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4. Hong Kong's Response

4.1 Introduction

The Delegation had been amazed by the achievements of Denmark in response to climate change. The vision and determination by Denmark in boldly answering the call from climate change definitely worth the study by Hong Kong. During the Delegation, delegates visited the combined power station and wind turbines, district cooling system, electrical car charging facility and the waste-to-energy incineration plant. If these are solutions to climate change, it is great to know that Hong Kong will have her solutions to climate change as soon as the off-shore wind farm is being studied; the district cooling system at Kai Tak is being implemented; the electric vehicles are being promoted; and a waste-to-energy incineration plant is being planned.

However, when compared with Denmark which has been regarded as the pioneer in tackling climate change, Hong Kong is undoubtedly behind the step; but consideration should be made towards the constrains and difficulties faced by Hong Kong.

This section discusses the current action being taken by Hong Kong in response to climate change and the respective challenges and difficulties faced by her. This section also provides recommendations by the delegates.

4.2 Current Step by the Hong Kong Government (Policy Level)

4.2.1 From Air Quality Control to Climate Change Policies

Hong Kong is a leading financial and services centre in Asia (Fig. 4.1). The major contribution of greenhouses gases in Hong Kong are from power generation and transport sectors (Fig. 4.2). Back to the late 80's, the dissatisfactory air quality in Hong Kong caused health implication on Hong Kong residents and hindered foreigner from investing in Hong Kong. The Hong Kong Government then implemented the Air Quality Objectives (AQO) in 1989 which imposed stringent measures to reduce air pollutant emissions from key sources, like SOx, NOx and Particulates, including local power generation and transport sectors.

To strike for a blue sky, the Hong Kong Government put a lot of efforts in the air quality control on the power generation and transport sectors including AQO Review, Action of Blue Sky Campaign, Tax incentive scheme for environmental-friendly petrol private car and commercial vehicle, Railway as backbone of transport system and banned the construction of new coal-fired generating units.

With the extension of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol signed by China to Hong Kong Special Administrative Region from May 2003, in addition to the air quality control, the Hong Kong Government would like to reduce greenhouse gas emissions as far as practicable. In 2005, the First Sustainable Development Strategy for Hong Kong was launched with a highlight of

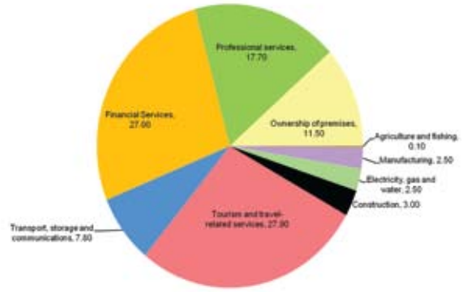

Fig. 4.1 Industries in Hong Kong

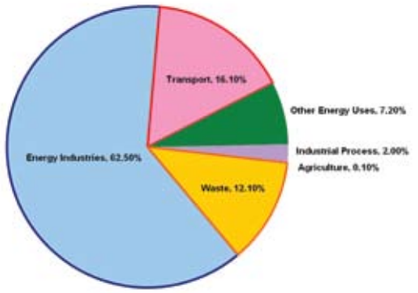

Figure 4.2 Greenhouse gas emission inventory in Hong Kong

encouraging the use of renewable energy in order to achieve a sustainable development and compact the climate change.

Since then, the Hong Kong Government has started to initiate Climate Change Policies which will be introduced in the following paragraphs, and has initiated cooperation with international communities such as subscription to the "Sydney Declaration on Climate Change" alongside 20 other Asia-Pacific Economic Cooperation (APEC) economies in September 2007 and joining the C40 Cities Climate Leadership Group (C40) in October 2007.

4.2.2 Hong Kong's Current Climate Change Policies

In addressing climate change and pinpointing the root, the Hong Kong Government has undertaken many initiatives by setting up legislation, policies and funding schemes to encourage low carbon economy and living.

Leading off for air quality control, the climate change policies in Hong Kong can be categorized into three major aspects, namely "Emission Capping and Control", "Reduction in Energy Consumption" and "Use of Renewable Energy". Fig. 4.3 summarizes the major policies currently undertaken in Hong Kong.

Emission Capping and Control

The current AQO of Hong Kong has been in place since 1987. With reference to the World Health Organization (WHO) Air Quality Guidelines released in October 2006, the AQO have been reviewed and new ones have been proposed as new standards for ambient air pollutant levels which are to be adopted in stages. This aims to further improve air quality and enhance the protection of public health. Nineteen initiatives were recommended as the emission control measures by the Air Quality Objectives Review (AQOR) [4.5]. Although these initiatives mainly set for dealing with the air quality control, many of these are indeed climate solution related. The nineteen initiatives are:

(1) Increasing the ratio of natural gas in local electricity generation to 50% together with additional emission abatement measures

(2) Early retirement of aged / heavily polluting vehicles

(3) Earlier replacement of Euro III commercial diesel vehicles with models meeting latest Euro standards

(4) Wider use of hybrid / electric vehicles or other environment-friendly vehicles with similar performance

(5) Ultra low sulphur diesel for local vessels

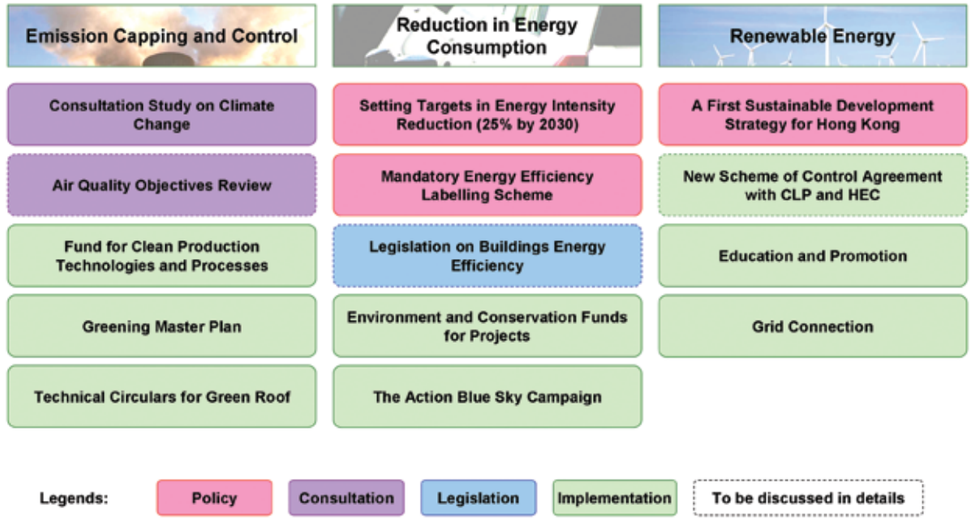

Fig. 4.3 Summary of major climate change policies in Hong Kong

(6) Selective catalytic reduction for local vessels

(7) Electrification of aviation ground support equipment

(8) Emission control for off-road vehicles / equipment

(9) Strengthening volatile organic compounds control

(10) Low emission zones

(11) Car-free zones / pedestrianisation scheme

(12) Bus route rationalization

(13) Expand rail network

(14) Cycling network connecting to major public

(15) Mandatory implementation of building energy codes

(16) Energy efficiency standards for domestic electrical appliances

(17) Light-emitting diode or equivalent alternatives for traffic signal / street lighting

(18) Tree planting / rooftop greening

(19) District water cooling system for Kai Tak Development

Reduction in Energy Consumption

Another current highlight for the climate change policy in Hong Kong is the legislation on building energy efficiency by mandatory implementing building energy codes.

Because developable land is scare, Hong Kong has been a "compact city" with a huge number of high-rises and mixed-use developments. 90% of the electricity is consumed by buildings. Improving energy efficiency in buildings would be an effective measure to address growing concerns about global warming and combat pollution. Thus, the Buildings Energy Efficiency Bill was introduced into the Legislative Council in December 2009 to commence the vetting procedures. This policy aims to promote energy efficiency and conservation by specifying minimum energy efficiency standards for new buildings in the city and achieve the energy intensity reduction target of at least 25% by 2030 (with 2005 as the base year) set by the Asia-Pacific Economic Co-operation (APEC) leaders. This policy demonstrates the Hong Kong Government's determination to optimize energy use and thus green house gas emission in a more mandatory manner.

Use of Renewable Energy

For the use of renewable energy, the new scheme of control agreements with two power companies, Hong Kong Electric Company (HEC) and CLP Power Hong Kong Limited (CLP), have been in place to encourage them in adopting more usage of renewable energy and investing in renewable energy facilities. The agreement sets out the electricity regulatory framework, procedures and policies. Under the agreement, HEC and CLP will make continuing efforts to improve their environmental performance and to promote the efficient use of energy. The Hong Kong Government is working hand in hand with the power sectors to combat climate change.

When comparing with Denmark which has various renewable energy resources such as wind energy, biomass and tidal energy, the potential renewable energy in Hong Kong is wind energy which will be further discussed in section 4.3.1.

Greenhouse gas emissions make no distinction between local, national or regional boundaries, and the fight against climate change requires concerted global action. Taking this international responsibility seriously and pro-actively, Hong Kong has joined other member economies of APEC and C40 Cities Climate Leadership Group to reconfirm her commitment to achieving the carbon emission reduction targets.

4.2.3 Education and Promotion

Without a doubt, to successfully combat climate change, the engagement of every individual is absolutely essential.

Nevertheless, "engagement of every individual" is always a difficult task but there is always a solution that is education and promotion.

In Hong Kong, when people talk about climate change, it usually links up with "sustainability". Although they mean differently in the dictionary, concept-wise if "sustainability" can be achieved, climate solutions must have been adopted. To give her citizens better understanding about the importance of climate change by telling its impacts on the nearest future and on their beloved offspring, the Hong Kong Government has wisely used "sustainability" and included it as the core subject of liberal studies implemented alongside the New Academic Structure for Senior Secondary Education and Higher Education in September 2009.

Moreover, to increase public engagement, the Hong Kong Government puts a lot of efforts in educating the public on climate change and hopes to build together the low carbon Hong Kong. Table 4.1 lists some examples which aim at increasing public awareness of climate change.

Apart from the Government, various non-governmental organizations (NGOs) and public sectors in Hong Kong also contribute in promoting solutions to climate change. Table 4.2 lists some of these examples.

4.3 Hong Kong's Climate Solutions in the Nearest Future

4.3.1 Wind Energy

The First Sustainable Development Strategy for Hong Kong issued in 2005 has set clear goals for the increased use of renewable energy in Hong Kong. Over the past few years, the Hong Kong Government and power companies have put an increasing effort in developing local renewable energy, especially wind energy.

Initiative	Form	Aim	Launched by
Low Carbon Living Style [4.6]	TV, Advertisement, Website	To encourage public and enterprises to adopt a low carbon living style. Examples of successful implementation of low carbon living style were provided for reference.	Environmental Protection Department
Hong Kong Sustainable Technology Net [4.7]	Website	To introduce to the public the renewable energy, energy efficient technologies and green building technology in Hong Kong.	Electrical and Mechanical Services Department
Educational Package on Climate Change [4.8]	Website	To provide students of Hong Kong the basic knowledge about climate change and its impacts on people and the natural environment, and to encourage Hong Kong people to take actions to help mitigate climate change.	Hong Kong Observatory

Table 4.1 Initiatives by the Hong Kong Government in educating the public about climate change

Initiative	Form	Aim	Launched by
Green Studio [4.9]	Eco-care mobile studio	To educate children on the causes and impact of climate change, and share green-living tips	CLP Power Limited
POWER U [4.10]	Website	To introduce climate change with interactive games to children and teenagers	CLP Power Limited
Climateers Program [4.11]	Web portal and wide range of supporting offline-community activities & on-going projects	To create a hub for climate change information, solutions, networking and social & cultural discussion, backed by a cutting edge carbon calculator specific to a Hong Kong lifestyle	WWF Hong Kong
Low-carbon Office Operation Programme (LOOP) [4.12]	Program	To encourage and assist LOOP companies or organizations to reduce their greenhouse gas emissions generated from office operation via the adoption of managerial and technological best practices, staff behavioral adaptation, and a labeling scheme	WWF Hong Kong

Table 4.2 Initiatives by NGO and public sector in educating the public about climate change

Hong Kong's first onshore wind turbine, Lamma Winds (0.8MW), is situated in Lamma Island and started commission in February 2006. Up to end April 2010, Lamma Winds generated over 3.8GW electricity and at the same time, reduced over 870 tones of coal consumption and 3200 tones of CO2 emission [4.13]. Although the major role of Lamma Winds is for trial, it has promoted the application of renewable energy in the community.

Fig. 4.4 Hong Kong's first onshore wind turbine – Lamma Winds

The Challenges

Upon the success of Lamma Winds, Hong Kong people are looking for a step further to an onshore or offshore wind farm. Nevertheless, the average wind speed in Hong Kong is about 3-4m/s which limits the full deployment of large scale wind turbine. Besides, due to the complex terrain in the territories (Fig. 4.5), the local wind speed varies very differently in different locations.

These two factors are the major constraints that prohibit the development of large scale wind farm.

For opportunity to develop onshore wind farm, in fact, wind technology development in Hong Kong has already supported onshore wind turbines ranging from small to large scale. However, the potential for large scale onshore wind turbine is limited due to lack of land availability.

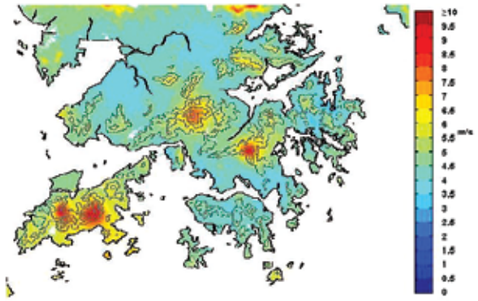

Fig. 4.5 Wind resource of Hong Kong

On the other hand, offshore waters offer more usable space which makes offshore wind more viable for Hong Kong. Nonetheless, busy marine traffic, ecological protection zones, dense underwater utility services are adding constraints to potential sites for large offshore wind farm. Fig. 4.6 shows the challenges for offshore wind farm in Hong Kong.

Developing Wing Energy in Hong Kong

To develop wind energy based on the low wind speed condition, Hong Kong has developed her own technology namely Micro-wind Turbine. Micro-wind turbine is the airfoil-blade turbines which is only 250mm in diameter (Fig. 4.7). It is very suitable to Hong Kong as the minimum wind speed for conversion of wind power into electricity is about 2m/s, which electricity can be generated in 80-90% of the time. Also, the cost can be much lowered under mass production when compared with small wind turbine for the same energy production. In addition, it does not require large area of land, where only small area is involved such as building roof. With flexible modular design, excellent graphic expression can be created for advertisement purpose.

Currently, two potential coastal sites have been identified for offshore wind farm and are being studied. The first one is a 200MW Southeast offshore wind farm which is located at approximate 9km east of Clearwater Bay

Fig. 4.7 Micro-wind turbine

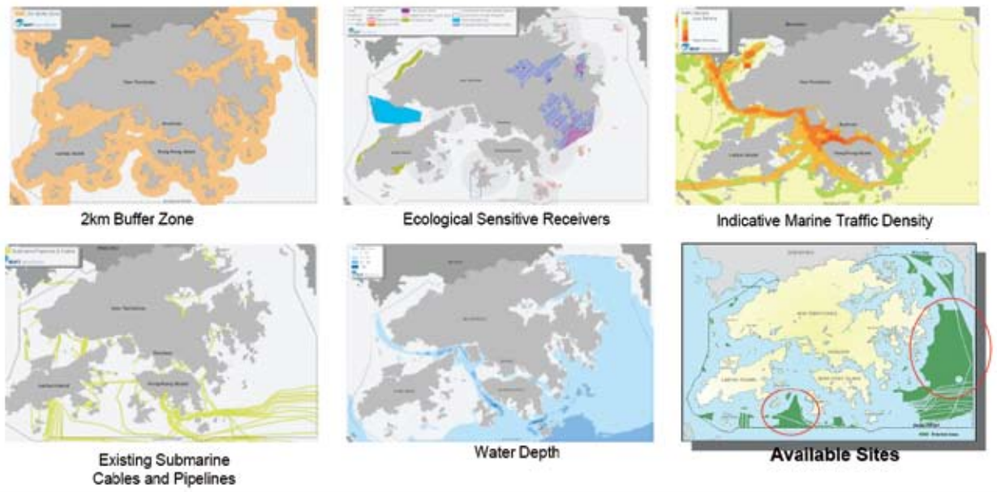

Fig. 4.6 Challenges for offshore wind farm in Hong Kong

Fig. 4.8 Using micro-wind turbine for graphic design

Peninsula. Environmental permit has been granted in Aug 2009 and the next phase is to install a wind mast for collection of on-site wind and wave data [4.14]. Another one is a 100MW Southwest offshore wind farm which is approximate 3.5 km to Lamma Island. Environmental impact assessment report of this project has been submitted for approval in Feb 2010 [4.15]. Both offshore wind farms will adopt the design of offshore transformer platform with transmission cable for connection to onshore grid. This demonstrates that the development of renewable energy becomes more significant in Hong Kong.

To sum up, the Hong Kong Government, power companies as well as local institutions have been progressively advancing and contributing to the development of wind energy over the past decade. Larger scale wind farms will be put forward in the foreseeable future with better utilization of nature wind resources in Hong Kong.

4.3.2 District Cooling System

Because of the prolong cold climate, Denmark has developed sophisticated technologies in district heating which integrated neatly with the power stations to achieve a high heat and energy generation efficiency for their massive heating demand. However, there is also a rising demand of chilled air in Denmark, particularly for commercial buildings and banks where cooling systems are needed for server rooms and a comfortable indoor environment during the summer.

Background of Air-conditioning System in Hong Kong

While the demand for chilled air in Denmark is increasing, Hong Kong is way above Denmark – air-conditioning systems account for one-third of the overall electricity consumption in Hong Kong [4.16]. Of this one-third, over 75% of energy is consumed by electric motor-driven centralized or decentralized air-cooled air-conditioning system (AACS), which utilizes air as a medium of heat exchange. The remaining 25% is consumed by water-cooled air-conditioning system (WACS) [4.16]. The Hong Kong Government states clearly that using water as medium of heat exchange is intrinsically known to be more energy efficient than using air and therefore conversion from AACS to WACS would result considerable energy saving [4.16].

Currently, there are two types of WACS in Hong Kong: Cooling Tower Scheme and Central Seawater Scheme. These two schemes require individual chiller plants to be installed in end-user side, with continuous supply of water as a medium of heat exchanges. The difference between is that Cooling Tower Scheme draws fresh water from fresh water main in existing supply network (Fig. 4.9), whereas Central Seawater Scheme applies at costal area where ample supply of seawater is available and a seawater pump house is established (Fig. 4.10).

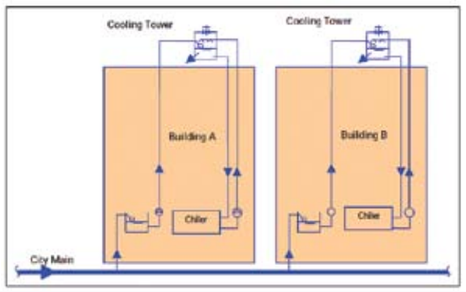

Fig. 4.9 [4.19] Cooling tower system

Implementation Study of District Cooling Systems in Hong Kong

Similar to Denmark, the development of District Cooling System (DCS) (a type of WACS) in Hong Kong is also in a preliminary and first-trial implementation stage. The Electrical and Mechanical Services Department of Hong Kong has carried out

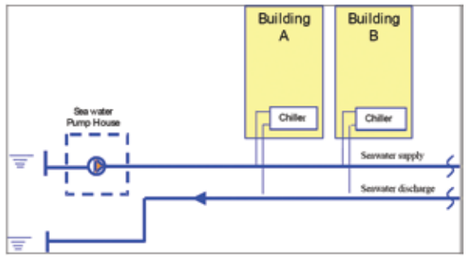

Fig. 4.10 [4.19] Central seawater scheme

detailed territory-wide implementation study of WACS in Hong Kong since 2003, strategic environmental assessment of DCS, and detailed feasibility studies and planning of DCS in two districts in Hong Kong: former Kai-Tak Airport and Wanchai and Causeway Bay [4.17].

According to the findings from the above studies, a typical 20% to 35% saving of electrical energy can be achieved by using DCS, compared to traditional AACS [4.18] [4.19], and it is the most energy efficient solution amount various WACSs in terms of economy of scale, diversity in cooling demand for different buildings, and high standard of plant operation and maintenance (Fig. 4.11).

The detailed implementation studies and planning of DCS in the district above-mentioned demonstrates two different scenarios: development of DCS in an entirely re-developed former Kai Tak District (currently known as South-East Kowloon Development) and installation of DCS in an already built urban commercial and residential district of Wanchai and Causeway Bay.

DCS in South-East Kowloon Development District [4.18]

The planning of DCS in South-East Kowloon District (SEKD) takes advantage of the planning of the district as the alignment of pipe networks, location of central chiller plant and seawater pump stations can be incorporated with the planning of zones and phasing of development of different future land uses and railway development (the Shatin to Central Link), preventing future reconstruction projects and possible road works induced in laying of pipe works and plants. DCS in SEKD is designed to serve primarily non-domestic users as the studies revealed to be financially viable and the demand from non-domestic users can be forecasted and anticipated. The system can also incorporate domestic users whenever demand is noticed. It is noted that a full-scale DCS will be designed to cover the entire SEKD with incorporation to future domestic users.

DCS in Wanahai and Causeway Bay District [4.19]

Implementation of DCS in Wanchai and Causeway Bay District (WCCB) is comparatively complicated. First of all it involves extensive road works and pipe laying works which induces and further reinforced the long-lasting traffic congestion problem in the district, causing adverse social impact in commercial and municipal activities. Besides, as there is no free space to build a central chiller plant, implementation of DCS means arising land acquisition and ownership issues, which may result conflicts of interest in related parties in the district. The DCS implementation study thus divides the district into five zones according to geography and financial activities in these zones. The study revealed and listed out the percentage of potential customers who will choose DCS, ranging from 30% to 100%, with a combination of utilizing other WACS: the Cooling Tower Scheme at places where seawater is not available, and Central Seawater Scheme at Wanchai North where existing seawater pipe network were built in costal developments.

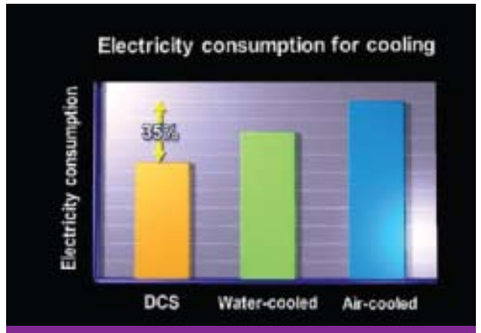

Fig. 4.11 [4.20] Comparison of electricity consumption between district cooling system and conventional centralised water-cooled and air-cooled air-conditioning system

In fact, Hong Kong has been in the same pace as Denmark on DCS development within the city, whereas huge potential with feasible financial model has been envisaged for the case of Hong Kong in regard of the readily available seawater resources and high demand of chilled air within a densely populated district. It is believed that DCS networks in Hong Kong will be further extended upon the successful implementation of the pilot projects in SEKD and WCCB.

4.3.3 Electric Vehicles & Charging Infrastructure

In Denmark, the market of electric vehicles (EVs) is being expanded and the setting up of associated charging infrastructure is ongoing. This is also the same in Hong Kong, where a surge in the number of EVs and charging stations is expected.

In fact, EVs are particularly suitable for small cities like Hong Kong. Since driving distances are relatively short, the demand for battery capacity is not rigorous. Due to its higher energy efficiency, electricity costs incurred for an EV is 75% lower than fuel prices for a conventional gasoline vehicle [4.21]. Considering the close proximity of roads to buildings, the public is in need of quiet vehicles with less roadside emissions. This renders EVs a perfect substitute for gasoline counterparts.

Having regarded transportation as a major contributor of greenhouse gases and air pollutants, the Hong Kong Government started to encourage the use of EVs for the purpose of improving air quality in the 1990s. For example, the exemption of First Registration Tax for EVs has been launched since 1 April 1994. In early 2000s, trials of electric public light buses (PLBs) were conducted and an incentive scheme was implemented which offered owners a one-off grant for purchasing electric PLBs [4.22]. However, due to long charging time, limited driving range as well as short life cycle of batteries, EVs were not prevalent at that time.

Fig. 4.12 [4.23] Financial Secretary of Hong Kong showing support to the trials of EVs

Thanks to recent breakthrough in EV technologies, driving EVs in town is not just a vision but a practicable idea. To further reduce roadside emissions and to create business opportunities, the Hong Kong Government has taken new initiatives to further promote EVs since 2009. Institutions and power companies have also engaged in the development of EVs and charging facilities respectively.

Recent Efforts in the Development and Promotion of Electric Vehicles

In recent years, parties from both the public and private sectors have been working hard on the development and promotion of EVs. The Hong Kong Government has put forward a number of measures for enabling the use of EVs in the city, whereas utility undertakers, universities and local companies have echoed the call by participating in the research of EVs and charging facilities. Highlights of the action taken are discussed below.

As mentioned above, incentive schemes have been launched to encourage the public to adopt EVs. The Hong Kong Government has exempted the First Registration Tax for EVs since 1 April 1994 and recently extended the concession to 31 March 2014 [4.24]. In the Budget 2010-11, the Financial Secretary proposed to accelerate the tax deduction for capital expenditure on electric vehicles and other environment-friendly vehicles, which included a 100 per cent profits tax deduction in the first year [4.25]. This would encourage the business sector to purchase more electric commercial vehicles.

4. Hong Kong's Response

In addition, the Hong Kong Government provides financial support to the development of EV technology. For example, funding from the Innovative and Technology Commission established by the Hong Kong Government was granted to the development of "MyCar", the first locally designed EV which is now on sale in Hong Kong and in a number of European countries such as the United Kingdom and Denmark. This is a showcase of successful collaboration of local companies and universities in the research and development of EVs with the assistance of public funds.

Fig. 4.13 [4.26] MyCar

The presence of a reliable, convenient and economical EV charging network is crucial to the widespread adoption of EVs in Hong Kong. Starting from 2009, the Hong Kong Government and the two power companies in Hong Kong have been building charging facilities in government car parks and public car parks respectively [4.25]. These stations will be in full operation in 2010. To encourage the business sector to provide charging facilities, technical guidelines were issued by the Electrical and Mechanical Services Department in early 2010 to help them with the installation. Furthermore, CLP Power, one of the power companies in the territory, launched the first electric vehicle quick charger in Hong Kong in February 2010 for technical trials in a 6-month period [4.27].

In April 2009, the Hong Kong Government set up the Steering Committee on the Promotion of Electric Vehicles, which comprised representatives from institutions, power companies, property developers, car park operators and green groups, to formulate long-term strategy and specific measures on the wider use of EVs in Hong Kong [4.25]. The Committee has been making a number of recommendations on the strategy for promoting EVs in Hong Kong. Therefore, more concrete and comprehensive measures in line with this framework are expected in the near future.

The Prospect of Electric Vehicles

Despite the number of steps that have already been taken, more efforts are still required. For example, a complementary legislative framework is yet to be provided to allow EVs on an expressway. Since EVs are propelled by electric motors, it is also important to ensure that electricity is generated from clean sources for further reduction of greenhouse gas emissions.

Nonetheless, with the joint effort from the Hong Kong Government and the industries, the outlook for EVs is optimistic. In a few years' time, EV should possibly be among the major road users in Hong Kong.

4.3.4 Incineration Plant

Every city is facing the same problem of waste management. Especially when people can afford greater convenience and more purchases, they tend to throw away more rubbish. If wastes are not treated properly, e.g. dumping into a fill without treatment and management, besides causing serious environmental and hygienic impacts, the methane (one of the greenhouse gases) generated from the organic waste will further deteriorate the climate change problem. However, if they can be treated properly, it not only minimizes the adverse impacts, but also provides another source of energy during the treatment process.

Over the past years, Denmark has adopted waste-to-energy incineration as her core technology for waste management. The visit to Amagerforbrænding Waste Incineration Plant in Denmark gave delegates an insight into combating climate change in dealing with wastes. During incineration, the heat in burning the waste is converted into energies,

Fig. 4.14 [4.21] Charging stations developed by CLP Power

heat and electricity. Amagerforbrænding incinerated 435, 000 tons of waste in year 2008 and generated electricity and heat to 140,000 households [4.30]. This waste-to-energy scheme has duel benefit in waste management and energy provision.

Waste Management in Hong Kong

The Environmental Protection Department manages facilities for collecting, transferring, treating and disposing of a variety of waste types. Since 1989, the department has overseen the establishment of a Chemical Waste Treatment Centre, three strategic landfills and a network of refuse transfer stations. These waste facilities were built under the Waste Disposal Plan. Waste is also managed through legislations. The Waste Disposal Ordinance is used to enforce controls on waste disposal, including collection and disposal and the import and export of waste. The Dumping at Sea Ordinance is enforced to control disposal of dredged mud and excavated materials at designated marine disposal sites. Livestock Waste Control Scheme has been fully implemented in the management and disposal of livestock waste [4.28].

The existing three strategic landfill sites in Hong Kong would approach their capacity one by one in the early to mid 2010s [4.29]. In order to address the problem, the integrated waste management facilities (IWMF) with incineration as the core technology is raised out by the Hong Kong Government and under discussion.

Integrated Waste Management Facilities

Compared to the well implemented IWMF in Denmark, Hong Kong is at the tip of rising stage. Not as mature as establishing decentralized plant within the community, Hong Kong is planning its centralized facilities at remote site, given consideration to both potential social and environmental impacts.

The first phase of IWMF, comprised with a small sorting and recycling plant to recover recyclable materials from mixed municipal solid waste (MSW), will have a treatment capacity of 3,000 tons per day (tpd). The Hong Kong Government has carried out study on the selection of potential site and the two potential sites at Tsang Tsui Ask Lagoons and Shek Kwu Chau are suitable for consideration. The engineering and environmental impact assessment studies for the IWMF are currently being carried out. Key environmental issues such as air quality, human health, waste management, water quality, ecology, noise, landscape and visual and cultural heritage would be considered in the study.

It is believed as feasible for Hong Kong to implement IWMF. Firstly, Hong Kong's MSW energy value is about 10 MJ/kg (coal: 30 MJ/kg) which is favourable for combustion [4.31]. Secondly, the advance incineration technology is well-developed and worldwide implemented. Last but not the least, the landfill in Hong Kong is reaching its design capacity limit and an alternative waste management policy is necessary. Nevertheless, while Hong Kong people understand the need of the IWMF, they refuse to have an incinerator in their background.

During the visit to Amagerforbrænding,

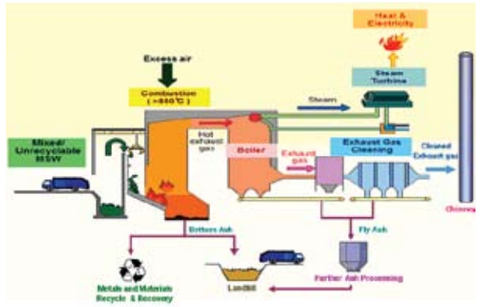

Fig. 4.15 [4.29] Process Flow Diagram of an Incineration System

it is learn that objection or protest from neighbouring residents were not quite violent as Danish people well receive the need for incinerator as the way out for waste management. For the case of Hong Kong, the hardware for IWMF is ready but civic education is the essential step in bring forward a better environment.

4.4 The Real Challenge

Despite the combined efforts from the Hong Kong Government and NGOs, Hong Kong is still at a very beginning stage in developing her roadmap and governing framework to tackle climate change. There would be a long agenda for further climate change policies to be initiated, launched and executed.

Public Respond and Political View
In the past few years, Hong Kong Government has been on the horns of a dilemma when launched a new policy. For example there was a considerable scepticism when the Chief Executive announced to deliver cash coupons for purchasing compact fluorescent lamps so as to promote energy efficiency and conservation. This reflects that although the Hong Kong Government is having intention to combat climate change, the current political atmosphere in Hong Kong leads Hong Kong people to criticize their Government, thinking that there must be collusion. If Denmark's example of introducing Sulphur and Carbon taxes in electricity production is going to be launched in Hong Kong, strong criticism may be expected. To tackle climate change, a series of previsional policy is necessary. To successfully launch the policy, citizens' support is the key, however, public resistance and conflict in society can prohibit it.

Hong Kong people witnessed the success of plastic bag levy by the Hong Kong Government to achieve the accomplishment of appreciation and positive feedback from the society. Nevertheless, it requires the effort by every Hong Kong people.

Research & Development
All parts of the world are working around the clock to develop new green technologies that are practical and economical. Hong Kong is now at the cutting edge of various technologies such as electric car and micro wind turbines. However taking up those virgin businesses is inevitably risky. Without any financial support, it is not easy for the industry to operate such businesses. Yet, through learning from Denmark, it is noted that the market potential of the green business is overwhelmingly large. The pioneer country has been putting considerable efforts in bringing their green technologies from universities to the market.

In Hong Kong, there is plenty of "hardware" (green technologies) emerging. What Hong Kong needs is the "software" (policies) to push the engineering achievement forward. So far, the New Scheme of Control Agreement is a good example of the Hong Kong Government in encouraging the utilities companies to research clean energy, to reduce carbon emission and to strive for higher energy efficiency. It is believed that Hong Kong can go further by giving out more incentives to her entrepreneurs to help them run their environmental business.

4.5 "Our Recommendations"

Through this delegation study, delegates found that the Hong Kong Government has initiated and launched a number of policies and schemes in the following areas: emission capping and control, reduction in energy consumption, promotion of renewable energy and education. But to make Hong Kong a truly climate friendly city, more actions have to be taken apart from existing.

Adopting a More Stringent Emission Reduction Target
Reference could be made to Intergovernmental Panel on Climate Change (IPCC) recommendations for developed nations, i.e. to keep below a 2 degree rise in global temperature. This means that Hong Kong has to reduce the emission by 25% by 2020 from 1990 level. Corresponding roadmap and strategies to achieve the target has to be set out.

Developing a Solid Low Carbon City Plan
A low carbon economy must come with a solid low carbon city plan. The Hong Kong Government can apply Urban Climatic Maps for future urban planning. In line with international practice, especially in Europe and in Japan, Urban Climatic Maps allow better planning as to building density, floor area ratio, air paths, non-building areas, open spaces and greenery by taking urban air ventilation into account. Better planned urban environments will use less energy and reduce greenhouse gas emissions. As buildings contribute to a high percentage of Hong Kong's total electricity use (over 90%), Hong Kong should aim to improve energy efficiency in buildings by legislation on Building Energy Codes.

Increasing the Use of Renewable Energy
Over 60% of Hong Kong's electricity is generated by coal-fired power stations. Although the Hong Kong Government is promoting electric vehicles, it cannot be considered as completely relieving climate change as the majority of the power generation still relies on coal. Therefore, to reduce carbon emission, the use of natural gas in power generation has to be increased and the use of renewable energy such as the Wind Farm project recently launched by the local electricity company should be put into practice in a faster speed.

Enhancing Corporation with Mainland China
China has made a lot of advancements in tackling climate change. As Hong Kong is an integrated part of China, Hong Kong shall determine to match her pace and work closely with Mainland China to share expertise, ideas and experiences to achieve emission targets.

Educating the Public
Collective efforts from citizens and organizations are required if Hong Kong is to achieve the emission target. Therefore, it is important to promote corporate and individual responsibility in tackling climate change. Some of the strategies may include investigating a simple scheme which is straight forward and practical and enable companies to measure, track and reduce office operation-generated carbon footprint. More promotion should be done on the awareness on climate change. Incentives could be provided to encourage communities to move towards a low carbon lifestyle. With the support from the public, the effectiveness of policy implementation could be increased dramatically.

Various organizations, such as CLP and WWF Hong Kong, have already been giving a helping hand to educate the public and promote awareness of climate change by means of advisements and campaigns. However, general public's awareness of climate change impacts is still inadequate. It is the government's turn to take up the leading role of education and promotion as well as to get citizens' trust towards government's decisions through better communication with the public before policy making. To come off in the climate change battle, the Hong Kong Government must be determined and work hand in hand with the community to tackle the society conflict in interests.

During the visit to Amagerforbrænding Waste Incineration Plant, delegates were amazed by the scene which a group of Danish kindergartners visiting the plant in learning waste reduction, waste sorting and waste management. Delegates believe that education is indeed the most important and therefore strongly recommend the Hong Kong Government while keeps boosting the awareness of climate change to the public, to include climate change in the syllabus for primary school or even kindergarten so as to make solutions to climate change, i.e. "save our planet" as habit.

Summary
There is no doubt that Hong Kong faces many challenges and difficulties in effectively bringing forward climate change solutions. Actually, Hong Kong has already been taking quite a few steps forward in tackling climate change, whereas the progress could definitely be significantly sped up with the support of a well-identified vision and framework of climate change policy by the Hong Kong Government.

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5. Steps by the World

Climate Change impacts not just happen in Denmark or Hong Kong, but it is indeed threatening the life of all life forms in the earth. If everyone is willing to take a little step towards climate solution such as energy saving, climate change impacts could be greatly relieved.

As mentioned in Section 2 of this report, engineers play an important role in fighting for climate solutions. This section describes the efforts being taken by engineers around the world.

5.1 Organizations' Technological Support to Climate Solutions

During the Delegation, delegates visited organizations which provide direct solutions to climate change. Findings and learnings from these organizations are presented in Section 3 of this report. The delegates also visited organizations which provide support to the technology development in tackling climate change.

5.1.1 COWI A/S

COWI is a leading northern European consulting firm. It provides state-of-art-services within the fields of engineering, environmental science and economics with due consideration for the environment and society. COWI has promoted wind energy since 1980 and was the consultant designing the world's first offshore wind farm in 1985.

Fig. 5.1 Mr. Ronberg introducing COWI design experience in offshore wind farm foundations

In the visit to COWI A/S, Mr. Jan Ronberg, Project Director of Marine and Foundation Engineering and Mr. Henrik Andersen and Mr. Benny Lee, Head of Major Bridges Department and Senior Bridge Engineer respectively, shared with delegates their experiences in foundation design to support offshore wind turbines.

Mr. Ronberg told delegates that careful planning of geotechnical investigations was necessary to understand the soil information for designing the wind turbine foundation type. This may include strength and deformation properties for both static and dynamic loading. The geotechnical investigation for offshore wind farms normally comprises geophysical surveys and geotechnical investigations.

COWI's experience in offshore wind turbine foundation is based on the design of foundations for large bridges worldwide over half a century. Over the years, COWI has developed innovative and practical offshore wind turbine foundation concepts.

Fig. 5.2 Mr. Andersen sharing the design experience of large bridge foundations

Erecting an offshore wind turbine will unavoidably give rise to adverse environmental impact. Nevertheless, it could be mitigated if measures are identified and taken. It was known from Mr. Ronberg that a thorough environmental assessment will be carried out whenever a new wind turbine is erected on land or at sea. He pointed out that COWI has solid expertise in assessing the environmental risks of erecting single wind turbine or wind farms. He accentuated that with the broad in-house competencies, suitable solutions to environmental conflicts

could be compromised among engineers, socio-economists and environmentalists.

Fig. 5.3 Souvenirs presentation to Mr. Ronberg (first left) and Mr. Andersen (first right)

Fig. 5.4 Group photo with Mr. Lee at COWI headquarters

5.1.2 Technical University of Denmark (Risø National Laboratory for Sustainable Energy)

Risø DTU is one of Europe's leading research laboratories in sustainable energy. It creates pioneering scientific and technical-scientific research result that can provide Danish society the opportunities for technological development and its application in society.

The DTU Climate Centre at Risø DTU conducts interdisciplinary research on climate change. The Centre has three objectives:

- to contribute to the development of collaborative and interdisciplinary climate research at DTU
- to increase the scope and quality of DTU's cooperation with, and provision of advice to the public and private sectors in the area of climate, both domestically and internationally
- to contributes to global climate research with its own projects with topics on (i) energy economic modelling of greenhouse gases (GHG) emissions and abatement costs; (ii) regional climate effects and adaptation strategies; and (iii) policy instruments and implementation

Fig. 5.5 Presentation by Ms. Halsnæs

In the visit, Ms. Kirsten Halsnæs, Head of DTU Climate Centre delivered a presentation on energy economic modeling of GHG emission in Denmark and global market, which gave delegates an insight into technological options for GHG emission reductions and the costs of GHG emission reduction within and between the countries. The model results reflected that the major constraints in Denmark are fluctuating and uncontrollable source of renewable energy, low energy efficiency in old buildings and high demand for fossil fuel for navigation.

To overcome these constraints, Ms. Halsnæs recommended that a flexible energy system comprising renewable energy system and conventional power station, which could reduce the marginal emission of GHG, should be introduced. She also recommended setting up an energy building code and renovating the buildings with adoption of climate solutions.

Following Ms. Halsnæs's presentation, Mr. Olexandr Balyk presented a research project on Global Renewable Energy System - a Modelling Exercise in ETSAP (Energy Technology and System Analysis Program) - TIAM (TIMES Integrated Assessment Model). The purpose of the research was to test the ETSAP-TIAM global energy system model and in the meantime to estimate under the existing model database the time required to achieve a globally 100% renewable energy system.

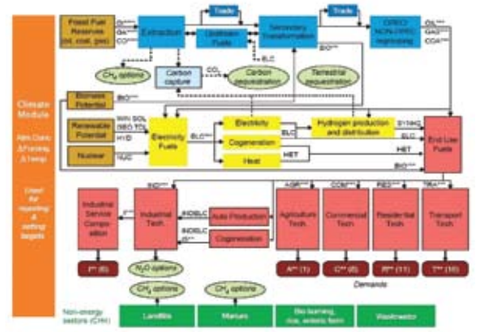

Fig. 5.6 TIAM - Reference Energy System [5.1]

The result reflected that a 100% renewable energy system had not been achieved and it was hard to reach the target due to the high economic growth scenario in the current TIAM. To reach 100% renewable energy system, it was necessary to refine renewable resource potentials. Assuming a large efficiency potentials did exist, energy efficiency would be the important area, where the databases for TIAM and thereby the investment possibilities for the model could be improved.

Fig. 5.7 Souvenirs presentation Ms. Halsnæs (second right) and Mr. Balyk (middle)

Apart from government's energy policy, education and research also play an important role in guiding the public to the path of adapting climate change. Risø DTU has demonstrated a very good example in this aspect. It has set up many engineering and science departments to offer taught academic programs on environment-related knowledge, as well as carrying out research on technologies in providing climate solutions. It has successfully organized conferences and workshops in promoting sustainable energy and other environmental-friendly technologies. It is believed that through collaboration between researchers, government sectors, industry and public authorities, a sustainable energy system could be developed and a society capable of climate solutions could be established.

Fig. 5.8 Group photo at Risø DTU

5.2 Other Renewable Energy Solutions

In the pre-delegation study, delegates identified some sites of interest in Denmark, where the zero carbon concepts have been applied. However, due to the tight itinerary, experiential learning about these sites was not made available. Also in the study, in order to better equip themselves with knowledge on climate solutions, delegates conducted a preliminary research on current engineering development on renewable energy worldwide. The following paragraphs summarized the findings of these aspects.

5.2.1 ZERO Carbon Sonderborg by ProjectZero [5.2]

ProjectZero is the vision of making Sønderborg region of Denmark to a pulsating ZEROcarbon region, creating a sustainable growth, cleantech capabiliteis and many new

jobs. Their goals are to reduce the region's domestic electricity consumption by half and the CO2 emission by 75% before 2020. And by 2029, their ambition is to fully eliminate the region's CO2 emission. The project's primary focus is energy - intelligent management of energy consumption and converting energy production to sustainable sources. Subsequently, the focus is on environmental aspects.

Fig. 5.9 ZEROcarbon Sonderborg [5.3]

With the vision fulfilled, the Sønderborg region will be a role model for other areas that aim at creating a sustainable, ZEROcarbon future. Three leading stars guide the strategy toward 2029 and show the direction toward which the Sønderborg region should move, if sustainability and economic growth should go hand in hand:

- Energy efficiency improvements that will strengthen the competitiveness of the business enterprises and reduce the energy costs for the citizens
- Multi-renewable energy supply based on local resources of renewable energy and supplemented by electricity from offshore wind turbines
- A dynamic energy system, where the interaction between energy consumption and production is performed with maximum efficiency and the prices are flexible due to the quantity of energy available

5.2.2 Ocean Wave Energy [5.4]

Ocean wave energy is captured directly from surface waves or from pressure fluctuations below the surface. Waves are caused by the wind blowing over the surface of the ocean. In many areas of the world, the wind blows with enough consistency and force to provide continuous waves. There is tremendous energy in the ocean waves. Wave power devices extract energy directly from the surface motion of ocean waves or from pressure fluctuations below the surface.

Wave power varies considerably in different parts of the world. Wave-power rich areas of the world include the western coasts of Scotland, northern Canada, southern Africa, Australia, and the northwestern coasts of the United States.

Ocean Wave Energy Technologies

A variety of technologies have been proposed to capture the energy from waves. Wave technologies have been designed to be installed in nearshore, offshore, and far offshore locations.

Fig. 5.10 Ocean wave energy [5.4]

While all wave energy technologies are intended to be installed at or near the water's surface, they differ in their orientation to the waves with which they are interacting and in the manner in which they convert the energy of the waves into other energy forms, usually electricity. The following wave technologies have been the target of recent development:

- Terminator devices
- A point absorber
- Attenuators
- Overtopping devices

5.2.3 Ocean Current Energy [5.5]

The relatively constant flow of the ocean currents carries large amounts of energy that can be captured and converted to a usable form. Ocean waters are constantly on the move. Ocean currents flow in complex patterns affected by the wind, water salinity and temperature, topography of the ocean floor, and the earth's rotation. The ocean currents are driven by wind and solar heating of the waters near the equator, though some ocean currents result from density and salinity variations of water. These currents are relatively constant and flow in one direction only, in contrast to the tidal currents closer to shore. Some examples of ocean currents are the Gulf Stream, Florida Straits Current, and California Current.

While ocean currents move slowly relative to typical wind speeds, they carry a great deal of energy because of the density of water. Water is more than 800 times denser than air. Ocean currents thus contain an enormous amount of energy that can be captured and converted to a usable form.

Ocean Current Energy Technologies

The United States and other countries, including Japan, China, and some European Union countries, are pursuing ocean current energy; while marine current energy is at an early stage of development. There are no commercial grid-connected turbines currently operating. Only a small number of prototypes and demonstration units have been tested. Some of these technologies have been developed for use with tidal currents in near-shore environments.

Under the most likely commercial development scenario, energy would be extracted from ocean currents by using submerged water turbines similar to wind turbines (See Fig. 5.11). These turbines would have rotor blades, which are generators for converting the rotational energy into electricity, and transporting the electrical current to shore for incorporation into the electrical grid. Also, there would be the need for keeping the turbines stationary, such as by posts or cables anchored to the sea floor. Additional components might include concentrators around the blades to increase the flow and power output from the turbines.

Fig. 5.11 Current turbine visualization [5.6]

Fig. 5.12 Ocean current project [5.6]

5.3 Institutional Cooperation

5.3.1 Future Climate - Engineering Solutions

Climate change is a major challenge for the global society. Engineers, whose main duty is to improve living standard of mankind, have been standing in the front line finding solutions to climate change.

13 Engineering Institutions from around the world joined together to initiate a project "Future Climate - Engineering Solutions"

which aim at demonstrating a technologically based outline for a sustainable future. Within the project the participating institutions develop national climate plans and technology prospects, which show how greenhouse gases (GHG) emissions can be reduced substantially and how a sustainable development can be achieved.

Fig. 5.13 Future Climate - Engineering Solutions Joint Report prepared by 13 engineering institutions around the world [5.7]

The engineering institutions participated in the project include:

- The Norwegian Society of Engineers (Norway)
- Institution of Mechanical Engineers (United Kingdom)
- The Institution of Engineers (India)
- The Association of German Engineers (Germany)
- The Japan Society of Mechanical Engineers (Japan)
- The American Society of Mechanical Engineers (USA)
- The Finnish Association of Graduate Engineers (Finland)
- Union of Professional Engineers, UIL (Finland)
- Engineers Ireland (Ireland)
- The Swedish Association of Graduate Engineers (Sweden)
- The Association of Professional Engineers, Scientists and Managers, Australia (Australia)
- Federation of the Scientific - Engineering Unions in Bulgaria (Bulgaria)
- The Danish Society of Engineers (Denmark)

The basic assumption of the project is that GHG emissions and concentration of GHG in the atmosphere can be reduced to a sustainable level known as the best-case stabilization scenario presented in the 4th Assessment Report by the UN Intergovernmental Panel on Climate Change (IPCC), and the global mean temperature is stabilized at 2.0ºC to 2.4ºC.

Among the national climate plans, five key common findings were observed and were regarded as the most feasible and adequate findings for bringing down GHG emissions. The five findings are:

- A reliable GHG reduction targets
- Proven technologies for near-term GHG reduction needs and promising technologies for mid and long term needs
- Innovative engineering solutions
- Energy efficiency
- Clean transport

On the basis of the key common findings, five main recommendations for a new global climate agreement are put forward by the engineers:

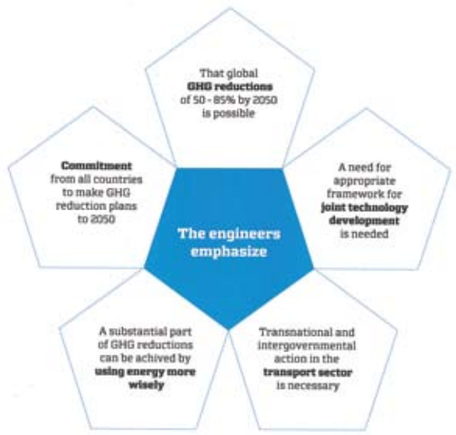

Fig. 5.14 Engineering solutions - a climate call from engineers [5.7]

- Commitment to "binding but differentiated" targets for all countries
- Commitment to developing national GHG reduction plans towards 2050 before 2012
- Setting up a framework of joint technology development
- Strengthening financial support to allow transfer of technology
- Commitment to a common effort in the area of transport

Summary of the IDA Climate Plan for Denmark

In order to push sustainable development ahead with stable economic growth, energy security and commercial advantages, Danish Society of Engineers (IDA) in the Climate Plan for Denmark has provided valuable recommendations to help Denmark achieve the ambitious goals.

From the evolution of renewable energy, the efficient use of power, energy saving at industry and homes, the control of transportation emissions, optimization of food production, progression of biomass, direction of investment, to the impact on employment in Denmark, IDA looks into the important issues regarding climate change and researches the constructive measures in the climate plan.

IDA provides 9 key recommendations to bring their nation to success [5.8]:

1. To enter into national energy-saving agreement of reducing 2% energy consumption each year
2. To establish a coordinated energy-saving trust of 1.55 billion DKK for promoting electricity and heat savings
3. To develop innovation markets and feed-in tariffs for promoting renewable energy including wind power, biomass and wave energy
4. To support innovation based on research, development and demonstration by increasing funds
5. To reorganize the infrastructure by converting the tax system to consumption-dependent
6. To reorganize goods and expand the rail transport
7. To optimize food production and consumption as well as biomass production
8. To initiate the Danish climate adaptation strategy listing the necessary measures to be implemented
9. To work towards an ambitious international climate agreement and proceed by means of concrete action

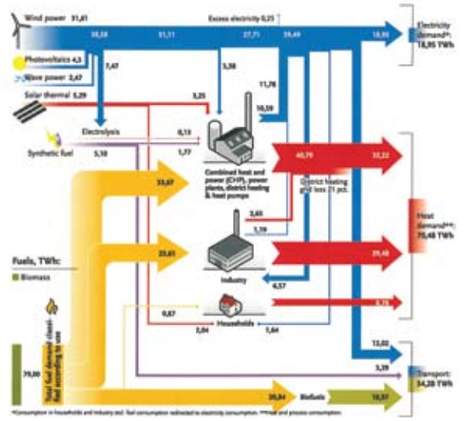

Fig. 5.15 The IDA Climate Plan 2050 [5.8]

5.3.2 Engineers: Designing a Resilient Hong Kong

Hong Kong people are proud to have the world-class city Hong Kong as their home. There is no doubt that Hong Kong engineers played an important role in establishing this. They built the city's resilience, by giving ingenuous engineering solutions, responding efficiently to any arising problem.

The Engineering Society of Hong Kong was founded in 1947 with an aim of bringing together engineers of different disciplines for their common concern. The Society flourished and as a result the Hong Kong Institution of Engineers (HKIE), was incorporated under the Hong Kong Institution of Engineers Ordinance, Chapter 1105 of the Laws of Hong Kong in 1975. The HKIE has established close relationship with engineering institutions throughout the world and it has signed

agreements for reciprocal recognition of professional qualifications with engineering authorities in Australia, Canada, Ireland, the Mainland, New Zealand and the United Kingdom. It has also signed agreements of co-operation with other organizations in Europe, the Mainland, North America and Southeast Asia [5.9].

The vision of the HKIE is to sustain excellence in the engineering profession. It is also the body responsible for qualifying engineers. Currently the HKIE has over 23,000 members representing nearly every discipline in the broad field of engineering in Hong Kong.

In the session 2009/2010, Ir Dr. Andrew Chan, President of the HKIE, has set "Sustainability" as the central theme for his session. In his HKIE Presidential Address 2009, Ir Dr. Chan elaborated on what as an engineer could do better to build the resilient and sustainable Hong Kong.

He explained by the fact that Hong Kong has 7 million people in 2009 and four times GDP/capita of that in 1975 but virtually the same land area available that gives 50% higher density in terms of population per m2. To continue the success in the future, Hong Kong needs resilience by design. He challenged members, i.e. engineers to lead the way.

Fig. 5.16 Ir Dr. Andrew Chan, President of the HKIE for session 2009/10 in the HKIE Presidential Address [5.9]

"Resilient Hong Kong" by Engineers

Hong Kong's carbon footprint, though with CO2 emission per capita at 5.5tCO2 which is lower than the Organisation for Economic Co-operation and Development (OECD) countries and some of the Asia neighbours, has been going up since 1990 (Kyoto Protocol). The major contributors of Hong Kong's CO2 emission are electricity generation (64%), transport (16%) and waste (9%).

Ir Dr. Chan emphasized that Hong Kong needs resilience in the built environment; Hong Kong needs sustainable infrastructure. The infrastructures include energy and buildings, water, waste, transport and food supply which are well known by the engineers.

Fig. 5.17 Ir Dr. Chan challenging engineers to design a resilient Hong Kong [5.9].

The HKIE Protocol of Engineering a Sustainable Hong Kong

Also in the HKIE Presidential Address 2009, The Hong Kong Institution of Engineers Protocol of Engineering a Sustainable Hong Kong was launched. The President, Vice Presidents, Chairmen of Divisions and Committees showed their enthusiastic support and devotion to sustainability by signing the Protocol. The Protocol establishes the principles and provides a central framework for the HKIE to lead the engineering community and allied professions towards a resilient future for Hong Kong.

Fig. 5.18 Mr. Leo Chan, chairman of Young Members Committee for Session 2009/2010 signed the Protocol

Principles of the Protocol

- Respect and care for Earth and all life in the community and its diversity
- Securing Earth's resources and beauty for present and future generations
- To be ready to lead and contribute to a sustainable future

Commitments under the Protocol

- Motivate and support HKIE members to understand and promote sustainable development with a balanced approach on environmental, social and economic aspects in the delivery of projects and services
- Develop and promote cooperative and productive partnership with other organisations and government bodies relating to sustainability field
- Devise plans and activities to educate, promote and improve the concepts of sustainable development to members as well as to the public
- Encourage and assist members to participate and exchange views and ideas on sustainability with other partnering stakeholders in different activities like forums, workshops, exhibitions, etc
- Raise the alertness of members and other development professionals the importance of sustainable development and recommend sustainable engineering practices in their workplace
- Work with different stakeholders in partnership to formulate, promote and disseminate views on sustainability issues associated with the built and natural environment

Summary

Hong Kong needs an integrated sustainable infrastructure for low carbon living and it is engineers who make decisions on the infrastructure. As each issue affects energy consumption and carbon footprint, for a resilient future, engineers must think holistically when planning and designing the infrastructure.

Fig. 5.19 Young engineers supporting the Protocol of Engineering a Sustainable Hong Kong

5. Steps by the World