduced. As for the up-and-down emission level since 1998, the link between power generation and demand provided the explanation. Figure 6 shows the year-on-year changes of the relevant parameters.

Figure 6 - Year-on-Year Changes in Power Supply and Demand



The 1st bar on the left-hand-side of Figure 6 means that, despite the economic downturn, there was an increase in electricity demand in 1998. The increase was driven mostly by the commercial sector and to a lesser extent the domestic sector. With a reduced net power import [2nd bar, negative compared with the year before], the local power output increased [3rd bar] to meet the demand and hence the higher emissions.

In the two years that followed, the emissions were either reduced because more electricity was imported or increased because of higher electricity demand.

In the other words, had there not been an increased electricity import since 1999, the post-1997 emissions would be increasing monotonously instead of fluctuating as seen Figure 1.

CONCLUSIONS

Despite the pressure of rapid economic and population growth, the HKSAR managed to keep greenhouse gas emissions in 2000 to a level comparable to 1990. A new and efficient gas-fired power station and importing nuclear energy are the keys to the emission reduction. The vast majority of the emissions were carbon dioxide from fossil fuel consumption. Methane, almost all came from landfills, was the next most significant greenhouse gas in Hong Kong. The recent trend of total emission was, to a large extent, reflecting the local power generation output that in turn depended on the demand and the net power import.

REFERENCE

[1] ERM-Hong Kong Ltd, *Greenhouse Gas Emission Control Study*, for EPD, HKSAR; 2001

[2] Turton, H and Hamilton, C; *Comprehensive emissions per capita for industrialized countries*; The Australia Institute; 2001

KEYWORD

Emission Inventory
Greenhouse Gas