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For information

**Greenhouse Gas Emissions and
their Effects on Global Warming**

PURPOSE

This paper informs Members of the latest trend of greenhouse gas (GHG¹) emissions, their effects on global warming and the measures being taken to reduce GHG emissions in Hong Kong, including programmes to promote energy conservation and the development of renewable energy.

BACKGROUND

2. At the meeting on 12 February 2007, Members asked for an information paper setting out the GHG emissions in Hong Kong, the long-term strategy on the development of renewable energy and energy conservation and the emission inventory of the power plants in Hong Kong.

GREENHOUSE GASES AND GLOBAL WARMING

3 GHG emissions have been rising rapidly since the industrial revolution because of human activities. For instance, carbon dioxide is emitted from burning of fossil fuels and deforestation; methane and nitrous oxide from agricultural activities; and halocarbons from refrigeration. In the atmosphere, these gases act like a “greenhouse”, by allowing short-wave radiation from the sun to pass through to the earth’s surface but hindering the infra-red radiation from the earth’s surface from escaping into the space, thus causing the earth’s surface to warm up. With more GHG released to the atmosphere due to human activities, more heat is being trapped near the earth’s surface, giving rise to “global warming”.

4. Associated with global warming are other changes in the climate

¹ GHG include carbon dioxide, methane, nitrous oxide, water vapour, ozone and several other trace gases such as halocarbons.

system, including changes in the frequency and intensity of extreme weather and climate events such as heat waves, cold spells, heavy rain, droughts and tropical cyclones, and a rise in the sea level. These changes have profound impacts on natural and human systems, and are often adverse in nature. Recent findings released by the Intergovernmental Panel on Climate Change (IPCC) conclude that warming of the global climate system is unequivocal and most of the increase in the global average temperatures in the past 50 years is *very likely* due to an increase in GHG concentrations arising from human activities.

5. Whilst global warming is primarily caused by long term accumulation of GHG emissions in the atmosphere, urban heat island effect is a different phenomenon. The latter stems from the retention of heat by concrete and tarmac, reduction in air ventilation due to concentration of tall buildings, and heat production by air-conditioning, vehicles, cooking, machines, etc. in dense urban cities. Findings of the IPCC suggest that urban heat island effects are real but local in nature, and they have negligible influence on the global climate.

GREENHOUSE GAS EMISSIONS IN HONG KONG

6. Hong Kong is a small emitter of GHG. The volume of GHG emissions totalled about 44.8 million tonnes CO₂-equivalent (CO₂-e)² in 2005, accounting for about 0.2% of the global GHG emissions. Approximately 85% of the total Global Warming Potential (GWP)-weighted GHG emissions in Hong Kong were CO₂. The emissions per capita in Hong Kong, which were around 6.4 to 6.5 tonnes in recent years, are lower than those recorded in most of the developed economies such as the USA (about 24 tonnes), Canada (about 24 tonnes), Australia (about 27 tonnes), UK (about 11 tonnes), Japan (about 11 tonnes), European Union (about 9 tonnes) and Singapore (about 9 tonnes). Hong Kong's carbon intensity, as measured in terms of GHG emissions per unit of GDP, was 27.6 kg per HK\$1,000 of GDP in 2005 and was one of the lowest amongst developed economies.

7. The historical trend of GHG emissions in Hong Kong from 1990 to 2005 are set out at **Annex A**. The total GHG emissions in 2005 exceeded the level in 1990 by 14%, largely due to economic growth and population increase in the period. In terms of per capita emissions, they dropped by 6% in 2005 as compared with the 1990 level and by 17% when compared with the historical high in 1993. Hong Kong's carbon intensity fell by 41%

² CO₂-equivalent: A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). The CO₂-equivalent for a gas is derived by multiplying the tonnes of the gas by the associated GWP.

between 1990 and 2005.

8. Energy industries, mainly electricity generation, is the major source of GHG emissions, accounting for over 60% of the total local GHG emissions. The current financial plans of the two power companies do not contain any proposal for the development of new power unit or plant. The historical trend of GHG and other air pollutant emissions from Hong Kong's power plants between 1990 and 2006 is at **Annex B**.

9. The transport sector, contributing to about 16% of the total emissions, is the second largest emission source. Further details are shown at **Annex C**.

CLIMATE CHANGE AND ITS EFFECTS

10. At the global level, the findings recently released by IPCC's working group indicate that warming of the climate system is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. Some notable conclusions include -

- (a) the amounts of carbon dioxide and methane now in the atmosphere far exceed the pre-industrial levels by 35% and 1.5 times respectively. Future greenhouse gas concentrations are difficult to predict as they would be affected by a host of factors such as economic growth, new technologies and government policies, etc;
- (b) the world's average surface temperature has increased by around 0.74°C over the past 100 years (1906-2005). Eleven of the last 12 years rank among the 12 warmest years since instrumented temperature measurement began around 1850;
- (c) a warming of about 0.2°C is projected for each of the next two decades. The best estimate is that global temperatures would increase by 1.8 to 4.0°C by the end of this century (compared to 1980-1999 levels);
- (d) as a result of thermal expansion of the oceans and melting of ice sheets and glaciers on land, global average sea level rose at an average rate of 1.8 mm per year between 1961 and 2003. It is projected to rise by 18 to 59 cm by the end of the century (compared

to 1980-1999 levels);

- (e) widespread changes in extreme temperatures have been observed over the last 50 years. Cold days, cold nights and frost have become less frequent; while hot days, hot nights, and heat waves have become more frequent. It is very likely that the upward trend of having high temperatures and heat waves will continue in this century; and
- (f) the frequency of heavy precipitation events has increased over most land areas. In this century, heavy precipitation events will become more frequent. Precipitation is likely to increase at high latitudes and decrease over most subtropical land regions.

11. At the local level, the Hong Kong Observatory (HKO) has carried out a series of studies on the climate change in Hong Kong. The key findings are set out below -

- (a) between 1885 and 2006, the temperature in urban Kowloon rose by 1.5°C, at an average rate of 0.12°C per decade. The rate of increase climbed up substantially in recent years, reaching 0.34°C per decade in 1989-2006. During the same period, the temperature at Ta Kwu Ling and Lau Fau Shan in the rural areas rose at a rate of 0.12°C and 0.28°C per decade respectively, which was close to the global average of 0.2°C per decade;
- (b) it is projected that by the last decade of this century, the annual mean temperature in Hong Kong would rise by 3.5°C above the 1961-1990 average of 23.0°C. This trend is consistent with the projected warming of 1.1°C to 6.4°C for the global average temperature from the recent IPCC findings;
- (c) between 1947 and 2006, the average number of very hot days (maximum temperature of 33°C or above) in a year averaged around 11. It is projected that by the last decade of this century, the number would surge to 24;
- (d) between 1947 and 2006, the number of hot nights (minimum temperature of 28°C or above) in a year increased from practically

none to 19 days. It is projected that by the last decade of this century, the number would further increase to 30;

- (e) from 1947 to 2006, the number of cold days (minimum temperature of 12°C or less) in a year decreased from 30 to 13. It is projected that by the last decade of this century, the number would further drop to less than one. There is an 80% chance that there will be no cold day in any given winter by then; and
- (f) during the past 50 years, the mean sea level in Victoria Harbour in Hong Kong rose by 0.12 m at an average rate of 2.5 mm per year, which is similar to that of the South China Sea. In this century, the sea level rise in Hong Kong is likely to follow the projected global trend of 18-59 cm.

12. These climate trends will be reviewed this year taking into account the full international scientific findings from IPCC's Fourth Assessment Report. The temperature and rainfall projections for Hong Kong will be re-evaluated as new global climate model outputs become available.

RESPONSES TO CLIMATE CHANGE

13. Since 1992, over 180 countries, including China, have signed the United Nations Framework Convention on Climate Change (UNFCCC) which calls for the widest possible cooperation by all countries to respond to the challenges posed by global climate change. In 1997, the Kyoto Protocol to the Convention was adopted under which industrialized economies (Annex I Parties) committed to limiting their individual GHG emissions during the period from 2008 to 2012. The combined GHG emissions of all Annex I Parties should be reduced by at least 5% below the 1990 levels. Based on the principle of common but differentiated responsibilities, parties not included in Annex I (Non-Annex I Parties) are not required to commit to any limits or reduction of GHG emission.

14. The UNFCCC and Kyoto Protocol were extended by the Central Peoples' Government (CPG) to Hong Kong with effect on 5 May 2003. As with other Non-Annex I developing countries which have ratified the Kyoto Protocol, China (including Hong Kong), is not required to achieve any GHG emission limits. Instead, it is required to submit national communications in accordance with the specific requirements of the Protocol by around 2010. In order to assist CPG in fulfilling the obligations under the Protocol, the

- (a) emission inventories of greenhouse gases;
- (b) appropriate measures for Hong Kong to facilitate adequate adaptation to and mitigate climate change;
- (c) cooperation activities in promotion of development and application of environmentally sound technologies pertinent to climate change;
- (d) cooperation activities in scientific research related to climate change;
- (e) activities in promoting public awareness and disseminating the relevant messages.

GREENHOUSE GAS REDUCTION MEASURES

15. Although Hong Kong is a small emitter of GHG and is not obliged under the Kyoto Protocol to limit its GHG emissions, we have been actively pursuing a string of measures since the 1990s with a view to reducing GHG emissions as far as practicable in support of the international efforts in this area.

Electricity Generation

16. Gas-fired power generation units emit 50% less CO₂ than coal-fired units. It is the Government policy that all new generating units should be powered by natural gas with effect from 1997. To reduce emission of air pollutants, power companies have also been encouraged to take various measures, among other things, to maximize the use of natural gas for power generation.

Demand Side Management

17. In the 2005/06 Policy Address, the Chief Executive called on the power companies to implement demand side management to promote energy efficiency and conservation. The Administration has proposed in the Stage II Consultation Paper on the Future Development of the Electricity Market in Hong Kong that financial incentives be provided to the power companies under the post-2008 regulatory regime to further improve their performance in energy efficiency and conservation.

Energy Efficiency and Conservation

18. Our policy objective is to increase and sustain conservation of

energy in order to reduce the growing trend of energy use. To achieve this objective, the Energy Efficiency Office was set up under the Electrical and Mechanical Services Department (EMSD) in 1994 to spearhead and coordinate Government's efforts to promote energy efficiency and conservation. The Administration has developed standards and guidelines, implemented different programmes to promote our community's understanding and awareness of the importance of energy conservation, and taken appropriate actions in achieving energy saving.

19. Government bureaux and departments have been taking the lead in energy conservation. The Administration has pledged to reduce its power consumption by 6% between 2002/03 to 2006/07 (i.e. 1.5% per year). We are on track to achieve the target. Between 2002/03 and 2005/06, Government already cut its electricity consumption by 5.6%, which is equivalent to an electricity saving of 120 GWh and a reduction of CO₂ emissions of 84,000 tonnes annually. The Administration further pledged in the 2005/06 Policy Address that all Government office buildings should achieve a 1.5% reduction in electricity consumption starting from January 2006. Preliminary data show that the electricity consumption of major Government office buildings was reduced by 2.9% in 2006.

20. The Administration endorsed the Clean Air Charter initiative led by the business community to demonstrate our commitment to improve air quality. It also issued an internal circular in January 2007 to provide guidance to bureaux and departments in adopting energy efficient measures in their operations to fulfill the commitments under the Charter. Departments are required to report progress of their initiatives in their annual environmental reports.

21. Air-conditioning is the most important source of electricity consumption, accounting for approximately 30% of the overall consumption in Hong Kong. The Administration has taken the lead to drive down the amount of electricity consumption from air-conditioning by setting the room temperature of air-conditioned Government premises at 25.5°C in summer months since 2004. The Administration has also been actively promoting the initiative of setting room temperature of air-conditioned premises at 25.5°C to the private sector and the community at large.

22. The Administration also promotes the switching of air-cooled air-conditioning systems to water-cooled systems which are more energy efficient. A Code of Practice for Water-cooled Air Conditioning System was published in July 2006 covering guidelines for cooling tower design, installation, testing, commissioning, operation and maintenance.

Building Energy Efficiency

23. The EMSD has launched an Energy Efficiency Registration Scheme for Buildings since 1998 to promote the application of the Building Energy Codes covering lighting, air conditioning, electrical, lift and escalator installations.

24. A technical circular was issued in November 2005 to require all works departments to apply energy efficient features in new Government buildings and retrofit projects where feasible. All new Government buildings and retrofit projects are also required to fully comply with the Building Energy Codes. Energy audits and re-audits were also conducted in over 200 major Government venues. Energy saving projects have been implemented to reduce the electricity consumption in these buildings.

25. Planting on the rooftop could help attenuate urban heat island effect in the dense urban areas and might contribute to reducing electricity consumption for air-conditioning. In the 2006/07 Policy Address, the Administration pledges to adopt the concept of green roofing whenever practicable in the design of new Government buildings. Since 2001, about 50 Government buildings have incorporated rooftop planting or flat roof landscaping while another 30 projects are under planning or construction. The Architectural Services Department has recently completed a study on Green Roof Application in Hong Kong.

Energy Efficiency Labelling Scheme

26. The EMSD has been operating a voluntary Energy Efficiency Labelling Scheme (EELS) for household and office appliances and equipment as well as for vehicles since 1995. The energy efficiency and performance information of over 3,000 product models covering 18 product types registered under the voluntary EELS is available on the EMSD's website for public consumption.

27. To further encourage the use of energy efficient products, the Energy Efficiency (Labelling of Products) Bill, which provides for a mandatory EELS, was introduced to the Legislative Council for first reading and commencement of second reading debate on 18 April 2007. The initial phase of the mandatory EELS covers room air-conditioners, refrigerators and compact fluorescent lamps.

Renewable Energy

28. Renewable energy (RE) offers proven alternatives to the burning of fossil fuels for power generation. The Administration is committed to a wider application of RE in Hong Kong. After considering the social, economic and environmental conditions in Hong Kong, and having regard to the outcome of the public engagement process undertaken by the Council for Sustainable Development, the Administration promulgated the First Sustainable Development Strategy for Hong Kong in May 2005. The Strategy sets a target of having 1-2% of Hong Kong's total electricity supply met by RE by 2012.

29. The two power companies have launched pilot projects to develop commercial-scale wind turbines. Hongkong Electric Company's first wind turbine commenced operation in February 2006 on Lamma Island. The China Light and Power's Environmental Impact Assessment (EIA) report suggests that the indicative date for the operation of its wind turbine at Hei Ling Chau is in 2008. The two power companies are also conducting studies on building off-shore commercial wind farms in Hong Kong waters.

30. To further promote the use of RE, the Administration has proposed in the Stage II Consultation Paper on the Future Development of the Electricity Market in Hong Kong to provide additional incentives to power companies to develop RE, including a higher rate of return for RE infrastructure.

31. The Administration will continue with its on-going efforts to promote the use of RE in public works projects. A technical circular was issued in 2005 requiring works departments to incorporate RE technologies in all works projects as far as practicable. So far, 39 RE projects have been implemented in various Government premises, with another 8 projects under planning. The Housing Department has recently launched a pilot project to install photovoltaic panels in one of its public housing projects.

Land Transport

32. The extensive and energy-efficient public transport system in Hong Kong has been instrumental in helping to control our GHG emissions at a low level as compared with other developed economies. Some 90% of the 11 million commuter trips each day are made on the public transport system. The Administration will continue to extend the coverage of the public transport system, particularly the railway network, so that more commuter trips could be done on the system.

33. On promoting the use of cleaner vehicles, we launched the “Tax Incentives Scheme for Environment-friendly Petrol Private Cars” in April 2007. Private cars meeting the energy efficiency and exhaust emission criteria can have the First Registration Tax reduced by 30%, subject to a cap of HK\$50,000 per car.

34. The liquefied petroleum gas (LPG) vehicle programme for taxis and light buses can also reduce GHG emissions. Presently, almost 100% and some 56% of the taxi and public light bus fleets are using LPG.

Landfill Gas Utilization

35. All three operating landfills are utilizing landfill gas to produce energy for on-site consumption. Around 47% is utilized for use by on-site facilities and the remaining 53% is flared for safety reasons and to prevent its emission to the atmosphere. As for the closed landfills, about 61% is utilized as energy for on-site use while the remaining is mostly flared. Landfill gas extracted from the closed Shuen Wan Landfill is used as fuel at the Towngas Production Plant in Tai Po. We will continue to maximize the treatment and utilization of landfill gas from the three existing and 13 closed landfills as fuel substitutes.

Plantation Programme

36. Apart from controlling GHG emissions, the Administration has been embarking upon a major tree planting programme to enhance the capacity of CO₂ absorption. In the past five years, over 11 million trees were planted in Hong Kong. Another 1.2 million trees will be planted in 2007.

Public Awareness and Education

37. Raising public awareness and public education with a view to promoting lifestyle and behavioural changes at all levels are another key to reducing GHG emissions.

38. Our efforts in this area include the development of various energy efficiency guidelines to promote energy conservation in commercial properties; launching the Energy Efficiency Registration Scheme for Buildings to promote voluntary compliance of Building Energy Codes; organizing Energy Efficiency Awards to promote sustainable energy use and recognize good energy saving practices; carrying out public awareness programmes for promoting energy efficiency and renewable energy;

providing information to the public through technical talks, web-based education kits, school talks, information leaflets and energy end-use databases; and mobilizing the community to take action at personal level to adopt energy saving measures under the “Action Blue Sky” campaign.

FUTURE EFFORTS ON CLIMATE CHANGE

39. Just as it is important to continue to build on what we have been doing to take on the challenge of climate change, it is equally crucial for us to have a better grasp of the likely impact of climate change on our city and identify further adaptation and mitigation measures. Taking account of the recent release of the findings of major studies on climate change, particularly those published by the IPCC, the Administration will commission a new round of study to tap into the findings of all these international studies and assess the impacts of climate change on Hong Kong. It will provide us with a solid scientific basis to develop further our adaptation and mitigation measures as well as for the preparation of the HKSAR submission to CPG for meeting the national communications obligations under the Kyoto Protocol.

40. Members are invited to note the information set out in this paper.

**Environmental Protection Department
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