

Greenhouse gas emission and its control in Hong Kong

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(1) Greenhouse gas (GHG) emission in Hong Kong

Carbon dioxide (CO₂) is the major greenhouse gas (GHG) emissions in Hong Kong. In the year 2005, 99% of the GHG emissions in Hong Kong is due to CO₂ (Table 1). There was a substantial reduction in GHG emissions in the year 1993 but after 1999 the GHG emissions was back on the uprising trend. CO₂ has increased by 11% between 1990 and 2005 (Figure 1). This figure is much lower than the global growth of 28% between 1990 and 2004 (IPCC, 2007).

Table 1: Hong Kong Greenhouse Gas Emission Inventory (Gg)

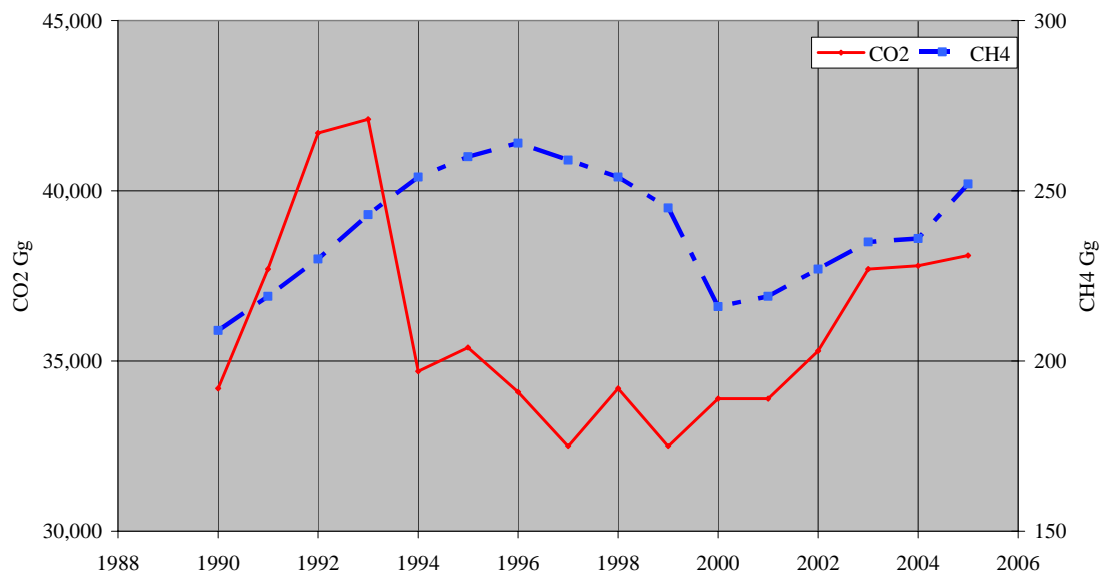
	CO ₂	CH ₄	N ₂ O	HFC/PFC/SF ₆
1990	34,200	209	1.8	-
1995	35,400	260	2	0.072
2000	33,900	216	2.1	0.222
2005	38,100	252	2.1	0.549

Source: HKSAR, Environmental Protection Department

http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/table_ghg_wtc.pdf

Figure 1: GHG emission trend in Hong Kong

Figure 1: Hong Kong Greenhouse Gas Emission



CO₂ is the main emissions in the Hong Kong GHG emissions inventory. About 80% of the CO₂ is emitted by the energy sector and 50% of the total GHG emissions are for electricity generation. Transport is the next most significant source, accounting for about 20% of the total GHG emissions. The waste sector is the third most significant source, accounting for about 15% of the total GHG emissions (HKSAR, EPD, 2000).

(2) Kyoto Protocol

Kyoto Protocol of 1997 has established a target to reduce GHG emissions by at least 5% below 1990 levels to the commitment period during 2008 to 2012. 35 countries and the European Community are required to reduce greenhouse gas emissions below levels specified for each of them in the treaty. The targets include CO₂, methane CH₄, Nitrous oxide N₂O, Hydrofluorocarbons HFCs, Perfluorocarbons PFCs and Sulfur Hexafluoride SF₆.

China is a non-Annex I parties to the convention and Hong Kong is not a party to the UN Framework Convention on Climate Change in its own right. However, it is HKSAR's policy to contribute to international efforts to stabilize GHG concentrations in the atmosphere. Since there was a 11% increase in CO₂ emission between 1990 and 2005 in Hong Kong, mitigation measures are required if Hong Kong is to limit its GHG emissions to 1990 levels or below.

(3) Measures to reduce greenhouse gas emissions in Hong Kong

On a worldwide basis, there are numerous technologies that are available for the reduction of GHG emissions. IPCC has listed key mitigation technologies and practices according to seven different sectors: energy supply, transport, buildings, industry, agriculture, forestry/forests and waste (IPCC, 2007).

Control of GHG emissions in Hong Kong has been studied by Environmental Protection Department (EPD). Thorough recommendations on control measures that are relevant to Hong Kong have been written. The executive summary of this consultant report can be found on the EPD website (HKSAR, EPD, 2000). The groups of measures and policy instruments listed in this report is extracted and listed in Table 2.

Table 2: Groups of Measures and Policy Instruments

Measure	Individual Measures	Policy Instrument
End Use Efficiency	<ul style="list-style-type: none"> • Water-cooled Air Conditioning (WACS) / district cooling • Improved building envelope performance via OTTV • Energy efficient Air-cooled Air Conditioning (AACS) systems • Energy efficient packaged and room air conditioners • Higher efficiency lighting, refrigerators, appliances 	<ul style="list-style-type: none"> • (h) <i>Regulation</i>, (g) <i>Planning</i>, (d) <i>Financial Incentives</i> • (h) <i>Regulation</i> • (h) <i>Regulation</i> or (d) <i>Financial Incentives</i> • (h) <i>Regulation</i> or (d) <i>Financial Incentives</i> • (h) <i>Regulation</i> (eg via standards) (d) <i>Financial incentives</i>, (a) <i>Information, Education</i> (b) <i>Technology Demonstration</i>, (c) <i>Voluntary Agreements</i>, (e) <i>Market Mechanisms</i>, (f) <i>Economic Instruments</i>
Wider Use of Natural Gas	<ul style="list-style-type: none"> • Electricity generation coal -> natural gas and Electricity generation conversion efficiency improvement (primary-to-secondary for coal/steam ~33%, for CCGT~50%) • Town Gas -> natural gas and less GHG-intensive fuels (avoids CO₂ emissions from the naphtha cracking industrial process) • Natural Gas Vehicles (NGVs) where appropriate (eg diesel -> NGV) 	<ul style="list-style-type: none"> (g) Energy sector <i>Planning</i> and (h) <i>Regulation</i> (g) Energy sector <i>Planning</i>, need for (h) <i>Regulation</i> • (g) Energy sector <i>Planning</i>; (h) vehicle licensing <i>Regulation</i>

Measure	Individual Measures	Policy Instrument
Alternate Energy Sources & Renewable Energy	<ul style="list-style-type: none"> • Fuel cells for distributed electricity generation • New renewable installations (any type) • Distributed PV installations (including on-site PV installations in schools and institutions) 	<ul style="list-style-type: none"> • (b) <i>R&D, Technology Demonstration</i> • (h) <i>Regulation</i> (eg: utilities required to source minimum supply from renewables) • (b) <i>Technology Demonstration</i> • (d) <i>Direct investment</i>
Waste	<ul style="list-style-type: none"> • Implement Waste Reduction Framework Plan • Waste-to-Energy Facility (WEF) • Landfill gas capture for electricity generation • Enhanced anaerobic digestion for Municipal Solid Waste • Sludge incineration 	<ul style="list-style-type: none"> • (g) <i>Planning</i> • (g) <i>Planning</i>, (d) <i>Financial Incentives</i> • (g) <i>Planning</i> • (g) <i>Planning</i> • (g) <i>Planning</i>
Transport Measures	<ul style="list-style-type: none"> • Taxi Diesel -> LPG • Other applicable vehicles Diesel -> LPG • Bio-fuel mix up to maximum fraction • Electric Vehicles • Electric trolley bus • Increase vehicle efficiency using replacement of older, inefficient goods vehicles; and hybrid-electric vehicles; • Promote newly commercialized and demonstrate nearly-commercial technology: Low/Zero Emission Vehicles Fuel cell vehicles 	<ul style="list-style-type: none"> • (h) <i>Regulation</i> • (h) <i>Regulation</i> • (h) <i>Regulation</i> • (h) <i>Regulation</i> and/or (d) <i>Financial Incentives</i> • (g) <i>Planning</i> • (h) <i>Regulation</i> (eg: vehicle efficiency standards); and/or (f) <i>Economic Instruments</i> (eg: levy on low efficiency vehicles); and/or (d) <i>Financial Incentives</i> and/or (a) <i>Information</i> (eg: vehicle energy efficiency labeling) • (b) <i>R&D, Technology Demonstration</i>; (d) <i>Direct Investment</i> by Government

Measure	Individual Measures	Policy Instrument
	<ul style="list-style-type: none"> • Reduce vehicle use by reducing road use • Switch from high GHG to low GHG-intensity modes • Freight road -> rail 	<ul style="list-style-type: none"> • (f) <i>Economic Instruments</i> (Road pricing) • (g) <i>Planning</i> • (g) <i>Planning</i> and/or (d) <i>Direct Investment</i>
Land Use Change & Forestry	<ul style="list-style-type: none"> • Invest in plantations for long-life products • Offset emissions (eg with sequestration projects) • Afforestation and/or reforestation 	<ul style="list-style-type: none"> • (d) <i>Financial Incentives</i> • (c) <i>Voluntary Agreements</i> • (d) <i>Direct Investment</i>
High GWP Gases	<ul style="list-style-type: none"> • Monitor and Control 	<ul style="list-style-type: none"> • (h) <i>Regulation</i>
General Support Measures	<ul style="list-style-type: none"> • Disseminate information via EPD home page and publications (education and public information) 	<ul style="list-style-type: none"> • (a) <i>Information, Education</i>
Cross-Sectoral (market-determined)	<ul style="list-style-type: none"> • GHG emission tax • GHG emission tradable permits 	<ul style="list-style-type: none"> • (f) <i>Economic Instruments</i> • (f) <i>Economic Instruments</i>

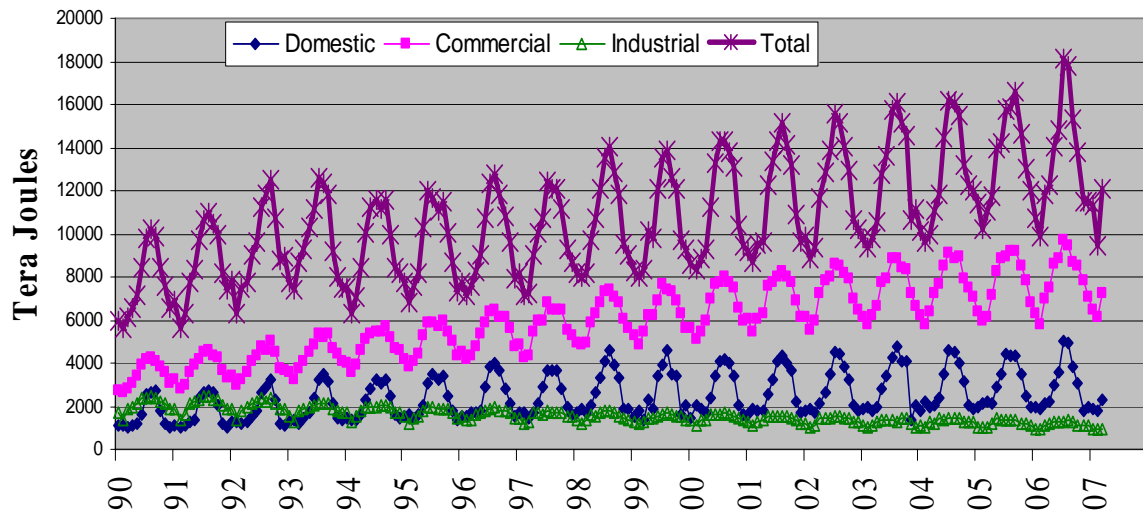
(4) Current position of Hong Kong in GHG mitigation

Hong Kong has good performance in GHG emissions control, we are among the cities that have lowest GHG emissions per capita. Both the Government of HKSAR and commercial sectors have been implementing green policy. Our government has adopted a mass transit transport system two decades ago; attained remarkable achievement in control of vehicle number; switched taxi from diesel to LPG; and subsidized hybrid vehicles. The power companies not only switched a portion of their fuel from coal to natural gas, but also took the lead to test electric vehicles and wind turbines. In the retail sector, energy labels appeared and energy saving lighting started to proliferate. We also owe some credits to the migration of industries out of Hong Kong. Despite all the good efforts, Hong Kong is still unable to meet the target of Kyoto Protocol.

The electricity consumption of Hong Kong is shown in Figure 2. Figure 2 indicates that electricity consumption is one of the most resilient phenomena. In the last 17 years, Hong Kong has experienced big changes both in political and economic regime. Even in the hardest year in 2003 which was a low point of local economic in synergy with an unprecedented endemic SARS, the electricity consumption in Hong Kong continued to increase. To achieve the target of Kyoto Protocol, there are at least two issues to deal with. One is the growth in demand and the second is

the cut of emissions per capita. While individual cut down his/her energy consumption, the decrease in total GHG emissions could be offset by a growth in population. It should be more fair to set the target as emissions per capita. Unfortunately, to combat climate change, it is the absolute amount of CO₂ in the entire atmosphere that matter. Cure of global warming is a tough task. Nevertheless, there is still something we can do about it.

Figure 2: Electricity Consumption in Hong Kong
Source: HKSAR, Census and Statistics Department



(5) Personal opinions

- (I) To mitigate GHG emissions in Hong Kong, we should manage all four classes of GHG, namely the CO₂, CH₄, N₂O and HFC/PFC/SF₆. Although the annual emissions of N₂O and HFC/PFC/SF₆ are much smaller than CO₂ and CH₄, they cannot be neglected due to their much higher global warming potentials (GWP). For 20 years time, the GWP of SF₆ is 15000 times that of CO₂. Furthermore, the use of HFC/PFC/SF₆ have been increasing rapidly in the past decade.
- (II) Mitigation of GHG emissions involves all walks of life. Low-carbon policy statement should be endorsed from top management and added to environmental management system. Education, training and dissemination of information is a long term commitment.
- (III) Electricity - on the demand side, the key issue is to save energy. The first big saving that can be achieved is to use water cooled air conditioning system. Central air conditioning (A/C) systems of commercial buildings consumed about one-quarter of the total electricity consumption in Hong Kong. Most of the existing systems are air-cooled system due to shortage of fresh water supply during 1980s. Switching from air-cooled system to water cooled system can save 10 to 20% energy. Multiply the two percentages and assume half of the central A/C units used water cooled systems, this measure can save about 2% of the total electricity consumptions in Hong Kong (the target is 16%). The availability of fresh water resource is a concern. Associated with the growth of Pearl River Delta Region, water supply from GuangDong province

- could become uncertain. It is worthwhile to explore the possibility of turning Victoria Harbour into a fresh water body (not for drinking, it is for the conservation of harbour and as a back up fresh water resources). Second, central air conditioning system, small scale domestic type air conditioners, refrigerators and lightings are also big electricity consumers. Third, town planning, layout and density of buildings have great influence on natural ventilation and human comfort. Tall building is not necessary a problem but tall buildings packed together induce urban heat island effect. A substantial amount of energy could be saved when residential buildings are well designed. Fung et al., 2006 reported that for a 1°C rise in ambient temperature in Hong Kong, the annual total electricity consumption will increase by 4.5%.
- (IV) Electricity - on the supply side, the key issue is to increase production efficiency and to switch to low-carbon fuel. Switching from coal fire to natural gas fire brings immediate benefit. Natural gas fired power generators can exceed 45% in system efficiency where as coal fired power generators seldom exceed 35%. About 4% CO₂ emission could be reduced from electricity generation when all coal fired generators are replaced by natural gas generators. In the long run, low-carbon fuel should be introduced. Trading of renewable energy, nuclear power, biofuels, and hydrogen fuel should be developed.
- (V) Transport, the key issue is to replace gasoline and diesel by greener fuel. There should be a wider use of natural gas, alcohol and LPG in vehicles. Some drivers might choose electric vehicles when most public carparks and gas stations could provide charging facilities. The government and developers should build more pedestrian road network (similar to the pedestrian flyover in central) and bicycle path to encourage walking and cycling. Some existing bicycle paths have safety problems.
- (VI) Buildings, the key issues are to improve insulation, use of efficient lightings, exploit natural daylight, solar power and wind power.
- (VII) Forestry/forests, the key issue is afforestation/reforestation/forest management. At present, there is one missing link in the conservation of woodland. Planting trees can remove CO₂ from the atmosphere. However, this carbon capture ability will decay with time when a tree grows old. At present, there is no woodland management in Hong Kong. We only plant trees without felling them. Hill fire is very frequent in Hong Kong, this make the effort of sequestration futile. A certain percentage of the woodland has to be felled when their carbon capture ability diminish. The timber gained can be used for bioenergy or paper making. On the proactive side, more effort is required to prevent hill fire.
- (VIII) Waste, the key issue is the emission of methane. In the past, landfill sites in Hong Kong did not recover methane due to economic reason. Now, there is a higher priority factor. To combat GHG emissions, collection of methane is essential in future landfill sites. Concerning sewage waste water treatment, it is worthwhile to explore the opportunity on methane production using anaerobic digestion of sewage. Again, it is definitely not economically sound and is a noxious industry but it is a very stable renewable energy source. At present, our sewage treatment facilities are solely an expenditure item. We build a city wide network to collect sewage and treat them but finally drain them into the sea. A more realistic and cleaner measure is to recycle used product and minimize waste.

Mitigation of GHG emissions is a classic example of social problems that is theoretically feasible but practically difficult to achieve. Point (III) to (V), if fully implemented could only reduce the total GHG emissions by no more than 5%. Under a business-as-usual scenario, GHG emissions reduction is a painstaking process. Mitigation measures have to cover all sectors of a society because every gain counts, no matter how trivial it is. The objective here is to achieve net reduction of GHG, not a slow down in growth rate. A breakthrough is needed either in the large scale manufacture of natural gas, extraction of hydrogen fuel from the ocean, or outer-space power plant. May be we have to wait until the climate become unbearable, then human being will adapt to a totally new living habit.

(6) Conclusions

Policy instruments and technologies are available for the reduction of GHG emissions in Hong Kong. However, it is rather pessimistic that we can meet the Kyoto Protocol target to lower GHG emissions to 5% below 1990 level. It does require bold, substantial actions and new low-carbon technologies to address the issue of global warming.

Reference:

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