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The Challenges on the Built Environment of Hong Kong

The social, economic and technological developments in different continents have inspired advancements in architectural design, construction technology as well as building services installations. In the 20th century, the advancements in science and information technology, the awareness of global environmental changes, and the knowledge on illnesses and medical treatments have raised public concerns on better environmental health, comfort, safety, convenience and conservation.

In this chapter, we will give a snap shot of the facts and figures, and the events that have had remarkable influences on the development trends of the built environment in Hong Kong. How these influences have generated new ideas, practices and regulations on the building features and services systems will also be addressed.

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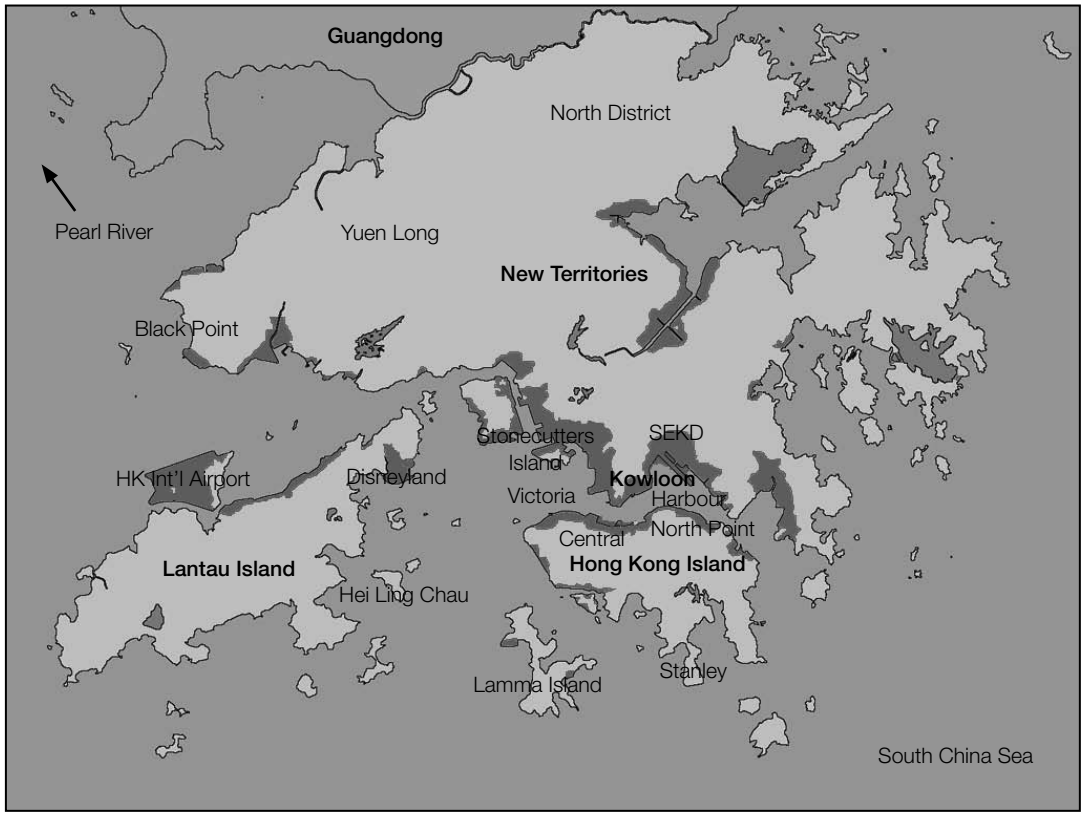
1 The Building Development in Hong Kong

Hong Kong is a place full of miracle. Beginning as a fishery and trading port in the 19th century, Hong Kong turns into a leading financial centre within 200 years. Geographically, Hong Kong is at the south of the Guangdong province, at the east side of the Pearl River Delta and facing the South China Sea (see Figure 1.1). Belonging to the subtropical climate zone, Hong Kong's weather is characterised by its hot humid summer with occasional showers and thunderstorms, and dry cool winter with the occasional cold front bringing strong chilly winds from the north. After World War II, the increased immigration from the Mainland China brought to its population growth and the low-cost labour supply, and as a result, the growth of the textile and manufacturing industries. As Hong Kong rapidly industrialised, the economy became driven by exports

Figure 1.1 Hong Kong territory with reclaimed land shown in dark colour



to international markets. Together with Singapore, South Korea and Taiwan, Hong Kong gained the reputation as one of the "Four Asian Dragons" for its high growth rates and rapid industrialisation between the 1960s and the 1990s. Living standards rose steadily with the industrial growth. Although Hong Kong is a small place with a land area of 1,100 km^2 (including the reclaimed land), its population today is growing to 7 million. The current people density is close to 6,400 people per km^2 and the household density 2,240 household per km^2. With the expected influx of immigrants from the Mainland in the multiples of ten thousands per year, these figures continue to grow. About 30% of Hong Kong's population live in public rental housing flats with another 18% in subsidised home ownership flats. These are facilitated by the Housing Authority. The remaining over 50% is with the private housing. Due to the lack of space in the city, few historical buildings remain in Hong Kong. Older buildings are regularly torn down to make way for urban developments. This makes the city more or less a centre for modern architecture. Dense commercial skyscrapers line the coast of Victoria Harbour, a valuable natural asset in the minds of the Hong Kong people no less than the Sydney Harbour in the minds of the Australian. Embraced by the surrounding mountains, Hong Kong's skyline ranks one of the best in the world.

Because of the massive building boom from 1999 to 2005, 225 skyscrapers over 150 metres were completed during the period. At present, Hong Kong has the world's greatest number of skyscrapers—most of these were built in the past two decades—well ahead of the second place New York City by more than 30%. As of 2008, five buildings in Hong Kong are of height exceeding 300 metres. The tallest building is currently the International Finance Centre II which was built in the Central District in 2003 and stands 415 metres tall. One eye-catching development project underway is the 118-storey International Commerce Centre located in West Kowloon. Upon its completion in 2010, this 484-metre new skyscraper will become the tallest building in Hong Kong, and will be ranked the third tallest in the world counting the top occupied level[1].

Like in most other modern cities, the social, economic and technological developments inspire advancements in architectural design, construction technology, as well as building services provisions. The rapid developments in technology and communication, the general awareness of global environmental impacts and the lessons from influenza pandemic have elevated people's expectation for better environmental health, human comfort, life safety, and task convenience. The demands have led to new emerging concepts on engineering design and facilities management. So despite Hong Kong's reputation of being intensely urbanised, the territory has made much effort in the last decade to promote a green environment. As an example, the recent public concern has prompted the severe restriction of further land reclamation from our most famous natural landmark—the Victoria Harbour. There are other successful and unsuccessful stories in relation to infrastructure development and building construction. Presented in this chapter is a snap shot of the events that have influenced the development trends of

the building and services system design and operation. Also addressed, here and in the following chapters, are how these influences have generated new ideas and called for new regulations on the building features and services systems. I would like to begin the journey with the hottest environmental concern—the global warming effect.

2 The Global Climate Change

2.1 The IPCC Observations

You may not feel surprised if I mention to you that in 2007, the land temperature in the world reached the historical high level ever since there were scientific records, and was higher than the average value of 1971–2000 by 0.67°C. This global warming phenomenon has been closely watching by the Intergovernmental Panel on Climate Change, which is better known as the "IPCC". The following is a re-organised abstraction from their *Report on Climate Change 2007* [2].

> *"The warming of the climate system is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. Observational evidences from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases. The records show, out of the last twelve years (1995–2006), 11 rank among the 12 warmest years in the measured global surface temperature since 1850. The 100-year linear trend (1906–2005) of 0.74°C is larger than the corresponding trend of 0.6°C (1901–2000). The temperature increase is widespread over the globe and is greater at higher northern latitudes. Land regions have warmed faster than the oceans. Rising sea level is consistent with warming. Global average sea level has risen since 1961 at an average rate of 1.8 mm/yr and since 1993 at 3.1 mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. Of more than 29,000 observational data series (from 75 studies) that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming. Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land cover and solar radiation alter the energy*

balance of the climate system. Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. Atmospheric concentrations of CO_2 (379ppm) and methane CH_4 (1774ppb) in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution."

The IPCC *Special Report on Emissions Scenarios*[3] projects an increase of global GHG emissions by 25 to 90% (CO_2-eq) between 2000 and 2030, with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. According to the IPCC *Technical Paper on Climate Change and Water* released on 9 April 2008, there is abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change. Over the 20th century, precipitation has mostly increased over land in high northern latitudes, while decreases have dominated from 10°S to 30°N since the 1970s. For the Asia region, some projected regional impacts are:

(i) By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease;

(ii) Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers;

(iii) Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development; and

(iv) Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

2.2 Climate Changes around Us

In the South China Sea region, monsoon affects much the regional climate and the global eco-system. Analysis of the monsoon climate clearly shows the sensitivity of the monsoon system in response to global mean temperature changes. El Nino-Southern Oscillation exhibits the greatest influence on the inter-annual variability of the global climate. Local climate change may follow the global trend. But it may also be affected by the other

factors such as urbanisation, irrigation, and desertification. For example, urbanisation leads to an increase in suspended particulates in the atmosphere and thus a decrease in visibility. As a result, the surface solar radiation decreases. The rise in temperature during daytime is then reduced, but this may be more or less offset by the heat released from air conditioning equipments and other urban activities. The net result can be insignificant change in the daily maximum temperature.

By carrying out trend analyses on meteorological observations in Hong Kong, the annual mean temperature data was found to have an average rise of 0.12°C per decade from 1885 to 2002. In the 56-year period after World War II (1947–2002), the annual-average daily minimum temperature T_{min} followed a rising trend of 0.28°C per decade. On the other hand, there was very little change in daily maximum temperature T_{max} but a mild increase of daily mean temperature T_{mean}. The increases in annual-average T_{min} and T_{mean}, as well as the reduction in daily temperature range, can be attributed to the global warming and some other local effects such as the urban heat island (UHI) phenomenon. Comparable occurrences can be found in Macau, though the temperature rise was less significant in this neighbouring city with less population density[4]. In the period 1947–2000, there were long-term increasing trends of T_{mean} and T_{min} respectively at 0.07°C and 0.25°C per decade, but there was no obvious trend in annual-average T_{max}. For the whole 20th century, there was again no asserted linear association of annual average T_{max} with time. T_{mean} was increasing at a mild rate of 0.047°C per decade. All these figures support that the UHI occurrence in the cities raises nighttime temperatures more than daytime temperatures.

2.2.1 What about the future trend in Hong Kong?

In a press release on 12 March 2008, the Director of the Hong Kong Observatory Mr. C. Y. Lam briefed about the updated projection of the temperature trend in Hong Kong in the 21st century[5].

> *"Taking into account various GHG emission scenarios and the effect of urbanisation in Hong Kong, by the end of this century there will be a temperature increase of 3.0°C for the low-end scenario, 6.8°C for the high-end scenario, and 4.8°C for the middle-of-the-road scenario… In summer, the number of hot nights (with minimum temperature ≥ 28°C) will increase. By the end of the century, the 'middle-of-the-road' number of hot nights is 41 per year. The 'high end' figure is 54. The corresponding figure at the end of the last century was 15. Similarly, the number of very hot days (maximum temperature ≥ 33°C) will also increase. By the end of this century, the 'middle-of-the-road' figure is 15 per year. The 'high end' figure is 19. The corresponding figure at the end of the last century was 7. The average of all calculation results based on different scenarios shows that by 2030–2039,*

there will be less than one cold day a year, meaning that for some winters, there will not be any cold days at all… For the situation in which the high emission scenario is coupled with continued urbanisation, the time for this to occur will be advanced to 2020–2029. We will all have the chance to witness the disappearance of winter in Hong Kong."

2.3 International Protocols

Hong Kong emits around 0.2% of the global GHG emissions. In 2005, the emission was 6.5 tonnes per capita. This was far below the level of most developed countries and 6% less than the 1990 emission level. But a continuous drop is not confirmed. Under the terms of the Kyoto Protocol, China (including Hong Kong) is not required to limit its GHG emissions, but has to submit "national communications" to the United Nations. Pressures of changing the requirements have been received in more recent meetings.

On the other hand, Hong Kong is committed to the Montreal Protocol on substances that deplete the ozone layer. The consumption of hydrochlorofluorocarbons (HCFCs) are progressively phasing out. Since January 2004, the import quota of HCFCs has been reduced by 35%. This will drop by a further 65% in 2010 and by 90% in 2015. At the Meeting of Parties to the Montreal Protocol held in September 2007, the members agreed to shorten the phase-out schedule. To cope with the new time frame, Hong Kong needs to further reduce the maximum allowable annual consumption of HCFCs from the original level of 48.6 to 34.7 weighted tonnes by 2010.

The annual consumption of HCFCs in Hong Kong was about 51.1 weighted tonnes in 2007. If this consumption level continues in the coming two years, Hong Kong will have to cut the local consumption by at least 16 weighted tonnes of HCFCs (equivalent to about 300 metric tonnes of R-22) by 2010. As most of the HCFCs consumed locally are for servicing air conditioning and refrigeration systems, the shortage of supply may have adverse impacts on the operation of these systems. The search for and switch to alternatives brooks no delay.

3 The Living Environment in Hong Kong

3.1 The Economy in the Last Two Decades

Hong Kong underwent a rapid transition to a service-based economy in the 1980s with the GDP growth averaged 7.2% annually. Much of the manufacturing operations moved to the Mainland China and the industry constituted only 9% of the economy in this

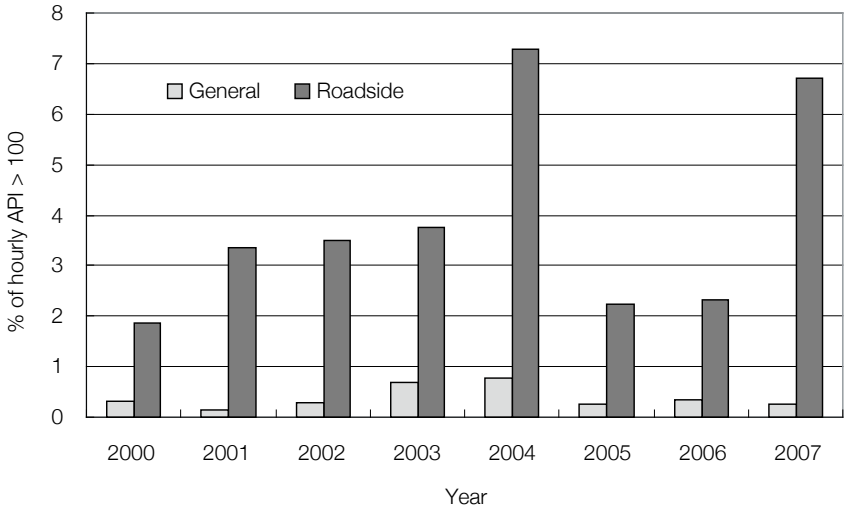
period. As Hong Kong matured to become a financial centre, the growth slowed down to an annual average of 2.7% in 1990s. The economy suffered a 5.3% decline during 1998, in the aftermath of the Asian financial crisis. A period of recovery followed, with the growth rate reaching 10% in 2000, although deflation persisted. From 2001 to 2003, the Hong Kong economy underwent a distinct slowdown which was firstly prompted by the downturn in the US economy suffered by the 911 terrorist attack in 2001, and later the outbreak of SARS locally in 2003 giving a three-year average of 2.0% per year in GDP growth. A revival of foreign and domestic demands led to a strong recovery in 2004, as the cost declines strengthened our export competitiveness. The 68-month deflationary period ended in mid-2004, with the consumer price inflation drifting at near zero levels. The economic growth was robust from 2004 to 2006, giving an annual average of 7.7%. Together with a moderate inflation rate, this is a clear indication of sound economic fundamentals.

Since the old days under the British sovereignty, Hong Kong has been a highly capitalist economy built on a policy of free markets, low taxation and government non-intervention. Despite the ripples, the GDP per capita of Hong Kong currently exceeds those of Japan and many European countries like the United Kingdom, France, Germany, Switzerland and Denmark. We are benefitted by the Mainland's open-door policy and economic reform. As an international finance and trade centre, the city has the greatest concentration of corporate headquarters in Asia Pacific. But the continuous deteriorating air quality in the last two decades has raised the alarm that the corporations may move their headquarters out of our territory. In fact, not only the business community, all parts of the Hong Kong society are worried about air pollution[6].

3.2 Air Pollution

The air pollution problem has been with Hong Kong for some years with no significant improvement despite the efforts spent[7]. Figure 1.2 shows for the period 2000–2007, the percentage of hours within the year that the Air Pollution Index (API) exceeded 100. API, at a scale 0–500, is the conversion of the ambient respirable suspended particulate (RSP), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and nitrogen dioxide (NO_2) concentrations measured at the government air quality monitoring network, which is in charge by the Environmental Protection Department (EPD). An index at 100 corresponds to the short-term Air Quality Objectives (AQOs) established under the Air Pollution Control Ordinance. Within the index range of 101–200 at the roadside, those people with existing heart or respiratory illnesses should avoid prolonged stay in areas with heavy traffic. From Figure 1.2 the worst was recorded in 2004 with 7.3% at the roadside that the API > 100, followed by 2007 at 6.7%. According to EPD, the pollutant levels were particularly serious in the Tung Chung and Yuen Long areas, which are

Figure 1.2 Percentage of hourly API exceeding 100 at EPD air quality monitoring network



geographically close to the Pearl River Delta industrial area. There are two main sources of air pollutants identified in Hong Kong: (i) the vehicle emissions, and (ii) the GHGs from thermal power plants.

In a survey of vehicle emissions in the periods from May to September 2003 and from November 2003 to February 2004, the pollutant levels were monitored at a number of locations including ambient, roadside and tunnel[8]. It was found that at six out of the seven measuring sites, the concentration of particulate matters at nominal 2.5 μm (PM2.5) was found higher than the United States Environmental Protection Agency Standard of 65 μg/m^3, on 24-hour average basis. In the worst case, the recorded PM2.5 was 288 μg/m^3 inside one vehicle tunnel. And the worst case at the roadside was 129 μg/m^3. The main pollutant source was identified from diesel fuel. PM2.5 assessment corresponds to small suspended particulate matters that may penetrate through the respiratory system of the human body and may reach the lung, and therefore is hazardous. So far Hong Kong has set acceptance level on PM10 but not on PM2.5. Volatile organic compounds (VOCs) are the other key air pollutants. During the survey, the highest record of 797 μg/m^3 was observed at the measuring station outside one Cross-harbour Tunnel.

In fact, the EPD has had a long-running program to control vehicle emissions. In 2000, the requirement of using low-sulphur-content diesel fuel was introduced. In 2005, over 90% of the taxis and one-third of the mini-buses were converted to use less polluting LPG (liquefied petroleum gas). Nevertheless, some of the cross-border vehicles

Table 1.1 Progress in achieving the 2010 emission targets (EPD 2007)

	1997 Emission (tonnes)	2005 Emission (tonnes)	Changes 1997–2005	2010 targets
SO_2	64,500	84,600	+31%	-40%
NO_X	110,000	93,800	-15%	-20%
RSP	11,200	7,200	-36%	-55%
VOC	54,400	40,200	-26%	-55%

are using diesel fuel available at Guangdong and the sulphur content is much higher than those in Hong Kong. From 2006 to 2007, all heavy diesel vehicles had to be installed with approved emission reduction devices and those newly registered had to comply with Euro IV standards. Incentive scheme is also offered to private car owners: the first registration tax for environment-friendly petrol private car has been reduced. On the other hand, the drivers are advised to switch off their engines when waiting.

VOCs are also emitted from a number of seemingly everyday products, such as paints, printing inks and hairsprays. Since 2007, new VOC regulation has been imposed in phases to prescribe VOC limits on selected products. New products in excess of the prescribed limits are banned.

The SO_2 level has increased in Hong Kong since 1997, and the main sources are from the two power companies, the Hong Kong Electric Company Ltd. (HEC) and CLP Power Hong Kong Ltd. (CLP). From 2006 onwards, HEC and CLP have retrofitted their coal-fired units with flue-gas desulphurisation (FGD) systems as an effective means of reducing SO_2. HEC will retrofit two more coal-fired units with FGD and low NO_X burners between 2009 and 2010. CLP will also install selective catalytic reduction systems, which further reduce NO_X, in its four coal-fired units between 2009 and 2011. Another direction is the switch from coal to natural gas for electricity generation. Natural gas combustion emits 90% less SO_2 and RSP than coal, and 80% less NO_X. CLP introduced its first gas-fired generating unit in 1996 and currently operates eight gas-fired units at the Black Point Power Station. HEC commissioned its first gas-fired unit in mid-2006 and converts an existing oil-fired unit to gas firing in 2008. The Hong Kong and China Gas Company also started using natural gas in the town gas production process, and accordingly, a reduction of CO_2 emission from the gas company by 20% was achieved in 2007.

The smog that hangs over the Pearl River Delta is a combination of emissions from Hong Kong and Guangdong. The governments of both jurisdictions have been working together for several years to tackle this problem. The targets, as listed in Table 1.1, have

been set to reduce the levels of key pollutants to well below the 1997 levels by 2010. Also listed is the status in 2005, after a progression of work done in Hong Kong. The situations were unfortunately disappointing in 2007 for both parties, making the 2010 targets difficult to achieve.

In October 2006, the WHO (World Health Organization) required the member countries to review their own AQOs and to work out a plan to achieve stringent new targets. One of their concerns is on PM2.5. Hong Kong was among the frontline members in support of the WHO. The work in Hong Kong encompasses an 18-month comprehensive review and the aim is to come up with new standards and long-term management strategy in 2009.

3.3 Water Resources and Treatment Issues

3.3.1 Water supply

For several decades after World War II, reservoirs remain the major source of fresh water supply in Hong Kong. Using reservoirs to collect rainwater was found to be grossly inadequate in 1963–64 when restricted water supply to the general public (one time within four days) was once imposed. Thereafter, the then Hong Kong Government (HKG) determined to purchase water from Guangdong. This reliable fresh water supply from the Pearl River has given much support to our urbanisation and economy growth. In 1981, Hong Kong experienced the last water supply restriction. From then on Hong Kong people are enjoying 24-hour water supply at all time. Nevertheless, the use of fresh water for cooling tower application in commercial air-conditioning systems was not allowed before the turn of the century. In 2000, the HKG launched a pilot scheme on the wider use of fresh water for water-cooled air conditioning in non-domestic buildings in the designated areas in Hong Kong. The building owners within the designated areas are thereon encouraged to install water-cooled chillers together with evaporative cooling towers.

In the 1970s, the HKG also imported the desalination technology as an alternative means of fresh water supply. But the rapidly escalated fuel price after the 1973 oil embargo finally led to the termination of the project. Although the utilisation of seawater in this aspect was not that successful, using seawater for toilet flushing as legislated in the 1960s has been highly rewarding. This greatly reduced the demand for fresh water and also enhanced public hygiene. In 1991, about 65% of Hong Kong's households were using free seawater for flushing. By 1999, there were 29 seawater pumping stations along the sea front and seawater constituted 23% of the total consumption of water in Hong Kong. Today, about 80% of the population is provided with seawater flushing.

For decades, seawater was also used for condenser cooling (either directly or indirectly through plate-type heat exchanger, and occasionally for seawater cooling tower application) in central air-conditioning systems, as well as in steam condensers of the thermal power plants for electricity generation in Hong Kong. At this end, Hong Kong has taken the leading role. Nevertheless, seawater quality remains an issue to be dealt with in the 21st century.

3.3.2 Seawater quality

Water quality of the Victoria Harbour was never a problem in the past when the sewage flows were much lighter. For years sewage was dumped untreated into the harbour and flushed away by tidal currents. This approach more or less worked until the early 1980s, when the growth in population and economic activity created sewage loads that were well beyond the holding capacity of the harbour. In 1989 the EPD unveiled a strategic sewage scheme, later known as the Harbour Area Treatment Scheme (HATS), to address this problem[9]. Stage 1 of the project involved the collection and transportation of the sewage from Kowloon and northeast Hong Kong Island to a sewage treatment plant on the Stonecutters Island for chemically enhanced primary treatment. This was commissioned in late 2001 with immediate positive results. Dissolved oxygen, which is essential to marine life, has increased by 10% overall. Compliance with the harbour's Water Quality Objectives was 90% in 2006 as against 50% in 2001. However, not all problems have been solved.

HATS Stage 1 treats 75% of sewage flows around the Victoria Harbour. The remaining 25%, generated by about one million people living in the north and the west side of the Hong Kong Island, are still dumping into the harbour without treatment. Furthermore, the treated effluent from Stonecutters is not disinfected, resulting in an excessive concentration of bacteria in the western waters. Four nearby beaches had to be closed for hygiene reasons, in addition to three others that were closed earlier because of local pollution problems.

HATS Stage 2 is divided into two phases, for making it more manageable and affordable. Stage 2A is to collect the rest of the sewage from the Hong Kong Island and disinfect the treated effluent from the Stonecutters. This is expected to cost HK$8 billion in capital expenses and $420 million in annual operation. It will be commissioned in 2014 provided the proposed sewage charge increases are approved by the legislature. Stage 2B, at the estimated costs of $10.8 billion for construction and $700 million for annual operation, will introduce a higher level of treatment (i.e. biological treatment) and will accommodate future sewage loads. However, several uncertainties may affect the planned schedule, including the future population growth and sewage load, as well as the need to sort out some complex land issues at the site earmarked for its development.

The schedule of Stage 2B will be reviewed in 2010–11, taking into account the latest relevant trends in pollution, load and water quality.

The HATS stage 1 for sewage currently costs about $320 million a year to operate, a figure that will rise to $740 million when Stage 2A is in service in 2014. Currently, only 54% of the applicable sewage services costs are recovered through the sewage charge; the rate has not been changed since 1995. In terms of the share of sewage services costs borne by the customers, the charge is actually declining. This is not only unsustainable, but also unfair because polluters are not paying their share. Therefore, the future direction is expected to increase the sewage charge to reflect the true cost of cleaning up the Victoria Harbour.

3.3.3 Reclaimed water

"Reclaimed water" refers to the sewage effluent that has been highly treated to make it safe for other uses, such as toilet flushing and irrigation. This has been widely practised in developed countries, like the United States, Japan and Australia. In autumn 2006, the EPD commissioned an advanced treatment plant and dedicated pipeline to treat some of the effluent from the Shek Wu Hui Sewage Treatment Works in the North District for producing high quality disinfected water. The reclaimed water serves a selected group of domestic premises, schools and elderly homes for non-potable uses like toilet flushing, landscape irrigation and water features. The demonstration scheme ended in 2008 and hopefully the results will form a basis for the wider use of reclaimed water in Hong Kong. At present, around 1.3 million Hong Kong people still rely on fresh water for toilet flushing, consuming 82 million m^3 of water per year that costs $330 million.

3.4 Solid Waste Treatment

The situation with municipal solid waste is more drastic because households do not pay any direct cost for collecting, treating and disposing waste. This is again inconsistent with the "polluter pays" principle, and also offers no incentive to the community either to reduce or to recycle waste. The three landfills in Hong Kong are running out of space and there are limitations for building new ones. It is therefore imperative to introduce new measures to reduce our waste loads.

The introduction of construction waste disposal charges in January 2006 set an important precedent. Since the charges came into effect, the construction waste disposed at the landfills has dropped by 40%. At this end, the municipal solid waste charges if introduced may also help to reduce waste.

The Chemical Waste Treatment Centre (CWTC) has been operating since 1993 and currently treats around 40,000 tonnes of chemical waste a year. It has been designed to meet stringent environmental standards and has performed admirably, with an environmental and engineering consultancy study concluding in 2006 that the CWTC does not cause any adverse environmental impacts. However, international environmental standards have changed in recent years. The European Union has some of the toughest standards in the world and, while most of the current CWTC's emission levels still meet those standards, they fall short for SO_2 and NO_X. The contract for the CWTC expired in April 2008, providing a good opportunity to upgrade its air pollution control system. The CWTC will also be installed with additional facilities in 2008–09 for receiving and treating clinical waste, thus enabling controls to be implemented on the treatment and disposal of this waste.

Getting people to recycle more can only be effective if there are outlets for their waste. The EPD has been developing a $257 million EcoPark to provide affordable, long-term land for the use of the recycling and environmental industries. The first three lots at EcoPark are for recycling plastics, waste tyres, wood, plaster, glass and other building materials. In addition, 36 short-term tenancies on 7.4 hectares of land elsewhere have been leased to recyclers. The EPD also operates the Kowloon Bay Waste Recycling Centre for the promotion of recovery and recycling electronic products. Since September 2005, the centre has been using by two separate charitable groups for running two pilot programs. A third pilot program has been started in 2006 to recycle cathode ray tubes and recover useful materials from waste computer monitors and televisions. At the end of 2007, the television broadcast of Hong Kong entered the High Definition Digital Era. Accordingly, many families started to replace their televisions with the digital ones. In the first quarter of 2008, the number of cathode ray tubes from waste televisions and computers received at the centre has already exceeded the annual quota. The lack of planning is expected to result in the final handling of these in the private recovery centres. As many of these private centres are located in the North District, the dismantled electronic wastes are easily polluting the soil and the nearby rivers.

3.5 Infection Diseases

Because of the early health education, professional health services, and well-developed health care and medication system, Hong Kong is among the healthiest places in the world. The people here enjoy an average 82-year-long life expectancy, which is the second highest in the world. The infant mortality rate is 2.94, the fourth lowest in the world. Among the world lowest is the fertility rate at 0.95 children per woman; this is far below the 2.1 children per woman required to sustain the current population. However, like many other world class cities, Hong Kong did suffer from influenza infections,

which from time to time impose new demands on medical as well as on building services provisions.

3.5.1 Influenza pandemic

An influenza pandemic is a global outbreak of disease that occurs when a new influenza virus appears (or re-emerges) in the human population against which the human has no immunity, then it spreads rapidly (in less than a year) and causes disease worldwide. Pandemics recur periodically, yet unpredictably, and are invariably associated with high morbidity and mortality as well as great social and economic disruption. The three influenza pandemic occurrences in the 20th century were the "Spanish flu" in 1918–19, the "Asian flu" in 1957–58, and the "Hong Kong flu" in 1968–69. The 1918–19 pandemic killed approximately 20–40 million people worldwide, more than the death toll in World War I. And during the last pandemic (H3N2) in 1968, 15% of the Hong Kong population was infected and there were about 33,800 fatal cases outside Hong Kong, mostly in the U.S.

3.5.2 Avian influenza

For more than 10 years, the outbreaks of avian influenza infection among poultry have been reported worldwide. The World Health Organization (WHO) has expressed concern that the avian influenza virus may re-assort its genes with those from a human influenza virus, thereby acquiring the ability to move easily from human to human and thus triggering a pandemic. Avian influenza viruses do not normally infect species other than birds. The first documented infection of humans with an avian influenza virus occurred in Hong Kong in 1997, when the H5N1 strain infected 18 people, resulting in six deaths. To prevent further infection, the HKG health officials slaughtered the chicken and duck populations. Close to two millions were slaughtered. Another outbreak of Influenza A (H9N2) occurred in 1999 with two people infected and thereafter, one case in 2003, and one case in 2007. To prepare for large-scale outbreaks, the public healthcare system, staff and hospital bed mobilisation plans have been prepared. Air-conditioning provisions in the hospitals have been reviewed.

3.5.3 Severe acute respiratory syndrome

In late 2002, an outbreak of severe acute respiratory syndrome (SARS) began in Guangdong. In February 2003, a doctor who had treated cases in Guangdong checked into a hotel in Hong Kong and infected up to twelve other guests there. A large number of healthcare workers were infected while treating patients in different hospitals. It

was then from Hong Kong the virus carried to other places and subsequently, posed an enormous threat to the international community. On 30 March, the HKG authorities quarantined the Block E of the Amoy Gardens, a private housing estate, due to a massive outbreak with more than 200 cases at the same block. The virus was brought into the estate by an infected visitor who was discharged from the hospital. Most of the cases were tied to apartment units at the same orientation and shared the same sewage pipe. One speculation of the virus spread was through excretion, and therefore through the wet drainage system. The other speculated theory in support of airborne transmission was the spreading through dried up U-shaped P-traps in the drain pipes, and was blown by a maritime breeze to the apartments via stairwells.

For weeks, there were many infected cases in Hong Kong and not until 24 May that the number of newly infected patients dropped to zero for the first time. Within the period, there were 1,755 identified SARS cases (299 of whom died) in Hong Kong and more than 400 infected patients were healthcare workers. The outbreak has heightened the public concerns on the possible dire consequences of building neglect and the perennial environmental hygiene problems. After the crisis, the review of the building services installations was not limited to hospital facilities but also the drainage system at large. In response, the Buildings Department has conducted a territory-wide survey to all private buildings on defective drains and participated in improving environmental conditions of some identified black spots.

3.6 Noise Impact

The city of Hong Kong is unusual and challenging for noise control. Activities go on till midnight, and sometimes overnight. In many old urban areas, residential, commercial and industrial premises are mixed together without clear demarcation. The background community noise is substantial since their developments were well before proper environmental and planning guidelines were in place. Many people are living next to noisy restaurants, bars, industrial processes and other potentially irritating activities. Sometimes it is not possible to eliminate the problem, but only to reduce its magnitude. The disclosure of noise information in properties sales brochures is a growing community expectation. As a matter of fact, the noise environment often changes. There could be nearby construction work, short-term amusement parks, or new railway line or road. Currently, noise from general construction works between 7 p.m. and 7 a.m. and on public holidays is controlled through construction noise permits. Noise from industrial or commercial activities is controlled by means of noise abatement notices, in that the one emitting the excessive noise is required to reduce it within a given period.

Comparing with stationary noise sources, traffic noise is perhaps the more difficult subject. In a densely populated city, heavy vehicles often have to travel near homes, hospitals, schools and many other sensitive receivers. As a result, more than 1.1 million people in Hong Kong are affected by excessive traffic noise of above 70 dBA. Traffic noise is expected to worsen over the next ten years due to increased traffic, especially in the early morning hours and at night. A study was commissioned by EPD in late 2006 to review the practices overseas in respect of noise standards and to keep abreast of international developments. Also reviewed are the Professional Practice Notes on Road Traffic Noise, which are used by architects, engineers and town planners in designing buildings and new roads, to provide more protection against traffic noise to the residents of new buildings.

4 The Integrative Efforts

A clean and healthy environment is core to our quality of life and the competitive edge of Hong Kong. The success requires the cooperation among the government, the public utilities, the private sector and the users as well. All parties are committed to providing high quality and sustainable living environment.

Sustainable development refers to one that meets the needs of the present without compromising the ability of future generations to meet their own needs. As a matter of fact, sustainable development is a co-operative concept. It encompasses not only environmental protection and conservation, but also holistic thinking and integrated approaches in balancing social, economic, environmental, and resource needs. A number of non-profit organisations, such as the Professional Green Building Council (PGBC) and the Hong Kong Building Environmental Assessment Method (HK-BEAM), have been instrumental in the growth of sustainable buildings. A comprehensive environmental assessment of buildings has been adopted, i.e. from design, construction to management of green buildings.

The Action Blue Sky Campaign, launched by the HKG in July 2006, is a wide-ranging publicity campaign to raise public awareness about energy conservation in all sectors of the community. The campaign encourages the community to take actions in their daily lives to improve air quality, such as setting air-conditioned room temperatures at 25.5°C in summer months. The Chief Executive, Sir Donald Tsang, set an example

by launching a "Dress Down in Summer" campaign to encourage civil servants to dress lightly in summer to engender a more comfortable work environment under the 25.5°C initiative.

4.1 Sustainable Urban Planning

4.1.1 Screen-like buildings

The real estate developments in Hong Kong basically follow the urban street pattern. Single blocks of building are packed along streets and most of them are managed independently. The quality then varies from block to block. In the last 30 years, the concept of private housing estate emerged and each estate is self-sustained, having its own shopping mall, sports club and sometimes even schools. Integrative and structured housing management is provided. The idea is particularly welcome by the middle class from the "convenience and economy of scale" points of view. Within a single estate, the number of tower blocks can be from less than ten to over a hundred. With the release of building height restriction after the relocation of the international airport out from the city centre, the new blocks can be from 30- to 70- storey. In particular, private developers are maximising revenues by constructing uniform blocks on seafront sites to give all apartment units some unrestricted sea view. Some buildings, like those in North Point, are actually hiding the beautiful skyline of Hong Kong.

Another controversy is on the "wall effect" caused by uniform high-rise developments, known as the "screen-like buildings". The wind blockage not only adversely affect air circulation and intensify the urban heat island effect, but also impact public hygiene and contribute to air pollution. A survey conducted by a green group in 2007 found that among the 138 private residential developments completed in recent years, around 75% could be classified as screen-like buildings[10]. Moreover, the forthcoming projects linked with railway stations all include high-density screen-like buildings of 50-storey or above.

Back to year 2005, the Planning Department completed a feasibility study on air ventilation assessment (i.e. the AVA Study). A set of design guidelines for the improvement of air ventilation was formulated based on the findings. The AVA Study has proposed a performance-based assessment system to compare the air ventilation impacts of various design options. In July 2006, the Housing, Planning and Lands Bureau and the Environment, Transport and Works Bureau jointly issued a technical circular specifically on air ventilation assessment, making this one important consideration in the planning of major government (re-)development projects. How the new private developments can minimise wind blockage is a matter of urgency in urban planning.

4.1.2 Land reclamation and district cooling

Land reclamation has been a government policy with long history, of expanding the urban areas along the seafront, both within and outside the Victoria Harbour. One recent example was the Hong Kong Chek Lap Kok International Airport, which was constructed in 1990s by reclaiming two small islands at the north of the Lantau Island to serve as the base for the 1,255-hectare airport platform. This was one of the largest earth-moving and dredging operations ever undertaken. A fringe development on this man-made island is a world-class exhibition hall—the AsiaWorld Expo. The relocation of the airport from the city centre to the suburb in 1998 has left a large piece of flat land available for urban redevelopment, known as the South East Kowloon Development (SEKD). This is regarded a favourable site for the application of district cooling technology[11].

District cooling technology is a sustainable means of cooling energy generation through mass production. In 2000, the HKG commissioned a consultancy on "territory-wide implementation of water-cooled air-conditioning systems in Hong Kong", in that three different schemes: cooling tower (CT), central seawater (CS), and district cooling (DC), were compared. It was concluded that the DC scheme is superior to the CS scheme with respect to energy efficiency, building floor space utilisation, and project life cycle cost. Hence the CS scheme should only be considered under special circumstances. Moreover, DC and CT schemes could co-exist in the same district to provide building owners and operators with more choices so as to introduce healthy competition.

The method of condenser heat rejection has a major implication on the central plant chiller efficiency. Generally speaking, seawater cooling could result in the highest overall DC plant efficiency. The continuous discharge of cooling seawater to the territory's coastal waters may elevate the temperature of seawater near to the cooling discharge outfall, bringing thermal stress to the marine ecosystem. This impact can be minimised through source control.

The HKG proposed land reclamation at the Victoria Harbour, as opposed by the green groups, has affected the SEKD (South East Kowloon Development) project implementation. According to the court decision, there should not be any reclamation unless the "public overriding need test" is satisfied, i.e. there are immediate needs and with cogent and convincing reasons; there exists no reasonable alternative; and the proposed reclamation has been kept to minimum.

4.1.3 Environmental impact assessment

The environmental impact assessment (EIA) process, which is backed by legislation, requires proponents of major projects to identify and mitigate environmental problems

before final approval can be obtained. EIA must be carried out as a part of the engineering feasibility study of urban (re-)development projects with an affected area of more than 20 hectares or involving a population of more than 100,000 people. Since 1998, the Environmental Impact Assessment Ordinance has protected more than 1.5 million people and more than 1,000 hectares of ecologically sensitive areas from adverse environmental impacts by requiring proponents to incorporate prevention and mitigation measures. Up to early 2008 more than 100 EIA reports have been approved. The process, from the earliest planning stages to project completion, involves a high degree of public inputs and transparency. Hong Kong Disneyland is an example of a major project that underwent an EIA from the earliest planning stages to completion.

In recent years, the scope of EIA has been expanded to encompass strategic environmental assessments (SEAs). The driving force behind SEAs is to promote environmentally sustainable policies. The emphasis is on the impact of policies, strategies or plans such as major land use planning studies, rather than projects.

4.1.4 Renewable energy

In 2000, a study commissioned by the Electrical and Mechanical Services Department (EMSD) found that solar power, energy from waste and wind energy have the potential for wider use in Hong Kong. In 2005, the HKG set a target of generating one to two per cent of Hong Kong's total electricity supply from renewable sources by 2012. Accordingly both power companies have been exploring the application of wind power in Hong Kong. In February 2006, the HEC commenced operation of its 800 kW wind turbine at Lamma Island for public demonstration and technical evaluation, while CLP has planned for the operation of its first wind turbine at Hei Ling Chau in 2008. In addition, the two power companies conducted EIA studies for building off-shore commercial wind farms in Hong Kong waters. The HKG is also promoting the adoption of renewable energy in its discussions with the power companies over the post 2008-regulatory regime for Hong Kong's electricity market, such as providing financial incentives in the form of a relatively higher return for renewable energy infrastructure.

In Hong Kong, the primary use of solar energy at present is to provide hot water for swimming pools and for the slaughterhouse in Sheung Shui. Some small-scale photovoltaic and wind systems have been installed in remote areas to generate nominal electrical power for lighting and on-site data recording equipment. To assist the public to better understand the technical issues and the application procedures relating to grid connection of small-scale renewable energy installations, the "Technical Guidelines on Grid Connection of Small-scale Renewable Energy Power Systems" was made available to the public in 2005. This was followed by a revised edition completed in December 2007 which extends the applicable capacity limit of the original guidelines from 200 kW to 1 MW.

4.2 Public Health and Safety

4.2.1 Fire safety

Fires in old buildings without the provision of modern fire safety measures can be disastrous. There are about 1,400 commercial, 9,000 composite, 3,000 residential and 1,700 industrial buildings in Hong Kong which were constructed with pre-1987 fire services (FS) standards, i.e. with much deviation from the current FS Code requirements. During fire incidents in tall buildings, most fire fighting and rescue operations have to rely on the provisions within the building. The risk is therefore high.

On 20 November 1996, a tragic fire outbreak at the Garley Building, an old 15-storey commercial building in South Kowloon, resulted in 40 fatalities and 81 injuries. The Discovery Channel labelled this over 20-hour catastrophic event as the "Hong Kong Inferno". On that day lift replacement was underway with the lift cars of two lifts being removed and their landing doors at all floors being opened. Bamboo scaffolding was erected inside the lift shafts where electric arc welding work was carried out on Level 15. Many smoke detectors on Level 2 were disabled by wrapping them up with plastic bags in order to stop unwanted alarm. The welding sparks fell through the lift shaft and caused ignition at the Level 2 landing. Unfortunately smoke and burning smell from the ongoing welding work lowered the fire alert of the occupants. Although the fire occurred during office hours, no one seemed to be aware at the early stage. The lift shaft acted like a chimney so the flame and smoke quickly reaching Level 13 and started another fire there. Such a tragedy could be avoided if proper maintenance procedures and fire precaution measures were in place, and strictly followed by the staff members of the property management and the lift company. Over the years, even for post-1987 buildings, there were many occurrences of fire owing to the temporary close down of fire protection systems and the removal of fire dampers for the convenience of building renovation works.

For years, FS provisions are for dealing with accidental fires, like the one at the Garley Building. This is so not until the recent release of BS 7974, in which the precautions on arson fire (i.e. fire set up purposely by igniting sources) and attack fire (i.e. due to military action or terrorist attack) are also considered. On the other hand, the adoption of the fire engineering approach is recommended. The fire engineering approach requires the designer to look into FS designs from the first principles. As with other engineering disciplines, FS design should allow the incorporation of new ideas and also value engineering. The extent of FS provisions should cope with the nature of the fire risk so that a reasonable level of safety can be achieved, whereas unnecessary intrusion into building design or over expenditure can be avoided. FS systems are the integral parts of the overall fire safety design and should be considered in a holistic manner. Through the fire engineering approach, the performance, reliability and cost

effectiveness of FS systems can be readily analysed and improved. For example, water storage requirements, the spacing of fire detectors and sprinkler heads can be determined through our professional knowledge of fire science instead of dictating the code requirements.

4.2.2 Gas safety

Gas explosions may occur inside process equipment or pipes, in furnished buildings or construction sites, in open process areas or confined spaces. It is most important in risk management to lower the explosion probability to an acceptable level, or otherwise this may lead to disastrous consequences.

On 11 April 2006, a fatal underground explosion occurred at the ground level of an old building in East Kowloon, due to the leakage of town gas from underground pipes. Two people were killed and eight injured. The building was damaged seriously. The gas system was managed by the Hong Kong and China Gas Company Ltd. that supplies town gas to 85% of the Hong Kong households, and also to commercial and industrial customers. After the accident, a comprehensive survey was carried out by the gas company to identify any possible accumulation of escaped gas of any kind in voids close to buildings. Openings found were sealed to stop the gas entry or exit, and the data were recorded in the electronic system for future reference. The precautionary work should continue.

4.2.3 Electrical safety

In Hong Kong, the transmission and distribution power cables laid underground are more than 22,400 km in total length. In most urban areas, the pavements are crowded with power cables together with other utility facilities. Damage to a live electricity cable, particularly in the course of excavation, may lead to an explosion. While the site workers and the passersby may be electrocuted or burnt, the damage may also cause power interruption and bring serious inconvenience to the general public. The EMSD is currently working together with the power companies to monitor statistically the incidents involving damages to underground cables. In collaboration with trade organisations and other government departments, the Code of Practice on Working near Electricity Supply Lines has been revised, aiming at providing practical and up-to-date guidance for the construction industry.

The code of practices for electrical installations in Hong Kong are derived from BS 7671 (i.e. IEE Wiring Regulations) which is the national standard for the safety of electrical installations in U.K. In addition, there have been modifications in technical requirements to suit the Hong Kong situation and trade practices. To enhance the safety

of the public and building owners, communal electrical installations are required to be inspected, tested and certified every five years. On the other hand Hong Kong does not set our own standards on the safety of household electrical products. To further improve the situation, since 2005 the EMSD and the trade had mutually agreed to set a time frame for the supply of electrical products in compliance with the latest IEC safety standards.

From 1 July 2007 onward, cable colour for fixed electrical installations in Hong Kong has been changed from the current red/yellow/blue/black colour to the new color scheme of brown/black/grey/blue, in order to align with the latest international standard. The change has stabilised the cable supply to Hong Kong and minimised price fluctuation.

4.3 Architectural, Services Design and Construction

4.3.1 Green engineering

The HKG carries a leading role in green engineering. Since 1995, legislative control over the Overall Thermal Transmittance Value (OTTV) has been introduced for regulating the building envelope performance of new commercial buildings, including hotels. Later on, a set of comprehensive Building Energy Codes (BECs) that address energy efficiency requirements on building services installations was released. To promote the compliance with BECs, the voluntary Hong Kong Energy Efficiency Registration Scheme for Buildings was also launched. The current effort is to make the BECs mandatory.

In 2006, the EMSD introduced an assessment tool to appraise the life cycle performance of commercial building developments, and to assess their environmental and financial impacts. The tool assists in the selection of alternative materials and/or systems. Many green building features will be brought into the Central Government Complex at Tamar, to be completed by 2011. Supported by the two power companies, the EMSD also periodically organises the "Hong Kong Energy Efficiency Awards" energy saving competition which is targeted at two private sectors: (i) Commercial and Residential Buildings, and (ii) Schools.

The professional institutions also play their part. The Professional Green Building Council (PGBC) continues to launch the Green Building Award, which aims to promote sustainable and green development, to recognise developments and research projects with outstanding contributions to sustainability and the environment, and also to encourage the industry towards wider adoption of sustainable practices in planning, design, construction, maintenance, and renovation projects. The PGBC comprises five local professional institute members, namely, Hong Kong Institute of Architects, Hong

Kong Institution of Engineers, Hong Kong Institute of Landscape Architects, Hong Kong Institute of Planners, and Hong Kong Institute of Surveyors.

4.3.2 Historic building conservation

Many historic buildings in Hong Kong are under the threat of demolition. The Murray House, a Victorian-era building constructed in 1844, now in Stanley Bay, was originally in the Central District where the Bank of China Tower now stands. It was dismantled in 1982 to give way for the modern landmark. The restoration of this building (originally as barracks for the British military) in 1998–99 was a fortune since the preference on modern architecture and infrastructure construction have torn down many other historic monuments without the chance of relocation, like the old Repulse Bay Hotel (1920) and the Central Post Office Building (1911). After all, relocation can only be seen as the last solution as this fails to reflect the historical development and architectural significance as it was in the old days. The existing legislation concerning heritage preservation in Hong Kong has been commented as "piecemeal" and weak.

In 1992 the United Nations Educational, Scientific and Cultural Organization (or UNESCO) launched the "Memory of the World" program to guard against collective amnesia. This program set out to preserve valuable archive holdings and library collections all over the world, and ensure their wide dissemination. Building conservation requires particular expertise and care because historic monuments are significant and invaluable heritage of our culture that once lost or damaged cannot be replaced. The principle is that historic building has a special message from its creator and thus, its original structure and appearance must not be altered or falsified[12]. Development and preservation are not mutually exclusive. From the sustainable development point of view, we do not own heritage, but merely keep them for our future generations. The HKG needs to play a more proactive role, especially when the owner of a private heritage is expected to receive considerable benefits from the property developer through the selling.

4.3.3 Artificial intelligence and telecommunication

In 2004, Hong Kong Cyberport received the internationally acclaimed Intelligent Building of the Year Award 2004 from Intelligent Community Forum presented in New York. This information technology (IT) flagship of Hong Kong was being praised, not just for its state-of-the-art IT infrastructure and beautiful architecture, but more importantly the role model that it sets for future IT-connected community—broadband and information systems technology has been adding demonstrable value in the form of advanced services and merits to its tenants.

Back to 1970s, building automation existed in its early form as single functional

control and monitoring of discrete devices or systems. As the devices or subsystems in buildings getting more complex and inter-dependent, multifunctional control of subsystems became desirable for providing an efficient and effective integrated control system. Subsequently different integrated systems flourished in the early 1990s, and the developments had transcended to Building Management Systems (BMS) and Integrated Communication Systems (ICS) in the late 1990s. The more recent development has been to combine these two forming the Computer Integrated Buildings (CIB), which covers not only the conventional building subsystems integration, but also the integration to communication infrastructure to provide a new dimension of value services, and even extended to home automation. The joy of living will rise to a new horizon, when people can wishfully access their homes and control their appliances at some remote sites such as offices through the internet.

As a matter of facts, Hong Kong holds one of the most sophisticated and successful telecommunication markets in the world. This has been an important factor in Hong Kong's development as a leading business and financial centre. Broadband Internet access services are very popular in Hong Kong. Apart from fixed carriers, in January 2008 there were 171 internet service providers licensed to provide broadband services. As at the end of 2007, there were more than 1.87 million registered customers, using broadband services with speed up to 1,000 Mbps (Megabits per second). In the residential market, 76% of the households are using broadband service. Internationally, Hong Kong's broadband penetration rate is among the highest in the world.

4.4 Facilities Management

In the past, operation and maintenance service was never regarded as glamourous work. That may be true. Nowadays, buildings are huge and complex in function, and the building services installations are increasingly complicated. A diverse team with a serious professional attitude is required to take care of the day-to-day operation for achieving high quality and optimum performance. While the designers and the project managers live with the building services systems for some months during the design, construction and commissioning phases, the occupants and the operation and maintenance staff have to stay with them for many years. Post occupancy evaluations and full records are essential to ensure a new building be able to operate in its designed conditions.

On the other hand, as a result of the prevailing weak building care culture, there are increasing number of old and dilapidated buildings in Hong Kong showing signs of urban decay. Proper building management and timely maintenance of existing facilities help to prolong the overall life span of buildings, optimise the economic value of scarce land and improve the living environment.

4.4.1 Indoor air quality

Other than public health, an improved indoor air quality (IAQ) environment bears economic benefits such as reaching higher worker productivity, lower absentees, and lower medical costs. In Hong Kong, the EPD engaged a consultant to carry out a thorough study of the IAQ conditions in offices and public places in 1995–96. This was through questionnaire survey and field measurements[13]. The survey with more than 2,000 respondents found that 32% of the occupants were not satisfied with the IAQ situation in their workplace. This result was comparable to other similar studies done by the WHO. The measurements found that over an 8-hour period, about 38% of the offices were having CO_2 level above 1,000 ppm, and 20% having bacteria level above 1,000 cfu/m^3. The causes of these excessive concentrations were mainly inadequate ventilation and excessive occupancy density. One third of the offices were found to have too much formaldehyde in summer. Actually in many commercial premises, the building management purposely reduced the ventilating rate in order to save electricity costs.

Since 2003, the EPD has introduced a voluntary registration scheme with two classes, i.e. the "excellent class" based on a set of IAQ objectives with 12 parameters, and the "good class". If the IAQ objectives are complied with, an IAQ certificate will be issued for putting up at a prominent location of the building for public information. After the registration, the building owner is responsible for the post-certification IAQ control. As at April 2008, there were 37 excellent class certified premises and 73 good class certified premises on the list.

4.4.2 Energy management

Energy management works with an interrelationship between three microscopic factors: finance, technology and human behaviour, under the impact of four macroscopic factors: physical, economic, social and political climates. The ultimate goal is to pay as little as possible for the energy consumed. Sometimes this may have nothing to do with energy saving, for example, to make use of the power company tariff structure for overnight thermal storage. The importance of human factor is often overlooked during the process. In fact, the best way to achieve efficient use of energy and conserve resources is to have everyone committed and taking action.

Energy audit involves periodic examination of energy use in premises. It becomes popular in both the public and private sectors to check whether energy is being consumed effectively and efficiently. It allows a comparison of energy use in similar periods or similar occasions, leading to the formulation of annual budgets and energy targets for future plan. To help into these, the EMSD has developed a set of energy consumption indicators and benchmarks for specific groups of buildings in Hong Kong. A benchmarking tool is available to allow users and operators to compare their

energy consumption levels with others in the same group, set future targets and identify measures to reduce energy consumption. Through energy audits, the HKG was able to reduce its electricity consumption by 5.6% between 2002–03 and 2005–06, which was equivalent to 120 GWh electricity saving and a reduction of CO_2 emission by 84,000 tonnes annually. Further reduction is deemed possible.

4.4.3 Waste recycling

One of the great challenges for Hong Kong's "high-rise" population is finding the space to separate waste for recovery. Most homes do not have room to store recyclable or re-usable materials. The "Program on Source Separation of Domestic Waste", introduced by the EPD in January 2005, aims to provide places close to home where residents can separate their waste and store the recyclable or re-usable materials until they are picked up by recyclers. The types of recyclables collected have been expanded from paper, aluminium cans and plastic bottles to include plastic shopping bags, compact discs and metal tins. Up to mid 2008, more than 940 estates and buildings, representing half of the Hong Kong population, enrolled in the program. About 30% of these estates implemented floor-based waste separation but most estates set up waste separation facilities on the ground-floor. The goal is to have 80% of the population, in more than 1,300 housing estates, participating in the program by 2010. Nevertheless, whether a program is successful or not should not be judged by the number of enrolled estates but the number of families that have actually put this into action. According to statistical findings, only less than 20% of the inhabitants in the enrolled estates are participating in the waste separation program. There are much rooms for improvement.

5 What's in Need?

Quality buildings are essential ingredients of a world class city. In Hong Kong, from time to time our built environment faces various domestic and international influences and challenges. While in the past some of these were global matters, many were coming from our own culture and perhaps, from our less than desirable living habits. We are expected to face greater challenges in the 21st century that will call for more changes of our practices for the benefits of economic prosperity whilst meeting our growing social and environmental aspirations. Sustainable development cannot be preceded just by setting slogans or through demonstration projects. It requires a radical change in the values and attitudes of the community in favour of our future generations.

The application of building services technology in providing safety, health and comfort, is a task which requires continuous and shared efforts of all parties. The government, through setting standards and promoting community participation, is responsible for raising public awareness and exercising reforms on one hand, and regulating the side-tracked behaviour on the other. The public utilities are to provide stable and economical energy sources to the customers with greatest convenience and without introducing environmental pollution and life hazards. The learnt societies and pressure groups are expected to react from their precise observations and visions through the public media, and equally important, to undertake educational and professional development activities. Academics are to search for innovations, evolutions and in depth analyses in response to technological advancements and environmental changes, and at the same time, to re-organise knowledge for the public and the young. For the designers and project managers, it is their roles to alias with the suppliers and contractors to ensure that new installations are delivered in time and in full compliance with the professional standards and statutory requirements. They are also to work in hand with the operation and maintenance team to ensure that performance specifications are fully met, and systems are economically operated and well maintained throughout the life cycle. For the owners, users and general public, it is their utmost safety, health and comfort that moves the technology forward. The basic needs and conservation desire are no doubt the motivation behind the efforts of all parties. With the collective efforts from each and every of us, we together are going to create a marvellous and green built environment for Hong Kong.

Notes

1. Wikipedia, the free encyclopedia. List of tallest buildings and structures in the world, http://en.wikipedia.org/wiki/List_of_tallest_buildings_and_structures_in_the_world.
2. IPCC. (2008). *Climate change 2007, the fourth assessment report of the Intergovernmental Panel on climate change, Vol. 1–3*. Cambridge University Press.
3. Nakicenovic, N. and Swart, R. (Eds.) (2000). *Special report on emissions scenarios*. IPCC.
4. Chow, T. T., Chan, A. L. S., Fong, K. F., & Lin, Z. (2006). Some perceptions on typical weather year—From the observations of Hong Kong and Macau. *Solar Energy, 80*(4), 459–467.

5. HK Observatory. Director of Hong Kong Observatory talks on climate change and 2008 outlook (12 March 2008). www.hko.gov.hk/wxinfo/news/2008/pre0312e.htm.
6. Civic Exchange. (December 2008) Summary of Key Findings, Hong Kong's Silent Epidemic—Public Opinion Survey on Air Pollution, *Environment and Public Health—2008*.
7. EPD. (2007). *Environment Hong Kong 2007, Annual Report*. Environmental Protection Department, HKSAR.
8. EPD. (February 2005). *Final report of determination of suspended particulate and VOC emission profiles for vehicular sources in Hong Kong*.
9. EPD. An overview on water quality and controlling water pollution in Hong Kong. www.epd.gov.hk/epd/english/environmentinhk/water/water_maincontent.html.
10. GovHK. Press release: *Screen-like buildings*, February 28, 2007. www.info.gov.hk/gia/general/200702/28/P200702280173.htm.
11. Chow, T. T., Au, W. H., Yau, R., Cheng, V., Chan, A., & Fong, K. F. (2004). Applying district cooling technology in Hong Kong. *Applied Energy, 79*(3), 275–289.
12. Chui, H. M., & Tsoi, T. M. (August 2003). *Heritage preservation: Hong Kong and overseas experiences*. Report. Faculty of Social Science, University of Hong Kong.
13. EPD. (1995). *Consultancy study on indoor air pollution in offices and public places in Hong Kong*. Final Report. CE 14/95.