

# A CLEAN AIR PLAN FOR HONG KONG

Environment Bureau in collaboration with  
Transport & Housing Bureau  
Food & Health Bureau  
Development Bureau



March 2013





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## Message from the Chief Executive

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It is a priority of this Government to reduce air pollution and the associated risks to people's health. Improving Hong Kong's air quality is a complex exercise that requires strong understanding of environmental sciences, ability to chart evidence-based multi-disciplinary policies, effective feedback and assessment mechanisms and financial resources to take action.

We are fortunate to have these conditions in place, together with the active collaboration and determination within the HKSAR Government to deliver results. I commend the Environment Bureau on presenting *A Clean Air Plan for Hong Kong* in collaboration with the Transport and Housing Bureau, Food and Health Bureau, Development Bureau, as well as other relevant departments.

### **CY Leung**

Chief Executive  
Hong Kong Special Administrative Region

# A CLEAN AIR PLAN FOR HONG KONG



## Our pursuit

Develop a comprehensive plan

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## Our approach

Adopt evidence-based approach to understand complexity and identify solutions

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## Basis of plan

Improve public health; and collaborate with key stakeholders including investing time in regional efforts

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## Air quality management system

Improve all aspects needed to understand, manage and review policies and measures

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## Roadside air quality

Target major emission sources, as well as use transport management and urban planning to reduce pollution

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## Marine emissions

Mandate fuel switch at berth for ocean-going vessels, use cleaner marine diesel for other vessels; and build on-shore power facilities for the Kai Tak Cruise Terminal

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## Power generation

Cap emissions from local power plants; review fuel mix and promote demand-side management to improve energy efficiency

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## Non-road mobile machinery

Regulate new machinery and existing machinery which has not been exempted

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# 1 | After the Haze

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**A**ir quality should not be just a passing concern – it is the envelope within which all our daily activities take place. Air pollution does not have to be part and parcel of life in Hong Kong. Strengthening our ability to reduce air pollution saves billions of dollars in future public health care costs, missed work days, school absences, not to mention the discomfort and suffering from preventable illnesses and premature death.

Our residents are impatient for improvement in air quality. They are becoming more and more knowledgeable about the issues and more and more pointed in the questions they demand answers to. Experts and activists are helping to raise public awareness about

This is the basis for Hong Kong to make choices, change behaviour where necessary and upgrade practices in controlling emission from major sources, including vehicles, vessels and power plants. We commit to engage stakeholders and the public regularly to share knowledge and perspectives.

In future, there will be ever more real-time, on-line air quality information that is locally and also nationally relevant. Our goal is for Hong Kong to be among the best in the world in understanding air quality so that we can continue to fight air pollution aggressively.

In two to three years, our roadside air pollution levels will begin to drop as the result of efforts to clean-up the city's oldest, dirtiest vehicles kick-in.

River Delta may well be a special designated Emission Control Area.

Also by then, our rail network will be more extensive. Commuters will find their daily journeys on rail, buses and at inter-changes smoother and more pleasant. Hybrid and electric vehicles of various types will be plying our roads in larger numbers. Many parts of the city will offer an exceptionally pleasant ambience for pedestrians, such as along the harbour-front, and cyclists can travel long distances along defined paths in the New Territories and even parts of Kowloon and Hong Kong Island.

By 2020, regional air quality will be much improved as a result of tighter regulation in Hong Kong and on the Mainland for both industry and transportation. Hong Kong will have designed effective programmes together with Guangdong to promote cleaner technologies in factories that will reduce smoggy conditions. Guangdong and Hong Kong are already partners in cleaning-up. We will see more 'blue sky' days not only in Hong Kong but also in Macao and the Pearl River Delta. By 2030, old behaviour will have changed – all emissions sources will be more stringently controlled throughout the region. Green and clean living will have taken root. This is our pursuit.

The many initiatives, schemes and programmes highlighted in this document involve many stakeholders and also the community as a whole to step-up. We look forward to your active support to improve air quality.

**Our goal is for Hong Kong to be among the best in the world in understanding air quality so that we can continue to fight air pollution aggressively**

air quality and health issues, and it is just a matter of time that technologists and artists will join hands to create easy-to-understand "apps" for personal mobile devices to keep people informed about air quality in districts and even specific pollution 'black spots'. We welcome the rise in knowledge and expectation within the community.

In four to five years, our roadside air quality will begin to improve more significantly as the mix of the commercial vehicle fleet change. By then, ships too will be using cleaner fuels while berthing, instead of continuing to burn high sulphur bunker fuel. Before the turn of the decade, the whole of the waters of Hong Kong, Macao and the Pearl

## 2 | Introduction

**W**e want to first set the stage to explain the background to Hong Kong's air quality before stating the new clean air plan because the plan is designed to address our specific circumstances.

A good place to start is to consider the questions frequently asked by the public.

### A: How does air pollution affect Hong Kong?

We need to consider both general air quality and localized air quality, such as at roadside.

First, greatly expanded industrialization in the Pearl River

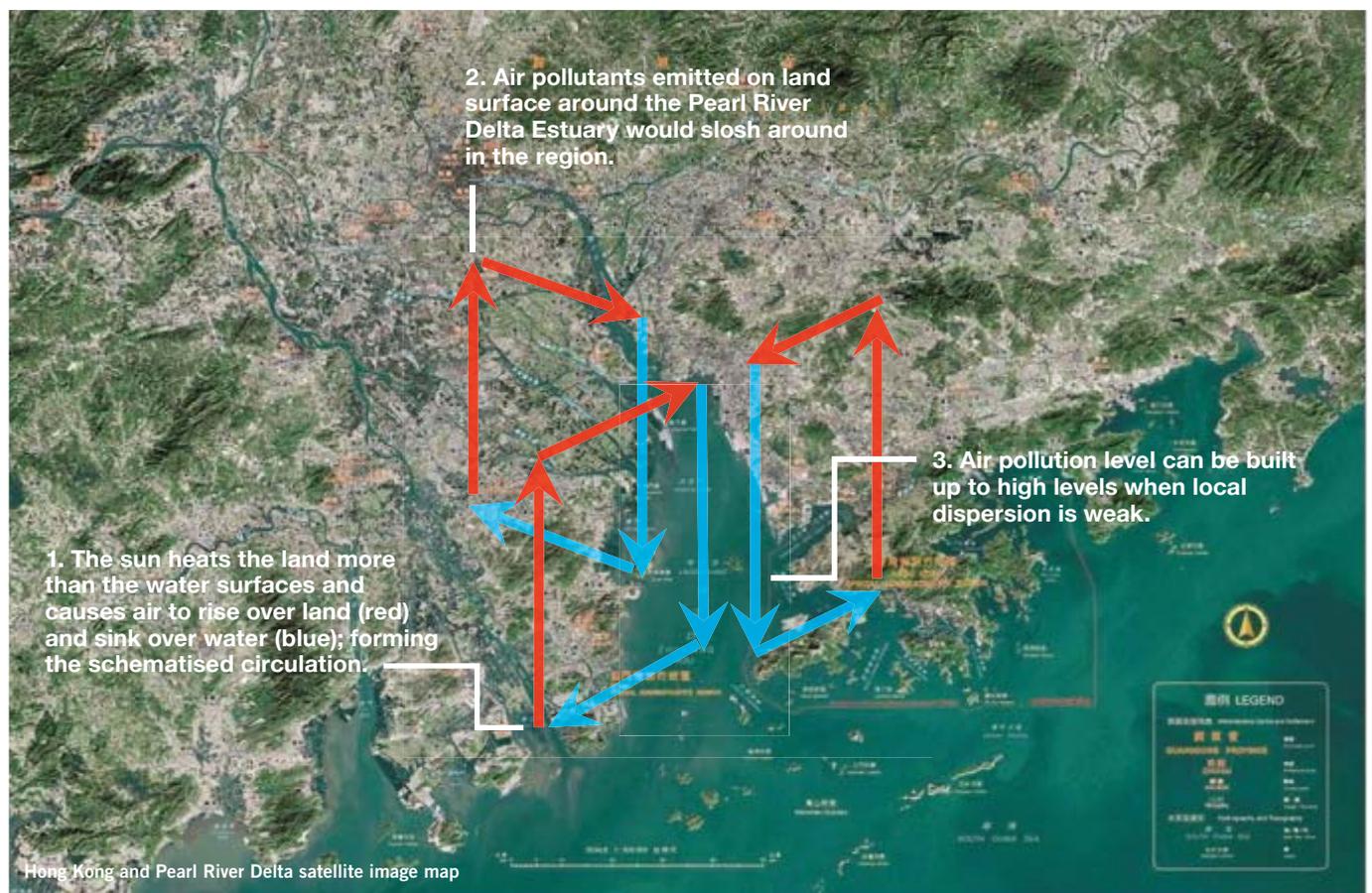
Delta (PRD), large population increases and economic growth in the entire Hong Kong-PRD region had great impact on the environment, including air quality. Many more activities and many more people now share the same air-shed.

Hong Kong-Macao-PRD share the same air-shed, home to some 60 million people and is one of the world's major industrial and logistics zones.<sup>1</sup> Hong Kong companies have significant investments in manufacturing, as well as port and transport facilities in the PRD.<sup>2</sup> In other words, this is a region with high emissions arising from a large variety of economic activities. In addition to

meeting the challenge of controlling emissions, the land-sea breeze created by air circulation between the sea and landmass in the PRD estuary can lead to the trapping of air pollutants within the region when wind flow is weak, thus causing very high pollution episodes.

Secondly, reducing people's exposure to air pollution will have the greatest positive health impact. Thus, reducing roadside air pollution in Hong Kong makes a substantial difference to health because a very large number of people will be exposed to lower vehicular pollution on a daily basis as a result of where they live or where they go.

**FIGURE 1** Land-sea breeze trapping effect in the HK-Macao-PRD region





vehicular emissions. This affects not only those on the roadside and in the vehicles on that road but also all those living or working in buildings on or near congested roadways.

- Recent evidence shows that Hong Kong is especially vulnerable to shipping emissions (burning of bunker fuel), which are highly toxic (SO<sub>2</sub>, NO<sub>x</sub>, PM and heavy metals),<sup>3</sup> because of the large number of ships releasing pollutants berthing and sailing near populated areas due to the particular shipping lanes being used<sup>4</sup> (see Figure 21).
- Emissions from local power plants have been greatly reduced. Further reduction opportunities are largely about changing the fuel mix of our power generation to decrease reliance on coal.
- Hong Kong is also affected by regional and super-regional pollution arising from sources in Guangdong and even further away. Regional pollution is an important factor in Hong Kong's chronically poor air quality (O<sub>3</sub> and PM<sub>2.5</sub>).

To deal with these challenges, cross-Bureaux and Departmental collaboration, as well as the government working with the community, can deliver substantial public health and other gains to the community, which are further elaborated below.

From our past experience, the boldest actions made the greatest difference. In the 1990s, Hong Kong banned the use of high sulphur fuels for industrial use, which brought immediate and significant health gains; and in early-2000s, the diesel-to-LPG switch for taxis and public light buses (PLB) also made a difference to roadside air quality, although much of these latter gains have been eroded over time as the emission reduction devices require regular maintenance.

### **B: What are Hong Kong's specific air quality challenges today?**

Our air quality challenges are:

- Poor roadside air quality presents the major daily public health threats in Hong Kong (NO<sub>2</sub>, diesel PM) – this needs to be dealt with decisively.<sup>3</sup> We need to deal with the most polluting vehicles (old diesel buses, trucks, lorries

and coaches) with actions bold enough to make a difference.

- Contributing to poor roadside air quality is worsening congestion. With vehicle speeds decreasing and the number of vehicles on the road increasing, Hong Kong is running into a vicious cycle – even as cleaner vehicles are being deployed, emissions per kilometre tend to rise due to slower average road speeds especially in city centres with high population and therefore high exposure risk.
- Another important contributing factor to poor roadside pollution is the increase in closely-spaced high-rise buildings on both sides of relatively narrow, busy roads in many parts of the city. High density development has often occurred without consideration for air ventilation corridors, creating 'street canyon' effects, trapping

**FIGURE 2** Summary of air policy focal points



### **C: How should Hong Kong deal with regional and local air pollution?**

Hong Kong must work hard to deal with its own pollution and collaborate with regional partners to deal with regional pollution.

The Central People's Government recognizes the nation's serious

air pollution problem and is moving ahead in cleaning-up, with Guangdong Province at the national forefront of emissions reduction efforts. The 11th Five Year Plan (2006-10) focused on reducing SO<sub>2</sub>; the 12th Five Year Plan (2011-15) has extended the control to also cover NO<sub>x</sub>; and the 13th Five Year Plan (2016-20) will likely push

emissions reduction further ahead. The mainland, including Guangdong Province, has also significantly tightened its air quality standards in 2012. Mainland officials have specific targets to meet under the 12th Five Year Plan for SO<sub>2</sub>, NO<sub>x</sub>, as well as energy and carbon intensity reduction.



It should also be recognized that:

- Hong Kong can influence regional air quality policy by taking a leadership position in both research and policy. Specific collaborative research, projects and action plans are developed jointly with our Guangdong counterparts.

Hong Kong and Guangdong Province have been collaborating to improve regional air quality since 2002. Significant regional reductions have been achieved for SO<sub>2</sub>, RSP, NO<sub>x</sub> and VOC by 20% to 55% by 2010, as compared with 1997. The Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection endorsed a new regional air pollutant emission reduction plan in November 2012, setting out specific targets for 2015 and target ranges for 2020. The two sides will review progress in 2015 to finalise the targets for 2020.<sup>5</sup>

The two sides are also actively discussing joint research projects to better understand the regional photochemical smog problem, as greater understanding is needed to fine-tune control policies.

**FIGURE 3 Hong Kong-Guangdong 2015 and 2020 emissions reduction targets/targeted ranges**

Pollutant	Area	Emission Reduction Targets/Ranges (As compared with 2010)	
		2015	2020
SO <sub>2</sub>	Hong Kong	25%	35-75%
	PRDEZ	16%	20-35%
NO <sub>x</sub>	Hong Kong	10%	20-30%
	PRDEZ	18%	20-40%
RSP	Hong Kong	10%	15-40%
	PRDEZ	10%	15-25%
VOC	Hong Kong	5%	15%
	PRDEZ	10%	15-25%

- Hong Kong has strong knowledge in air science both within the Environmental Protection Department (EPD) and our universities. Their expertise is recognised nationally and internationally. This capacity must be built upon so that Hong Kong continues to be a leader in air quality management (AQM).

The Hong Kong-PRD regional air monitoring network is the best in the nation and compares well with the best-of-the-best in the world.<sup>6</sup> It provides the vital data for evidence-based policies.

Our EPD officers and non-government air quality experts have longstanding collaboration with Guangdong and mainland government and non-government experts on research and control measures. We aim to expand our efforts to participate in the exchange of AQM knowledge regionally, nationally and internationally so that our officers and local experts can work at the cutting-edge of AQM knowledge.

The national government began releasing air quality data on-line to increase transparency on 25 November 2010, and further extended the coverage of pollutants to PM<sub>2.5</sub> and O<sub>3</sub> on 1 January 2013.

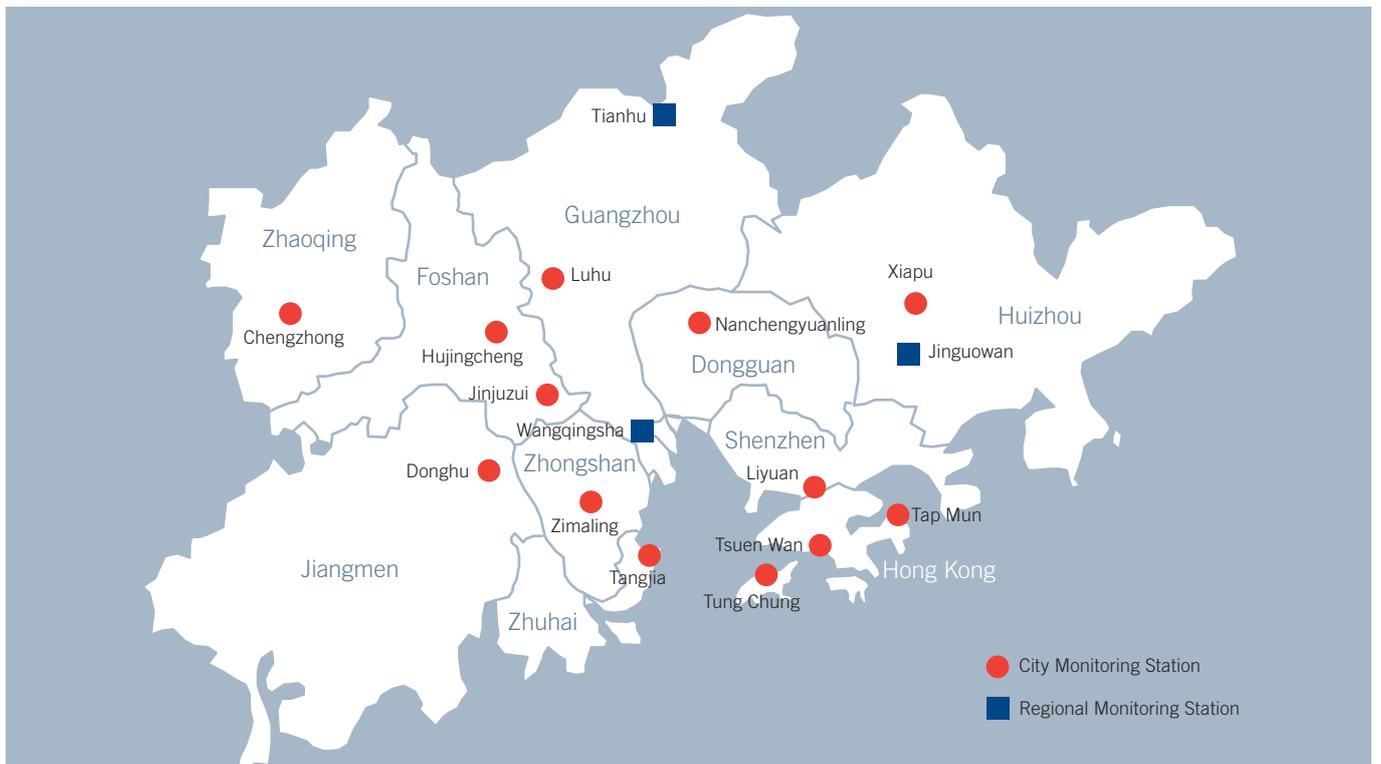
## 2 | Introduction

**FIGURE 4** Hong Kong and PRD networks of air monitoring stations

### Hong Kong's Air Quality Monitoring Stations



### Pearl River Delta Regional Air Quality Monitoring Network



- There are also good opportunities to target Hong Kong-owned factories in Guangdong Province to adopt ‘cleaner production’ practices and reduce air pollution.
- Hong Kong is reformulating our own air quality policy to focus on health protection by aiming to manage not only air pollutant concentrations but also population exposures. After all, local emissions harm us most because of their proximity and relatively high concentration, especially at roadside and areas most affected by shipping emissions. Tough local action for vehicular emissions, shipping emissions (and also power plants’ emissions) can improve public health substantially.

The government launched a five-year \$93.06 million Cleaner Production Partnership Programme (with the Hong Kong Productivity Council as the implementation arm) in collaboration with Guangdong Province’s Economic and Information Commission in 2008 to work with Hong Kong-owned factories to adopt cleaner production practices and technologies. Guangdong Province also started a similar programme for factories in Guangdong. Up until 2012, both programmes have produced good results. In December 2012, the Legislative Council approved a further \$50 million to extend the programme for two years with special focus on encouraging air pollution reduction, energy saving etc.<sup>7</sup>

Our thinking is to take the learning from this programme and work with our Guangdong partners to further develop it to dovetail with Guangdong’s cleaner production efforts for the 13th Five Year Plan so as to capture more significant regional emissions reduction.

- Our local air quality control measures are based on sound science. We use the health-based WHO Air Quality Guidelines (WHO AQG) as a constant reference. We work out quantitative interim targets, identify practicable

emission reduction measures sufficient to meet the targets, as well as prioritise the measures based on health gain and cost effectiveness.

- Through well-coordinated policies, other cities and regions around the world facing similar challenges have made substantial improvements through long term, coordinated, multi-pronged strategies – Hong Kong and our region can also meet the challenge.

In January 2012, the HKSAR Government announced its intention to adopt a new set of Air Quality Objectives (AQO) which makes reference to the WHO AQG and its interim targets, with a view of the new AQO coming into effect in 2014 subject to the passage of the relevant legislation. An Amendment Bill to amend the Air Pollution Control Ordinance was submitted to the Legislative Council in February 2013 to tighten the AQO, with a provision that the AQO shall be reviewed at least once every 5 years after the commencement of the new AQO.<sup>8</sup>

**FIGURE 5** Current and new AQOs

Pollutant	Average Time	Existing AQO (µg/m <sup>3</sup> )	WHO AQGs (µg/m <sup>3</sup> )				No. of Exceedances Proposed
			IT-1	IT-2	IT-3	AQG	
Sulphur Dioxide	10-min	---	---	---	---	500	3
	24-hr	350	125	50	20	20	3
Respirable Suspended Particulates (PM <sub>10</sub> )	24-hr	180	150	100	75	50	9
	Annual	55	70	50	30	20	N/A
Fine Suspended Particulates (PM <sub>2.5</sub> )	24-hr	---	75	50	37.5	25	9
	Annual	---	35	25	15	10	N/A
Nitrogen Dioxide	1-hr	300	---	---	---	200	18
	Annual	80	---	---	---	40	N/A
Ozone	8-hr	240 (1-hr)	---	160	---	100	9
Carbon Monoxide	1-hr	30,000	---	---	---	30,000	0
	8-hr	10,000	---	---	---	10,000	0
Lead	Annual	1.5 (3-month)	---	---	---	0.5	N/A

Recommended



**Professor Hao Jiming**

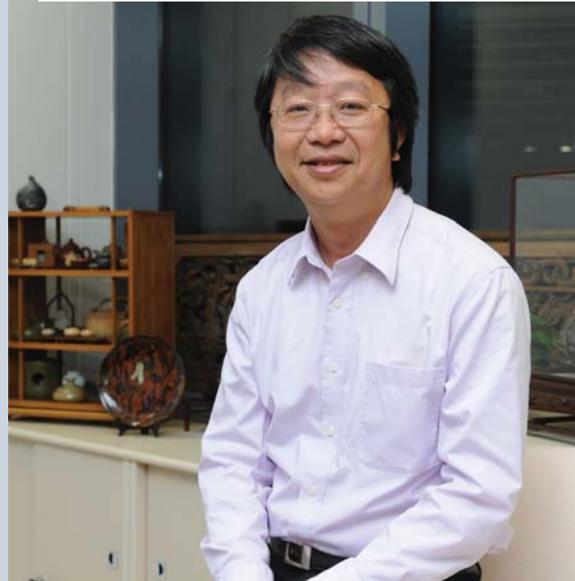
Academician, Dean of Environmental Sciences and Engineering, Tsinghua University, Beijing

“Together let’s try to first understand the nation’s future overall development direction. Then we need to know which are the most important local, regional and national environmental issues that people are concerned about – PM<sub>2.5</sub> pollution and regional haze just to name a couple – and lastly, we should collaborate to think about science, technology and control policy formulation to solve our challenges.”

**Professor Alexis Lau**

Hong Kong University of Science and Technology

“As China restructures its economic activities to be more environmentally sustainable, Hong Kong must leverage its own professionalism and expertise to play a role to advance the cause locally, regionally and nationally. We must think holistically about air quality management and climate change mitigation by adopting an evidence-based approach to form policies.”



**Agnes Mak**

Executive Director, Hong Kong Productivity Council

“The Cleaner Production Partnership Programme demonstrates the success model of public-private collaboration to improve the regional environment. Through 2,000 projects over 5 years and follow-up investment, Hong Kong-owned factories in the PRD reduced 10,000 tonnes of air pollutants and 10 million tonnes of wastewater discharge, securing a saving of RMB 700 million in energy costs per year.”

**Professor Tao Wang**

Hong Kong Polytechnic University

“We need to unite expertise and efforts in government and academia within Hong Kong, on a regional basis, as well as on a national scale to deal with complicated issues like photochemical smog. Scholars in Hong Kong are ready to work together locally and across the boundary to solve a major problem – air pollution.”



## D: How does Hong Kong's air quality compared to other cities?

In general, Hong Kong's air quality is broadly comparable to some other high-income Asian cities, such as Seoul and Taipei, but not as good as Singapore. Major cities in Europe, North America and Australia, for example, London, New York and

Sydney have better air quality than Hong Kong, and their surrounding regions have far fewer industrial, port and logistics activities.

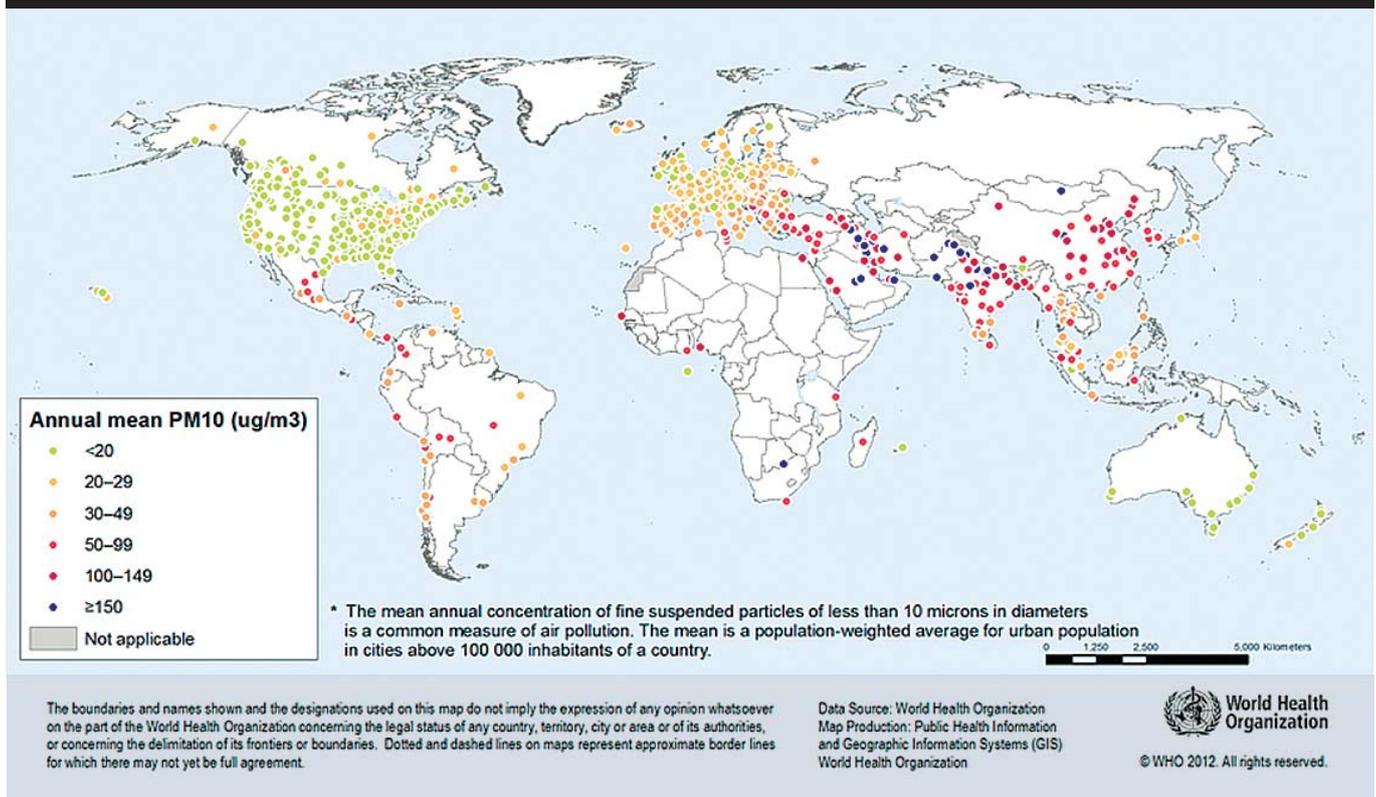
Each city has its own characteristics. Hong Kong's cityscape suffers from the 'street canyon' effect. Moreover, Singapore's equatorial climate have frequent rain showers, which help

to wash away pollution, whereas the natural air flow movements in the Hong Kong-Macao-PRD region tend to trap pollution.

In other words, Hong Kong must work doubly hard to fight air pollution than many other cities, and we are committed to do so.

**FIGURE 6** World exposure to PM, WHO 2012

### Exposure to particulate matter with an aerodynamic diameter of 10µm or less (PM10) in 1100 urban areas\*, 2003-2010



### 3 | The Basis of the Clean Air Plan

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Our Clean Air Plan has THREE premises:

1. Improving Hong Kong people's public health is the driving reason for taking resolute action;
2. Collaborating across Bureaux and Departments, and between the government and the community, can deliver the largest health and other benefits to Hong Kong people because there are limits to end-of-pipe solutions, especially with respect to roadside air quality; and
3. Investing time and effort in regional efforts will maximise the overall public health gains to Hong Kong as a whole.

**FIGURE 7** Premises of the Clean Air Plan



## 4 | Our Air Quality Management System

Our air quality policy aims to reduce air pollution and the associated health risk to the people of Hong Kong. AQM by the government is made up of the regulatory activities undertaken to reduce air pollution and the associated health risk. The AQM process includes understanding the sources of pollution and the health effects of the pollutants, and taking steps to reduce or control the sources of pollution to reach or not exceed specific targets.

**FIGURE 8 AQM System**

### ACTION

Regard the WHO AQG as a constant reference in setting the local AQO and in charting air quality policy.

Conduct relevant health studies together with local experts, consult Department of Health, and prioritise emissions reduction measures based on health protection gains and cost effectiveness.

Provide time-based targets and milestones for achieving the new AQO and striving for maximum gains.

Review the AQO no less than once every five years.

Monitor the extent of achieving the AQO and publish the progress periodically.

Monitor the effectiveness of control measures and publish them periodically, and fine-tune or reassess programmes where necessary for greater effectiveness.

Strengthen our air monitoring network by adding new stations in Tuen Mun (2013) and Tseung Kwan O (2014-15). Additional stations may be added where necessary.

Replace the Air Pollution Index (API) with a new health-based Air Quality Health Index (AQHI) to better reflect the health risks of air pollution and provide clearer health advice to the public and vulnerable groups. The AQHI has been reviewed and supported by the WHO. With the tightening of the AQO and the use of the AQHI, the number of hours that the air pollution is rated at 'high' or 'very high' will substantially increase even when there is no material change in pollutant concentrations.<sup>9</sup>

Provide readily available and user-friendly on-line performance reporting on all aspects of the AQM system, including air data, policy, reductions, targets, milestones, progress, programme effectiveness etc.

### GOAL

**To better join-up Hong Kong's AQM system to protect public health**

# **REDUCING ROADSIDE AIR POLLUTION TO LOWER HEALTH RISK**

Highest gains will come from aggressive tail-pipe control together with appropriate transport management and urban planning measures

## 5 | Reducing Roadside Air Pollution

**W**hile we must attack roadside pollution with vigour because this presents the greatest daily health risk to the people of Hong Kong, we also want to put in place an integrated people-centred policy in the longer-term to achieve cleaner, more efficient public transport through making public transport a preferred choice mode, managing road use and meeting diverse needs of the travelling public.

Bureaux and Departments are collaborating to deliver solutions ranging from end-of-pipe solutions (Environment Bureau and EPD), transport management solutions (Transport and Housing Bureau and Transport Department), urban

planning solutions (Development Bureau and Planning Department) to financial incentive solutions.

We reaffirm the longstanding policy that rail forms the backbone of public transport with franchised buses and other supplementary transport modes providing complementary services and filling service gaps to ensure the community is adequately served. In the coming few years, the West Island Line, Kwun Tong Line Extension, South Island Line (East),

Hong Kong section of Guangzhou-Shenzhen-Hong Kong Express Rail Link and Shatin-to-Central Link will become operational. This provides the backdrop for us to provide the community with a new mobility experience with reorganised bus routes and network that can serve the community better, and to provide bus-to-rail and bus-to-bus interchange that are easy and pleasant, as well as to take air quality and public health into account in transport management and urban planning.

### The 3 'S' Committee

This committee comprises the Secretaries for the Environment, Transport and Housing, and Development to discuss issues that transact across their Bureaux and Departments. Air quality is one of the issues frequently discussed at 3S meetings in this term of government.



Street canyons trap vehicular pollution

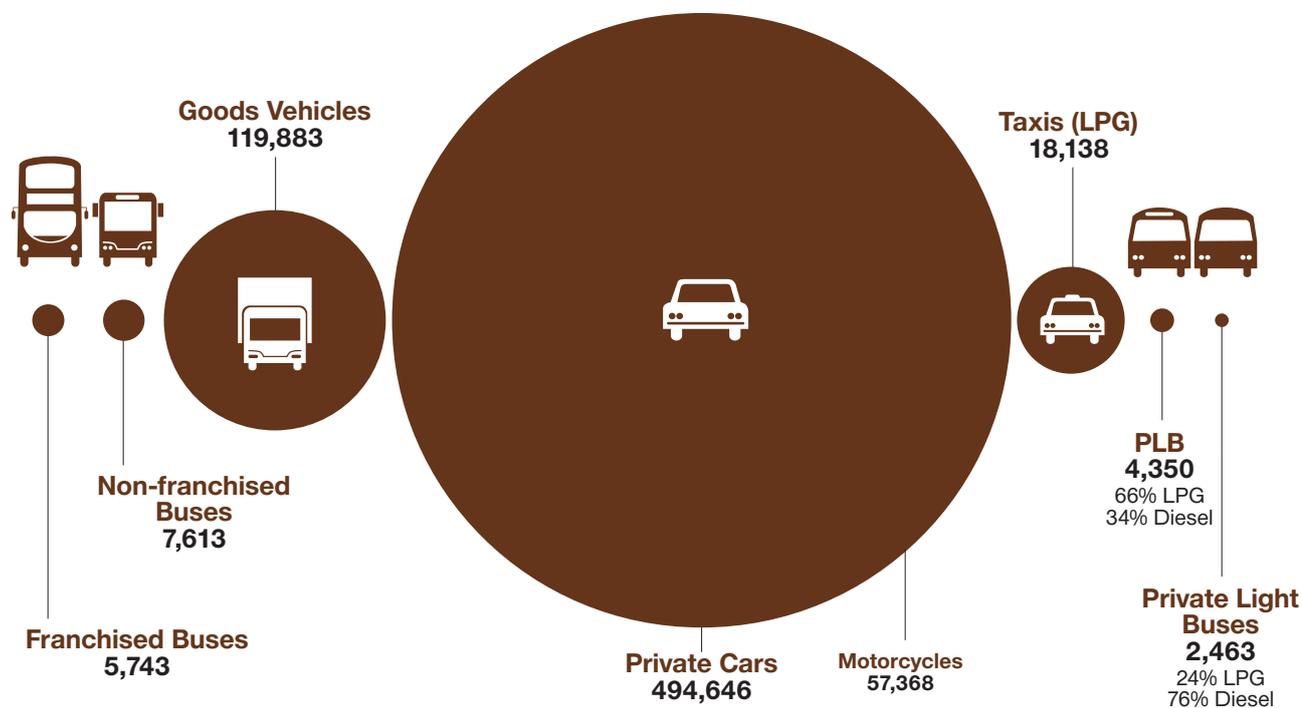
In the planning of new development areas, as well as revitalisation of old ones, we will look for opportunities to enhance air ventilation to prevent or mitigate the effect of 'street canyons', and promote non-motorised transport, such as improving walkability, pedestrianising where appropriate, and promoting cycling where safety is not compromised. Detailed plans will have to be worked out in the future.

### End-of-pipe solutions

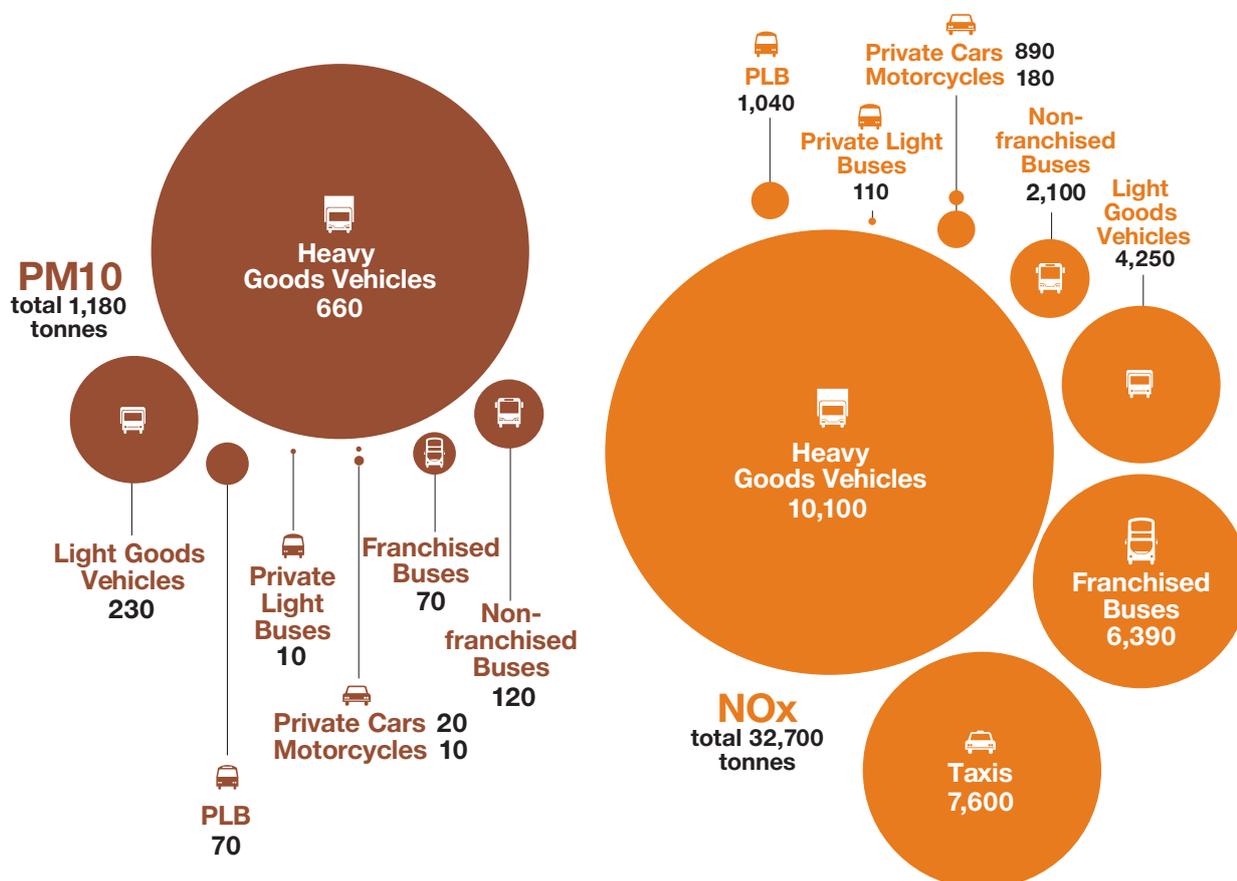
Before we present an extensive programme to deal with roadside emissions, we wish to present facts about Hong Kong's vehicular fleet. Figures 9-12 show the demography of Hong Kong's vehicles and their respective emissions profiles. In summary, Hong Kong still has a large number of highly polluting vehicles plying our roads.

## 5 | Reducing Roadside Air Pollution

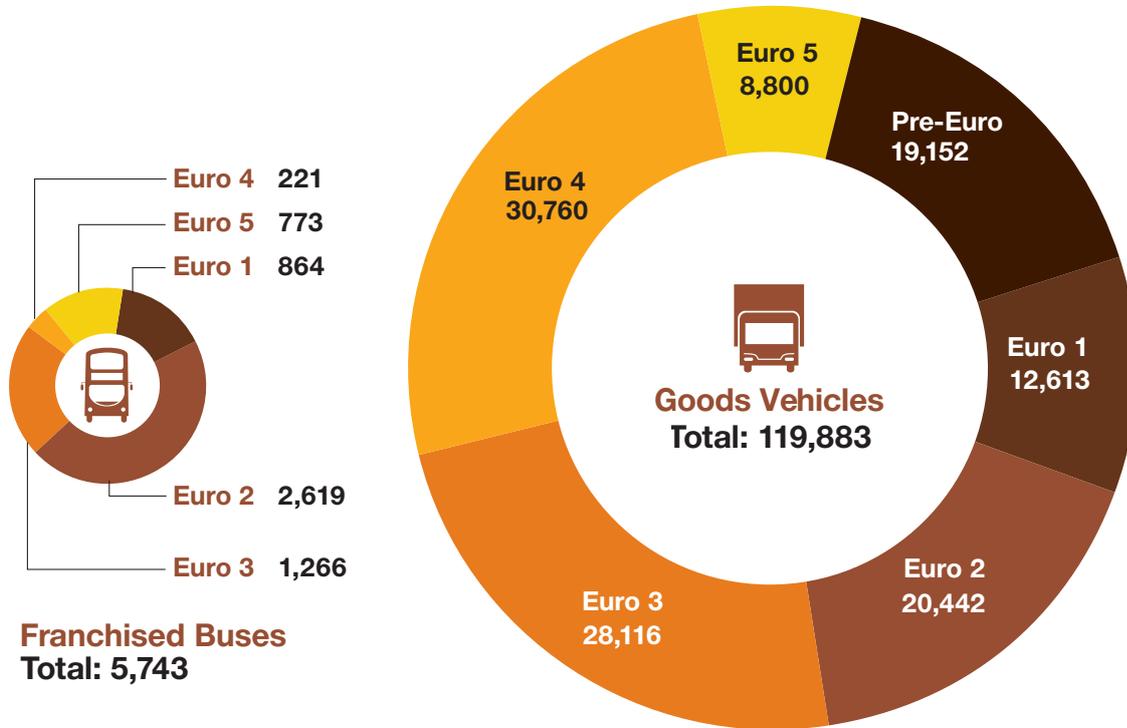
**FIGURE 9** Types and numbers of registered vehicles in Hong Kong (as at December 2012)



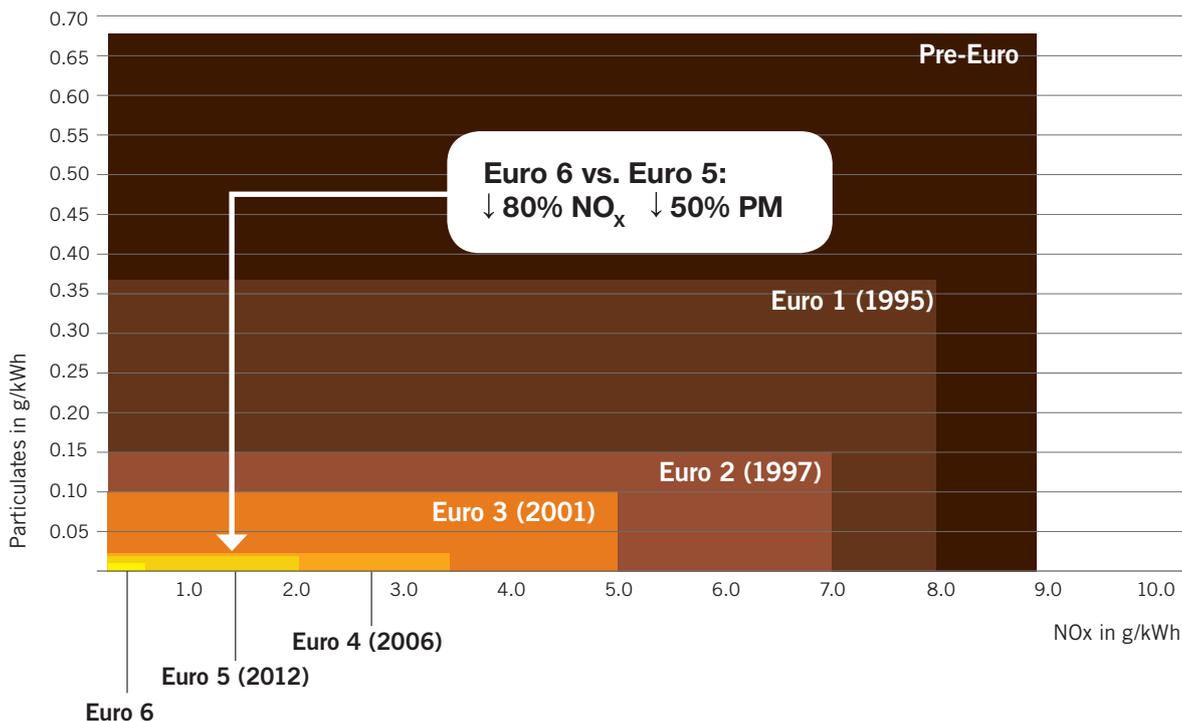
**FIGURE 10** Emissions profiles of Hong Kong's vehicular fleet (as in 2011)



**FIGURE 11** Emissions standards of diesel commercial vehicles (as at December 2012)



**FIGURE 12** Emissions comparison of diesel commercial vehicles (Pre-Euro to Euro 6)



## 5 | Reducing Roadside Air Pollution

From the preceding figures, it is clear that we must target diesel commercial vehicles (DCV), franchised buses and inadequately-maintained LPG vehicles as top priorities.

### Pollution from Hong Kong's vehicular fleet

Roadside pollution is mainly caused by vehicles within Hong Kong. Here we have a twin problem – firstly, the city's fleet of old DCV emits disproportionately large amounts of PM (which are carcinogenic and the finer PM<sub>2.5</sub> can enter deeply into our lung tissues) and NO<sub>x</sub>, the generic term for NO and NO<sub>2</sub>. A pre-Euro 3 diesel vehicle emits 7.5 to 34 times as much PM and 3.5 to-4.5 times as much NO<sub>x</sub> compared to a cleaner Euro 5 model. Thus, our policy is to replace the older, dirtier ones with Euro 5 or Euro 6 models (the latter is expected to come to market by 2014 and be available in Hong Kong in greater numbers by 2016).

Another thorny problem is the high NO<sub>2</sub> levels at roadside. The days where the roadside API exceeds 100 (the very high air pollution level range from 101 to 200) are mostly caused by high NO<sub>2</sub> levels. Since 1999, NO<sub>2</sub> levels have increased by 20% at roadside, even as their ambient levels have decreased. Combustion creates NO, and when it oxidises, it becomes NO<sub>2</sub>. The conversion of NO to NO<sub>2</sub> can be aggravated by O<sub>3</sub>, the ambient level for which has risen by 18% since 1999. Excessive NO<sub>x</sub> are emitted from badly maintained vehicles where their emissions-reduction devices have become defective. In Hong Kong, the main sources are LPG taxis

and LPG-powered PLB with worn out catalytic converters.

In summary, to tackle our roadside air pollution, we need to target both old diesel vehicles and inadequately-maintained LPG-powered vehicles.

### Diesel commercial vehicles (DCV)

Our new 'carrot and stick' programme is designed to incentivise the replacement of pre-Euro 4 DCV by cleaner models and to ban the use of the older models within a stated period in the coming years.<sup>10</sup> DCV include trucks, lorries, diesel-PLB and non-franchised buses (school buses, tourist coaches etc). This programme aims to remove the dirtiest DCV currently on our roads (pre-Euro, Euro 1, Euro 2 and Euro 3) over the period 2014 to 2016 for Pre-Euro 3 DCV and Euro 3 vehicles by 2019.<sup>11</sup> With these and other measures stated below, Hong Kong's roadside air quality will improve from year-to-year starting from 2014-2015.

### Taxis and LPG-powered PLB

Virtually all taxis and 66% of the PLB fleet are powered by LPG.<sup>12</sup> These vehicles are installed with emissions-reduction catalytic converters, which gradually wear out. Once worn out and not replaced, emissions from these vehicles will emit ten times more NO<sub>x</sub>, CO and VOC than when these devices were in good condition. Our tests show the devices of 80% and 45% of LPG taxis and LPG PLB in Hong Kong have worn-out. Unlike smoke from diesel vehicles, the emissions from LPG vehicles are invisible to the eye. Special sensors are needed to detect these emissions. Taxis and LPG PLB with defective emission-reduction devices could account for up to 40% of the roadside NO<sub>x</sub>. Thus, our key programme to deal with this problem is to fund a one-time replacement of these devices.

#### DCV replacement programme 2013

If all pre-Euro 4 DCV (excluding franchised buses) are replaced by Euro 5 model or better, the emissions of PM and NO<sub>x</sub> from vehicles will be reduced by 80% and 30% respectively, while the total local emissions of these pollutants will be reduced by 17% and 9% respectively. These represent very major reductions that should lead to PM<sub>10</sub> and PM<sub>2.5</sub> levels at roadside meeting the new AQO for these pollutants by 2020. This will reduce the number of premature deaths due to long-term exposure to these pollutants by around 14% per annum. Moreover, there will also be a reduction of cancer risk due to exposure by around 50% per annum.

Figure 15 shows the DCV replacement programme, coupled with other control initiatives targeting franchised buses and LPG-powered vehicles, will also reduce the NO<sub>2</sub> annual roadside level by about 40%, which is still not enough to meet the new AQO for this pollutant. The concentrations of roadside NO<sub>2</sub> will be brought closer to the new AQO with other non-end-of-pipe solutions and when more vehicles switch to newer and cleaner models.

As the number of pre-Euro 4 DCV will progressively drop over the period 2014-2020, there will be steady emissions reduction at roadside every year.

### New emissions control for LPG vehicles

As taxis contribute 20% of the road mileage in Hong Kong, we expect this programme to cut roadside pollution significantly. Taxis and PLB need good maintenance, including the regular replacement of their catalytic converters (on average about every 18 months) because they are high-mileage vehicles. The Legislative Council has already allocated \$150 million to provide a one-off subsidy to help the owners of these vehicles to replace the devices. Replacement should begin to take place from August 2013 by government contractors.

At the same time, we will be setting-up mobile remote sensors at roadside that can detect excessive emissions from LPG vehicles. We aim to deploy up to 5 sensors per day in different locations. Once detected, the vehicle owner will be notified of the need to repair his vehicle and pass an emissions test within 12 working days, failing which the vehicle licence will be cancelled (this is the same as when vehicle owners are requested to take their vehicles to undergo a smoke test).

This programme will also be effective for petrol vehicles. The low mileage of private cars do not call for frequent replacement of catalytic converters, and the excessive emissions problem from them is much less prevalent when compared to taxis and PLB. Our emission survey found converter failure in private car is less than 10%. Nevertheless, the owners of petrol vehicles identified by the remote sensors will also be notified to repair his vehicle and pass an emissions test.

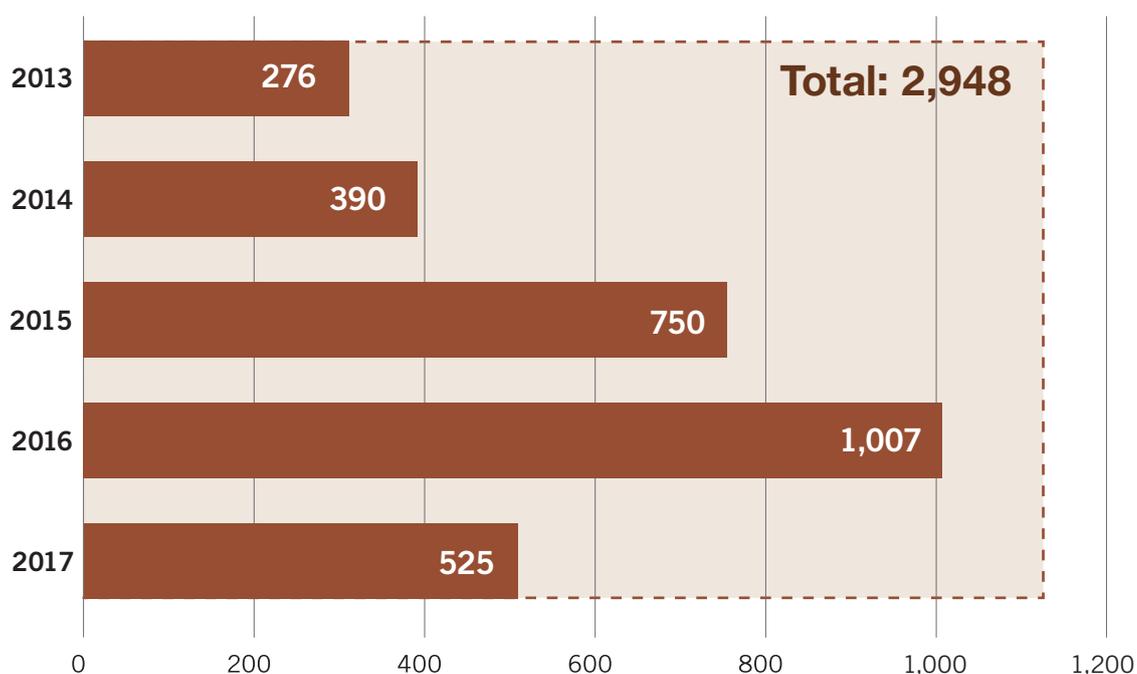
### Franchised buses

Franchised buses are permitted to have a life of up to 18 years in Hong Kong. There are no pre-Euro franchised buses anymore but there are still many pre-Euro 3 buses in service as at the end of 2012. Based on the age distribution of the bus fleet, about 2,950 buses will retire between 2013 and 2017, including all Euro 1 buses by 2015, the majority of Euro 2 and some of the Euro 3 buses.

We have a two-pronged strategy to maximise emissions reduction from the franchised bus fleet.

Firstly, we will work closely with the bus operators to replace their fleet with cleanest bus models in keeping with the bus replacement programme once such models are available in the market (subject to

**FIGURE 13** Normal retirement timetable of franchised buses 2013-17 (as at December 2012)



## 5 | Reducing Roadside Air Pollution

successful model testing under local operating condition), and also identify opportunities to switch to cleaner technologies (see below). Secondly, the government will subsidise the cost of retrofitting Euro 2 and 3 buses with selective catalytic reduction devices (SCR) to reduce NO<sub>x</sub> emissions to reach Euro 4 and 5 standards respectively.

### Changing vehicular technology

Another end-of-pipe solution is to change the technology of vehicles altogether. The switch from diesel to LPG for taxis and PLB is one such example. In 2010, the government proposed zero emission franchised buses as the ultimate objective. Funds were made available for the purchase of six hybrid buses and 36 electric buses for trial by the franchised bus operators. Trials will start when the vehicles arrive in Hong Kong starting in 2014. Moreover, hybrid and electric vehicles are also encouraged (see Pilot Green Transport Fund below). The government has been working with car park providers, property developers and managers, as well as the two electric utilities to provide charging facilities.

### Age limit for new DCV

As part of our measure (noted above) to replace polluting DCV, we also want a defined period for new DCV so that Hong Kong can renew its DCV fleet to benefit from model upgrade and change in technologies. Setting an expiry time for vehicle life is commonly practised around the world. For example, New York uses petrol vehicles for its taxi fleet and has a 6-year age limit for them,

### SCR retrofits for Euro 2 and 3 franchised buses

The franchised bus companies have retrofitted diesel particulate filters (DPF) on all Euro 2 and 3 buses to reduce PM from 2008-10, with the exception of a few bus models where retrofitting was technically infeasible. Our new retrofit programme aims to add a SCR to reduce NO<sub>x</sub>. SCR retrofits have been successful in Europe. Local tests have already been done and the Legislative Council will be asked to vote for the funding for this programme in the near future, after which the bus operators will arrange for the retrofit.

To strike a balance between emissions reduction and cost effectiveness, the retrofit scheme applies to those buses with at least two years of remaining service life after the retrofit and where there are reasonable numbers of those bus models. We estimate about 1,400 buses will be eligible for the retrofit. The SCR retrofit can reduce NO<sub>x</sub> emissions by at least 60%. This is the fastest, least costly, most efficient way of reducing emissions from our bus fleet's tail-pipe. Our target is to complete the retrofit by 2016 on a best endeavour basis.

### Zero emission franchised buses



To develop a zero emission franchised bus fleet policy, we will need to identify the steps, timeline and costs for the transition. Bus companies are already required to replace buses before they reach 18 years.

Requirements were included in the three new bus franchises granted in April 2012 requiring bus operators to acquire the most environmentally-friendly buses in terms of vehicle exhaust emissions (with the ultimate objective of acquiring zero emission buses) that are technologically-proven and commercially available when buying new buses, taking into account feasibility in terms of operation and passenger service requirements and affordability for the bus operators and passengers. The same provision will be included in the other franchises upon their expiry in 2016-17.

### Low/zero emission vehicles



Availability of private passenger hybrid and electric vehicles (EV) in the market is critical for adoption, and also the wide availability of charging points as far as EV are concerned.

Hong Kong now has over 1,000 charging points, which compares very well with cities in the US and Europe. To promote expansion of the charging network, policy is in place for car parks in new developments to be granted concession on Gross Floor Areas where they enable EV-charging. For existing buildings, a hotline has been set up to provide assistance to EV buyers and car park operators for setting up EV charging facilities. EV charging now enjoys an increasing penetration in both new and existing private properties.



**Professor Donald R. Blake**  
University of California, Irvine, USA

“The catalytic converter replacement programme EPD is undertaking with respect to LPG-powered vehicles is unprecedented in the world. Reduction in the key air pollutants should be significant at roadside once the programme kicks in.”

**Professor Anthony J Hedley**

Professor Emeritus, The University of Hong Kong

“We welcome a new approach to air quality management. This is a defining moment in environmental health. However, we have no illusions about the complexity of this task and the obstacles to be overcome. Cleaner air will hugely benefit child health and reduce harm and economic cost to the whole community.”



**Professor Wing-tat Hung**  
Hong Kong Polytechnic University

“Roadside air pollution kills many people every year, including my mother who died of lung cancer because of working along roadside. Drivers also suffer from poisonous vehicle emissions. Everyone has the responsibility to save lives by reducing traffic emissions. Environmental and transport professionals, whether in governmental or non-governmental organisations should work together for clean air.”

**Professor T W Wong**

The Chinese University of Hong Kong

“Air pollution is a silent killer. It is especially dangerous to our children, our senior citizens, and the chronically sick residents. The government must accord air pollution control a very high priority.”



## 5 | Reducing Roadside Air Pollution

which will be shortened to 5 years in 2015. Goods vehicles on the Mainland, which are mostly diesel-powered, have a stipulated age limit of 15 years. In Hong Kong, new DCV will have a life of 15 years under our proposal.

### Transport Management Solutions

Road conditions affect vehicular emissions. Traffic congestions slow down vehicle speed, which in turn generate higher pollutant emissions. Congestion problems cannot always be solved by building more roads, especially in a small city like Hong Kong that already has a well-developed road network. To improve road conditions, we need appropriate policies and tools, such as to give priority to public transport, manage transport demand, and divert traffic using technology.

#### Low emissions zones

It makes sense to have the cleanest buses going into areas with the most people so as to reduce their exposure to pollution. We will designate low emissions zones for buses (LEZ) at busy corridors, where only the cleanest models will be allowed.

#### Low Emission Zones 2015

Since 2011, franchised bus operators have been encouraged as far as possible to use cleaner buses (Euro 4 and 5) for running on pilot LEZ in Central, Causeway Bay and Mong Kok, with the target of having only buses that meet Euro 4 or above emission standard in those zones by 2015. Based on the number of buses deployed on the routes that pass through those zones, about 2,300 cleaner buses will be needed for this scheme. On the current basis of the bus replacement timetable, approximately 2,100 Euro 4 or above buses would be available for deployment by 2015. Together with the SCR retrofit scheme, a sufficient number of cleaner buses will be available to meet the target.

#### Franchised bus routes rationalisation

Another major measure to improve air quality is the rationalisation of bus routes and network. This is a prime measure of the Transport and Housing Bureau and Transport Department, the details of which have been released elsewhere.<sup>13</sup> The Environment Bureau and EPD are working closely with them on the air quality front and will collaborate with them to explain the air quality benefits arising from bus route rationalisation to the public. The government needs the active support of District Councils and the public to achieve the outcomes we all wish to see.

#### Cross-harbour tunnels usage rationalisation

Yet another frequently discussed transport improvement is adjusting the tolls of the three road harbour crossings so as to redistribute traffic amongst them to ease congestion at the Cross Harbour Tunnel. The Transport and Housing Bureau and Transport Department have already released details elsewhere.<sup>14</sup> This initiative contributes to improving air quality, as it will improve traffic flow.

#### Vehicle inspection and maintenance

All commercial vehicles irrespective of age must pass the Transport Department's roadworthiness test for their licences to be renewed. Commercial vehicles are mainly diesel or LPG-powered. The tests being used for these two types of vehicles do not require the use of dynamometer and are not designed to screen out vehicles emitting high PM and NO<sub>x</sub>. What this means is that a diesel or LPG vehicle can pass the respective roadworthiness test but still has high pollutant emissions.

Private cars, which are predominantly petrol vehicles, when over 6-years of age must also pass the roadworthiness test for licence renewal. Again, no dynamometer is used in the test and like for LPG vehicles, it is ineffective in screening out vehicles with defective catalytic converters that emit high NO<sub>x</sub> and other pollutants.

In the case of smoky vehicles, EPD uses the dynamometer smoke test, which involves a large treadmill-like machine that simulates vehicle driving on a road. Since the test was implemented in 1999, combined with the \$1,000 fixed penalty, there has been an 80% reduction of smoky vehicles. However, this test does not measure pollutants such as PM and NO<sub>x</sub> that are creating the roadside air quality problems we have today.

To carry out the tests measuring various pollutants for the various types of vehicles, test stations will need to be upgraded to accommodate and operate the necessary equipment.

## Urban Planning Solutions

Hong Kong's city morphology in urban centres has one major disadvantage as far as air quality is concerned. Our city has high-rise buildings on either side of very busy roads and large numbers of people at roadside for much of the day. Hennessy Road on Hong Kong Island and Nathan Road of Kowloon are good examples of this type of city morphology. The emissions from

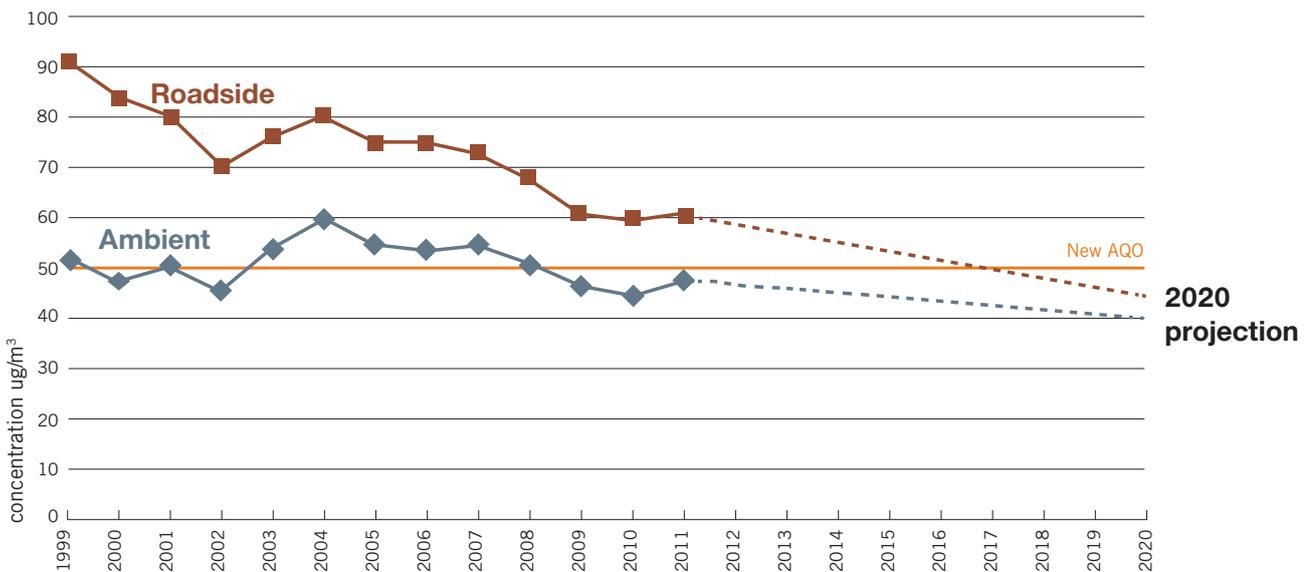
vehicles are trapped between the buildings resulting in poor roadside air quality, exposing a very large number of people on a daily basis.

Effective ways to deal with the 'street canyon' effect is to reduce tail-pipe emissions of the types of vehicles that ply the busiest roads. Thus, by focusing on cleaning-up franchised buses, taxis and PLB, as well as DCV,

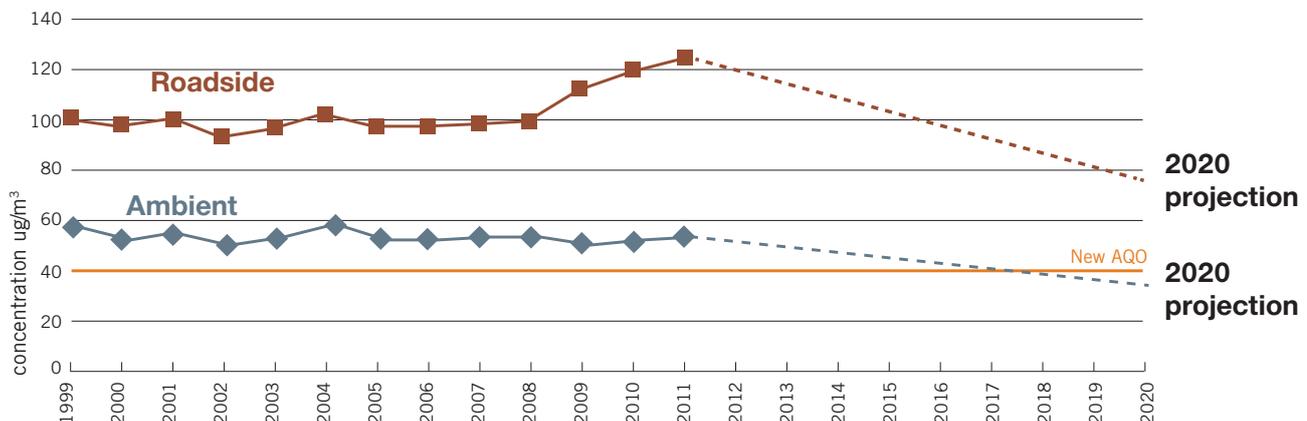
and by creating LEZ, roadside air quality will improve.

Over the longer-term, there are opportunities to use urban planning and design solutions in new districts and areas targeted for regeneration to combine with transport management for better air quality outcomes in addition to improving overall functionality and community well-being.

**FIGURE 14** Projected RSP concentration in 2020



**FIGURE 15** Projected NO<sub>2</sub> Concentration in 2020



## 5 | Reducing Roadside Air Pollution

### Urban greening

A useful measure is urban greening. Trees and other plants trap air pollutants in their bark and foliage, and can absorb air pollutants. The government has an existing greening policy to improve the quality of our living environment through active planting, proper maintenance and preservation of trees and vegetation, as well as to invest in plantings to beautify the streetscape, which also helps to cleanse the air. One of the targets is to bring about noticeable improvements in urban greenery. Development Bureau's Greening, Landscape and Tree Management Section has many plans to continue to green the city. Moreover, Development Bureau formulates guidelines and best practices for green-roofing and vertical greening of buildings, which can also reduce heat and therefore energy usage. In the light of the recommendations of the Council for Sustainable Development in 2010, Building Department, Lands Department and Planning Department have subsequently introduced a series of measures to enhance the design standard of new buildings to foster a quality and sustainable built environment, which includes the stipulation of site coverage of greenery in new developments. The Environment and Conservation Fund also provides funding support for greening projects of local non-profit making organisations.

### Pedestrian schemes

Pedestrian schemes are also useful. There are seven full-time pedestrian streets and some 30

part-time pedestrian streets, and more than 40 traffic calming streets. Pedestrianisation is challenging in Hong Kong due to limited road space and many competing needs. To expand pedestrian schemes will require skilful urban planning, as well as the support of the community.

### Cycling networks

A comprehensive cycling track network is being created in the New Territories from Ma On Shan to Tsuen Wan, via Sheung Shui, Yuen Long and Tuen Mun mainly for recreational purposes. The Ma On Shan-Sheung Shui section will be completed in 2013. Safe cycling in the busy urban areas is more challenging

and can generally only be achieved, with careful forward planning, in new development areas. Transport Department has just completed a study examining how to improve the existing cycling networks and bicycle parking facilities within the nine existing new towns.

### Financial Solutions

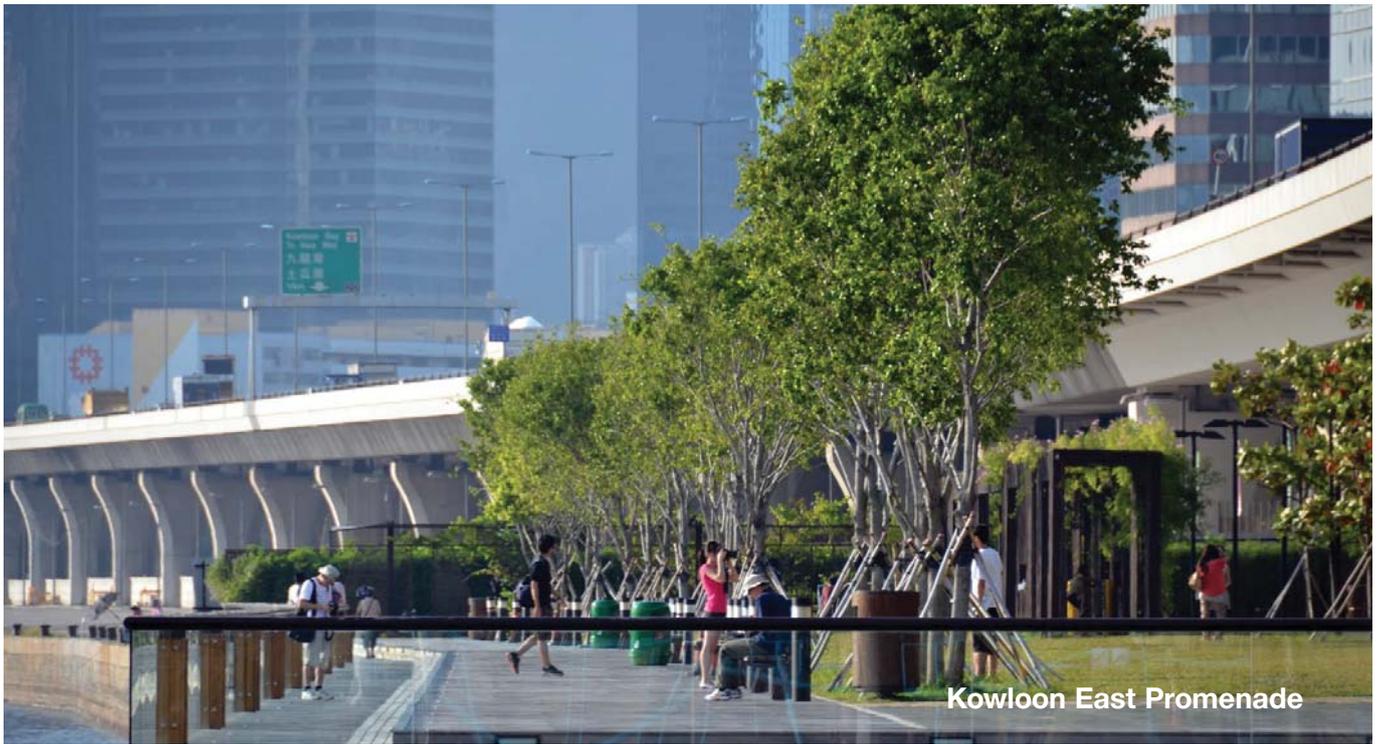
Governments have the ability to use a range of financial tools to help manage air quality beyond directly funding end-of-pipe solutions such as the DCV replacement programme and defective emissions reduction devices replacement programme for LPG taxis and PLB noted above.

#### Kowloon East

To take forward the initiatives for Energizing Kowloon East (EKE), Development Bureau has formulated a "CBD2" planning strategy, with "Connectivity", "Branding", "Design" and "Diversity" as the core concept. Our vision is to foster a pedestrian environment in Kowloon East which is "walkable", "stayable" and "sittable". The walking environment should be safe, comfortable, inviting and convenient for people to enjoy the walking experience.

Development Bureau has already taken forward various short-term pedestrian improvements, including footpaths widening, traffic signal modifications, pedestrian crossing improvements, and obstacles removal that hinder pedestrians (such as traffic signs). Medium and longer-term measures will also be implemented progressively. To enhance accessibility from Kowloon Bay MTR Station to the Kowloon Bay Business Area (KBBA) and further to the waterfront of the Kai Tak Development, Development Bureau is commissioning a feasibility study to improve the pedestrian environment for the KBBA. The study will focus on creating a pedestrian-friendly environment with attractive, vibrant streets and urban greening by firstly improving the at-grade pedestrian environment and secondly formulating grade-separated pedestrian links where necessary. A multi-disciplinary approach taking due account of the traffic and transport needs, as well as planning/urban design requirements will be adopted in tackling the issues and recommending solutions.

Development Bureau is also promoting more urban greening in Kowloon East. Trees and shrubs have been planted at various locations. Development Bureau will continue to coordinate with other departments to further enhance existing roadside greening there.



## 5 | Reducing Roadside Air Pollution

### Pilot Green Transport Fund

The government set-up the \$300 million Pilot Green Transport Fund for application by transport operators to trial innovative green transport technologies that can out-perform conventional methods, such as clean vehicles, emission reduction devices, fuel saving devices and conversions from conventional to alternative-fuelled vehicles. As of December 2012, 37 applications were approved, which covered trials of electric buses, goods vehicles and taxis, as well as hybrid light buses and goods vehicles.<sup>15</sup>

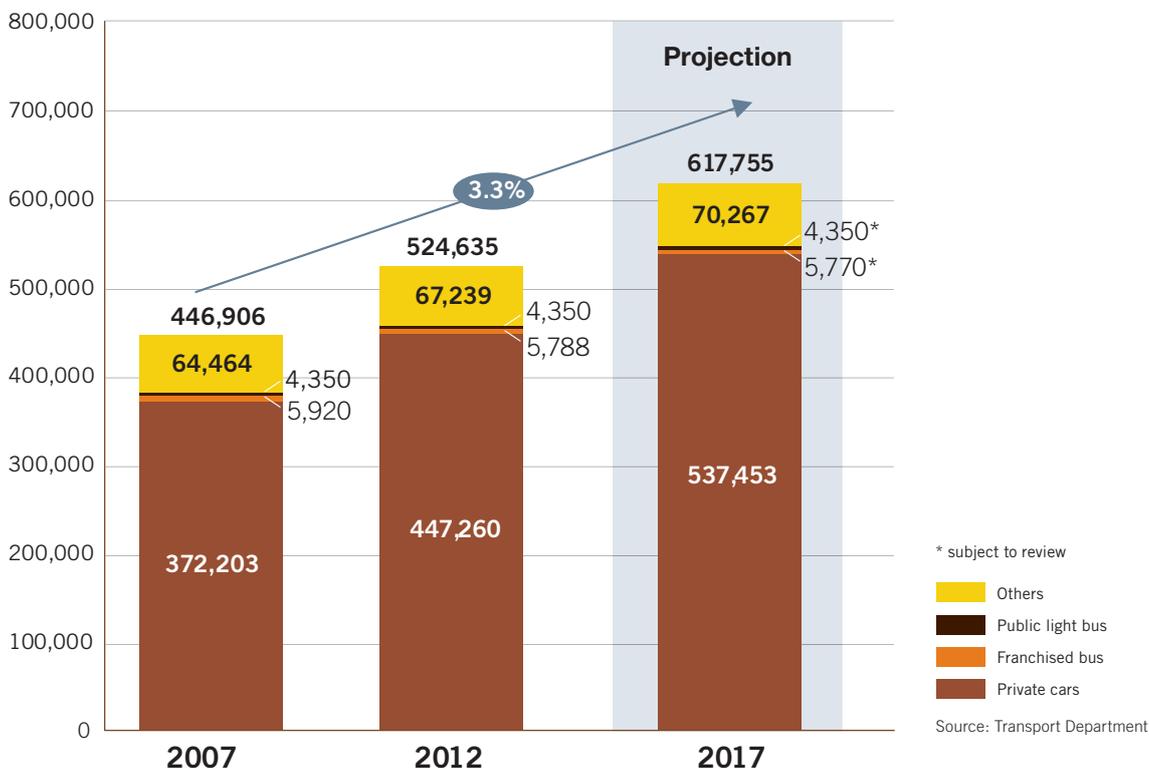
### Use of taxation as a tool

Taxation can be used to control the growth of private cars. For example, in 2011, the First Registration Tax (FRT) was increased for this category of vehicles by approximately 15% (for each tax band). It helped to slow the growth in the number of registered private cars from 5.8% to about 4.5%. Nevertheless, Figure 17 shows the projection of rise in vehicle numbers, particularly private cars, in the next few years.

While we do not encourage private car use where public transport service is available, but if such a vehicle has to be purchased, the government encourage buyers to choose environment-friendly petrol

private car. A reduction in FRT was first implemented in April 2007 for petrol vehicles. EPD has tightened the fuel efficiency and emissions requirement of qualifying models in December 2012 to be effective from April 2013. In April 2008, a reduction in FRT was also put in place for commercial vehicles to encourage buyers to opt for models that meet Euro 5 standards. EPD has likewise put forward new environment-friendly commercial vehicles emissions requirements for heavy duty and light duty vehicles for implementation from April 2013.<sup>16</sup> At the same time, we have also waived the FRT for purchase of EVs until March 2014 to encourage their wider adoption.

**FIGURE 17** Projection of registered vehicle numbers to 2017



# GREENING PORTS – A WORLD TREND

Hong Kong recognizes reducing shipping emissions will lower public health risk

## 6 | Reducing Marine Emissions

**H**ong Kong is the third busiest container port in the world. Container ships, cruise liners, oil tankers, dry bulk carriers and other types of large ships are often referred to as ocean-going vessels (OGV). There are also many types of ships referred to as river trade vessels that sail in regional waters. Ships that only sail in Hong Kong's local waters are local vessels.<sup>17</sup> Figure 18 shows the statistics of these vessels entering Hong Kong waters over the past few years. While the number of OGV has fallen, the size of the vessels has increased, thus emissions have increased.

These ships emit considerable quantities of SO<sub>2</sub>, PM and NO<sub>x</sub>. As the emissions are emitted at sea level, they are easily blown to areas with high population density in Hong Kong. In view of the high toxicity of bunker fuel, the pollution presents a major health risk.

### Regulating OGV

OGV, because of their size, contribute the bulk of the shipping emissions. The International Maritime Organisation (IMO) regulates the sulphur content of bunker fuel (up to 3.5% although the average

is 2.8%) and NO<sub>x</sub> emissions from vessel engines. The HKSAR government gives effect to these regulations through the Merchant Shipping (Prevention of Air Pollution) Regulation. All OGV visiting Hong Kong must comply with the latest IMO Standards and actions are being taken to reflect the latest standards in the Regulation. Transport and Housing Bureau will also consider amending the Regulation to expand the adoption of the direct reference approach for automatic updating of future IMO standards.

### Fair Winds Charter and fuel switch incentive scheme

From 1 January 2011, a number of shipping companies signed the two-year Fair Winds Charter to switch to a much cleaner 0.5% sulphur fuel while at berth in Hong Kong on a voluntary basis. The government applaud this effort from the shipping industry, and in response, the government launched the incentive scheme in September 2012 to reduce by half the port facilities and light dues of those OGV that switched to the cleaner fuel while at berth. The shipping companies have since renewed their commitment to switch fuel at berth for a further year till the end of 2013.

We are carrying out preparation work in relation to the proposed legislation to mandate the fuel switch for OGV at berth in Hong Kong waters. We will consider the feasibility of the proposed legislation in detail and consult the shipping trade, including the cruise industry. The Hong Kong Shipowners Association and Hong Kong Liner Shipping Association support mandatory fuel switch at berth in Hong Kong.

Figure 20 shows EPD's estimates in pollutant reductions if all OGV switch to a 0.5% diesel while at berth in Hong Kong.<sup>18</sup>

### Regional fuel switch at berth

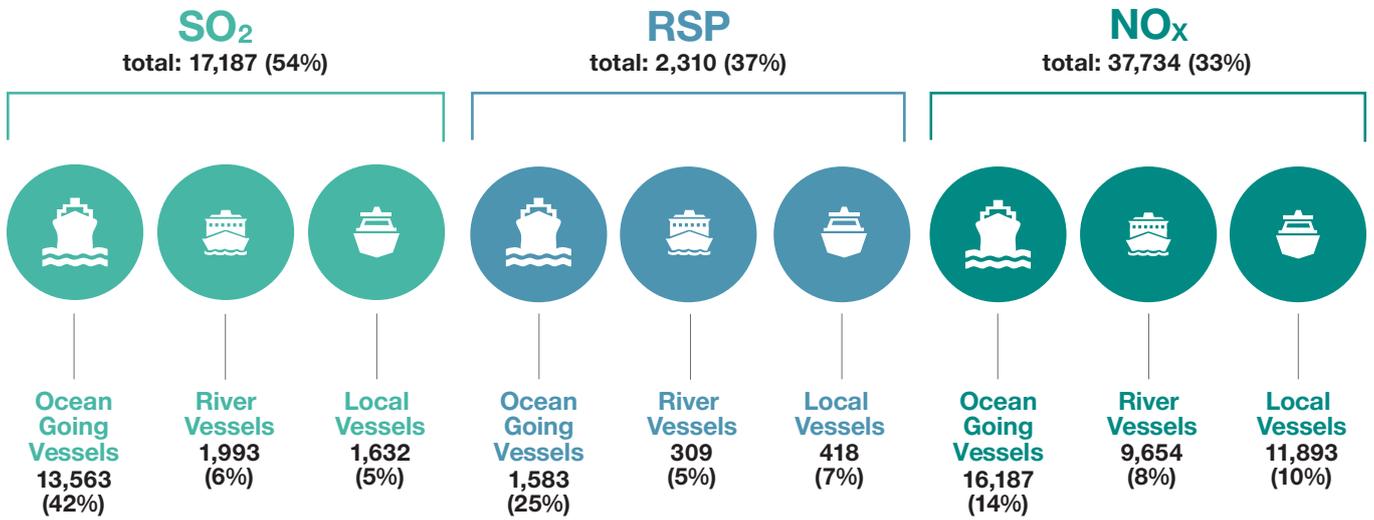
To maximise the public health and environmental benefits, we have begun discussion with relevant authorities on the feasibility of mandating fuel switch for all OGV berthed at Hong Kong and PRD ports. Such a regional initiative will have the greatest health benefit for residents in Hong Kong, Shenzhen, Dongguan, Zhongshan, Zhuhai, Macao and parts of Guangzhou who are located closest to ports and shipping activities. Indeed, Hong Kong, Shenzhen and Guangzhou are the third, fourth and seventh in ranking in terms of annual world

**FIGURE 18** Statistics of ships arriving in Hong Kong (2007-2011)

	2007	2008	2009	2010	2011
<b>OGV arrival</b>	37,150	35,850	33,157	32,645	32,490
<b>River vessel arrival</b>	188,840	181,510	172,348	179,168	172,180
<b>HK licensed vessels*</b>	13,524	13,318	14,125	14,606	15,463

\* excluding 800 government vessels

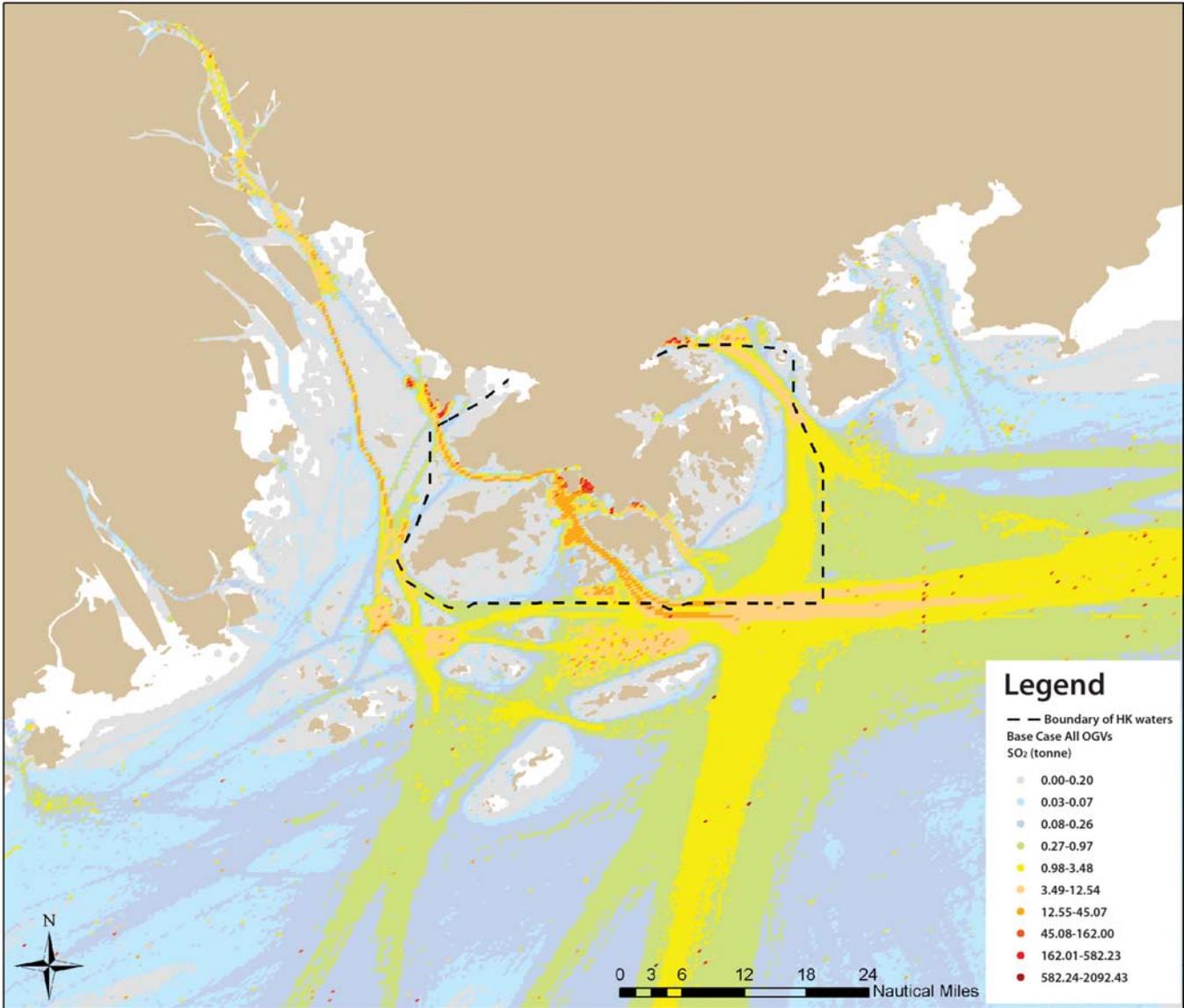
**FIGURE 19** Shipping emissions in Hong Kong in 2011



**FIGURE 20** Estimated territory emission reduction by mandating fuel switch at berth in Hong Kong  
(using 0.5% sulphur diesel with 2011 as base year)



**FIGURE 21** Spatial distribution of OGV SO<sub>2</sub> (2008)<sup>19</sup>



ranking in twenty-foot container equivalent unit (TEU), making up about 10% of global container throughput.

Longer-term, our vision is for the whole of the waters of the PRD to be designated an Emission Control Area (ECA) under the IMO, as is the case for the waters of North America and also of Northern Europe. ECA

designation requires all ships to use a 1% sulphur fuel, which will be tightened to 0.1% maximum by 2015. We believe an ECA designation will bring the highest public health benefits to the region.<sup>20</sup>

**Upgrading locally-supplied fuel**

The government will progressively upgrade the quality of locally-supplied marine light diesel. Our

immediate goal is for local vessels to switch from the currently-used marine light diesel with sulphur content of 0.5% to a cleaner diesel with sulphur content of 0.05%, which will reduce SO<sub>2</sub> emissions from these ships by about 90%.

A working group comprising representatives from EPD, Marine Department and Transport

**FIGURE 22 Emission Control Area in PRD – OGV using 0.1% sulphur diesel**  
Vessels within ECA using diesel with sulphur ≤ 0.1%

	SO <sub>2</sub>	RSP	NO <sub>x</sub>
<b>Emission reduction</b> (in tonnes) - % of OGV emissions	18,000	1,900	4,730
	96%	86%	24%
<b>Projected OGV emissions in 2020</b> (in tonnes)	18,700	2,220	19,800

Department, as well as from local marine industry has been formed to explore upgrading the quality of marine light diesel through regulation, the initial work plan has been announced in March 2013.

## Other measures

### On-shore power for cruise terminal

The Kai Tak Cruise Terminal will start operation in June 2013. The mandatory fuel switch at berth requirement will apply to cruise ships as well when legislation is passed. Moreover, the terminal has reserved space for the installation of on-shore power facilities. The government will study the design and requirements for on-shore power and seek funding from the Legislative Council for its installation at the cruise terminal so that vessels with the necessary equipment can connect to the grid to eliminate emissions at berth.

### Dark smoke from ships

To provide an objective benchmark for prosecution against excessive dark smoke emissions (mainly PM) from vessels in Hong Kong waters, Transport and Housing Bureau will propose amending the relevant

legislations to stipulate clearly that emissions that are as dark as or darker than Shade 2 on the Ringelmann Chart for 3 minutes or more will be an offence.<sup>21</sup>

### Slow steaming

Slow steaming helps to save fuel as well as reduce emissions. However, due to very busy shipping lanes in Hong Kong waters and the need for marine traffic management, speed reduction is already required in designated port and harbour areas. There may be other areas where slow steaming is possible but in some areas slow steaming may not be desirable for navigational safety. We need to consult the shipping sector, port operators and other stakeholders, including pilots, to explore feasibility from various perspectives including navigational safety, marine traffic density and cost.

### Government vessels

The government fleet of ships consists of about 800 vessels (including 114 of them with their main and auxiliary engines using Euro 5 diesel with 0.001% sulphur content). These vessels are being used for a wide range of activities

including policing, law enforcement, as well as nature conservation. EPD and Marine Department are reviewing the fleet's profile to consider how best to reduce emission, taking costs and benefits into account. Subject to findings, EPD will formulate strategies to deal with the high-polluting vessels in order to reduce their pollutant emissions, particularly NO<sub>x</sub>.

**Arthur Bowring**

Managing Director, Hong Kong Shipowners Association

“We are grateful to Government for its commitment to introduce regulation mandating fuel switch at berth, and for its further commitment to work with Beijing, Guangdong and Macao to extend shipping air emission reduction throughout the Pearl River Delta. It is through such regulation that air emissions from shipping can be significantly reduced, while maintaining fair competition within the industry.”



**Roberto Giannetta**

Secretary General Hong Kong Liner Shipping Association

“Responsibility for clean air does not fall solely on government. Rather, it is the communal duty of all. By launching the Fair Winds Charter, the shipping industry has put into action our commitment to cooperate with government and other stakeholders in addressing air quality concerns. This necessary first tough step aims to pave the way for others to follow. We remain equally supportive of mandatory legislation and clean marine emissions within the greater PRD air-shed.”

**Betty Ho**

urban planner, Hong Kong Institute of Planners

“Good town planning and urban design will contribute significantly to improving our air quality and living environment through provision of adequate green breathing spaces, facilitating natural ventilation within the urban fabric and reducing the need for vehicular traffic, etc.”



**Ir. Conrad T C Wong**

Chairman, Hong Kong Green Building Council, JP

“Hong Kong needs to be green and clean. Air quality improvement is a major task we need to tackle through various means. The Hong Kong Green Building Council is pleased to see the government making a major commitment and invest heavily in this area. We will support the government in whatever way we could. We wish to improve on our environment for our future generations.”

# **POWER PLANTS EMISSIONS ALREADY GREATLY REDUCED**

Further reduction will have to come from changing the fuel mix and better demand-side management

## 7 | Emission Control of Power Plants

In 2011, electricity generation is a major source of emission in Hong Kong, contributing 44% of SO<sub>2</sub>, 26% of NO<sub>x</sub> and 16% of PM<sub>10</sub>. The two electricity utilities operate four power plants in Hong Kong, which together meet about 77% of local electricity consumption. The remaining 23% is met by imported nuclear electricity from the Mainland under long-term contract. In 2011, coal usage made up 71% of the locally-produced electricity with the balance from natural gas.

### Technical memoranda

From November 2008 to October 2012, three technical memoranda were gazetted for tightening the emission caps for SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> among local power plants over time, with the first technical memorandum gazetted in 2008

specifying the emission allowances for the emission years from 2010, the second technical memorandum gazetted in 2010 specifying the revised emission allowances for the emission year from 2015, and the third technical memorandum gazetted in 2012 specifying the revised allowances for the emission years from 2017. In other words, the two power companies are required to increasingly reduce emissions under those technical memoranda starting from 2010. Figure 24 shows the required reduction levels, as well as the achieved levels with respect to the first technical memorandum.

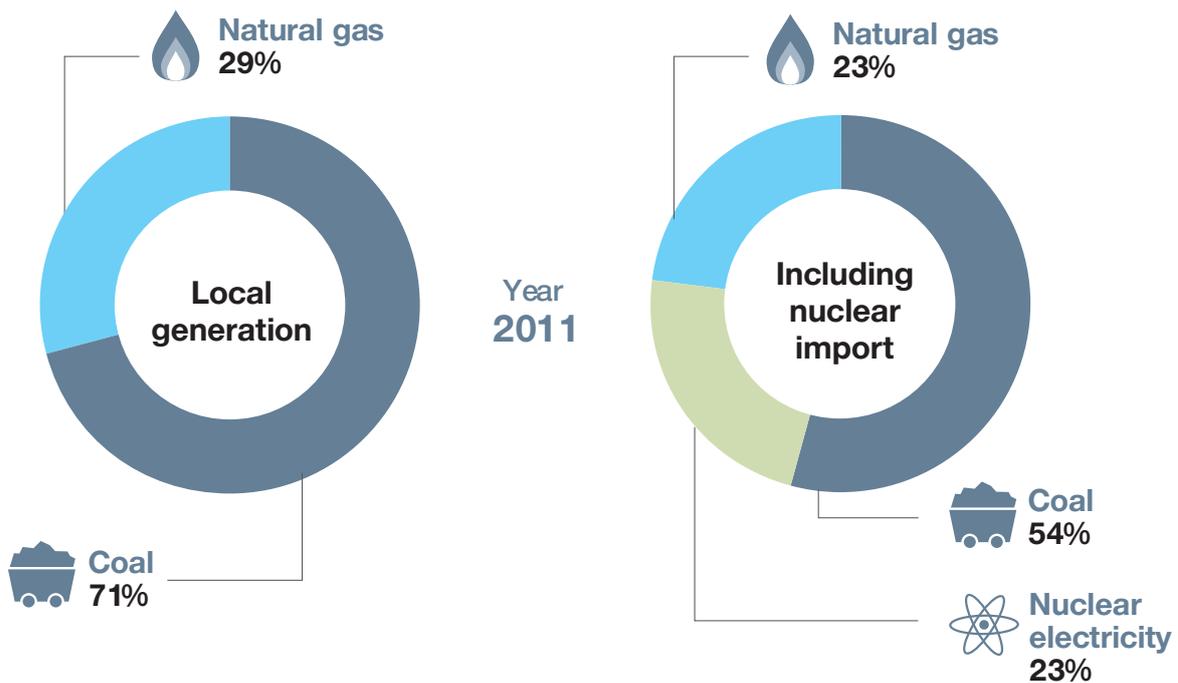
In order to meet the emission caps, the electricity companies have applied advanced technology to reduce emissions. They added flue gas desulphurisation and NO<sub>x</sub> control

equipment in recent years. They are also using low emission coals whenever possible. Further emissions reduction can be achieved through reducing the reliance on coal and switching to cleaner fuels on the supply side, as well as enhancing energy efficiency and conservation on the demand side.

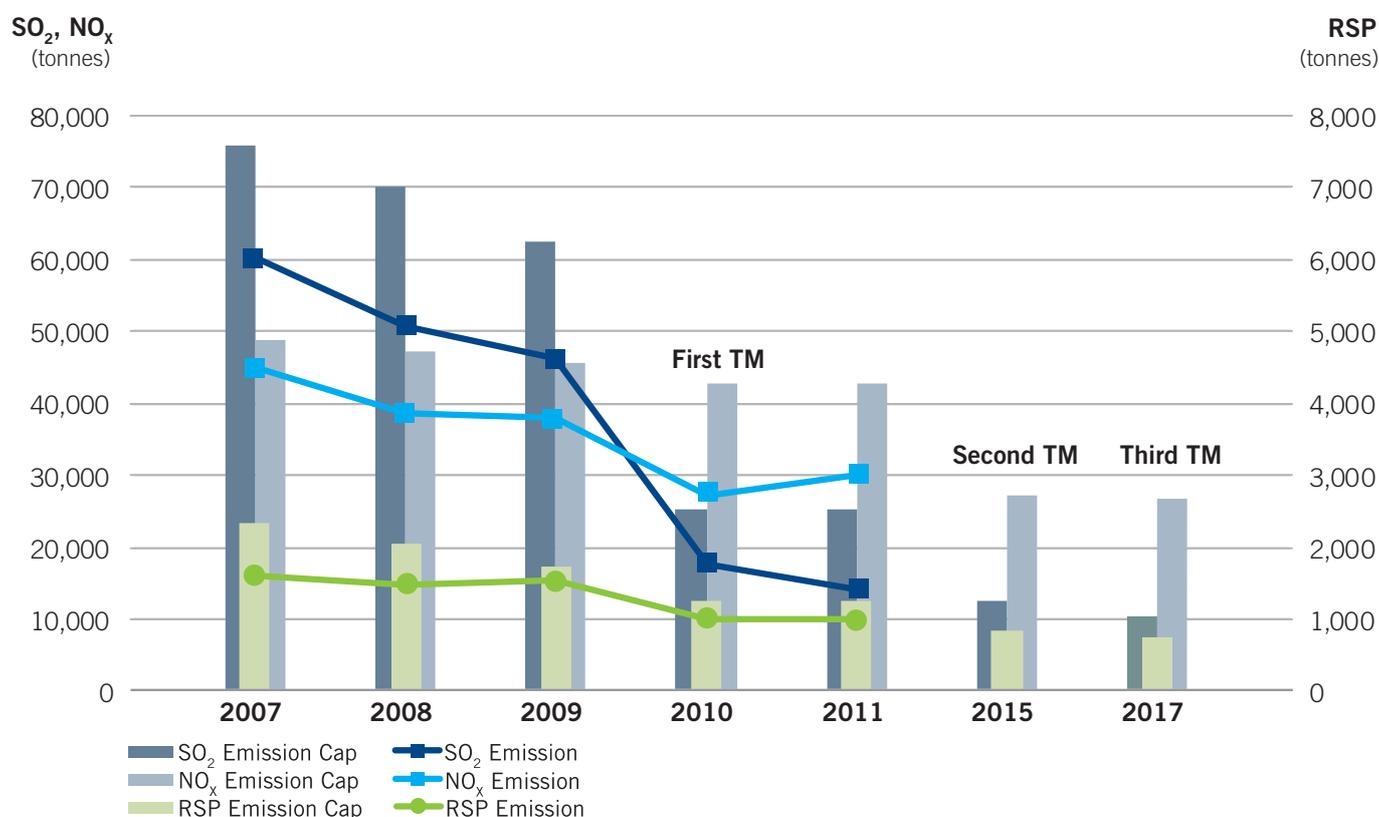
### Fuel mix change

The issue of fuel mix switching will have an impact on emissions from electricity generation. We will review the overall fuel mix, which will also provide us with a perspective in our discussion with the two power companies when the existing electricity market regulatory framework is reviewed. As this is subject to separate consultation, we will not discuss it in this paper.

**FIGURE 23** Hong Kong electricity fuel sources



**FIGURE 24** Emission caps and trend of Hong Kong's electricity sector



**Demand-side management**

Energy efficiency and conservation practices will also reduce emissions as less electricity is used. As buildings account for some 90% of the electricity consumption in Hong Kong, we will continue to promote energy efficiency in general and in buildings in particular.

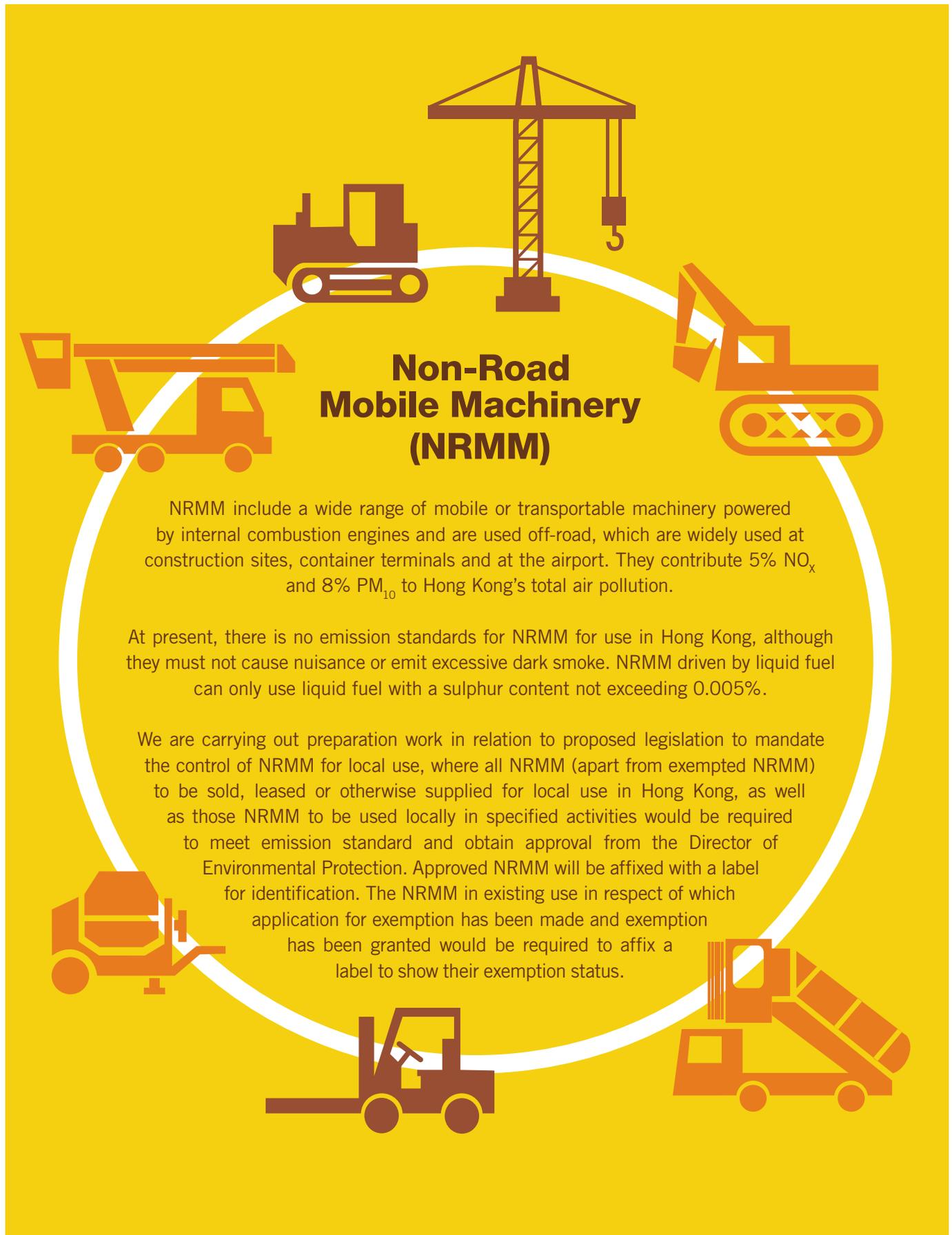
With the Buildings Energy Efficiency Ordinance already in effect, we will further review and consider tightening the relevant Building Energy Codes for building services installation. We will also promote the performance of energy and carbon audits in buildings, and the government will take the lead with its own buildings.

Our objective to maximise demand-side opportunities in both the public and private sectors will come about through improved inter-departmental coordination. As announced in the 2013 Policy Address, the Chief Executive has tasked the Secretary for the Environment to chair an inter-departmental steering committee to promote green building development in a holistic manner. Working closely with various stakeholders, the steering committee will strengthen coordination among various Bureaux and Departments in formulating implementation strategies and action plans for the promotion of green building in both the public and private sectors in Hong Kong.

**Other measures**

Other energy savings measures include incentivising consumers to save electricity through the tariff structure, reviewing the Mandatory Energy Efficiency Labelling Scheme to encourage consumers to use more energy efficient appliances, using more light-emitting diode (LED) or other energy efficient lamps for street lighting and traffic signals, phasing out the use of incandescent light bulbs, and implementing the District Cooling System at the Kai Tak Development.

## 8 | Emission Control of Non-Road Mobile Machinery (NRMM)



### Non-Road Mobile Machinery (NRMM)

NRMM include a wide range of mobile or transportable machinery powered by internal combustion engines and are used off-road, which are widely used at construction sites, container terminals and at the airport. They contribute 5%  $\text{NO}_x$  and 8%  $\text{PM}_{10}$  to Hong Kong's total air pollution.

At present, there is no emission standards for NRMM for use in Hong Kong, although they must not cause nuisance or emit excessive dark smoke. NRMM driven by liquid fuel can only use liquid fuel with a sulphur content not exceeding 0.005%.

We are carrying out preparation work in relation to proposed legislation to mandate the control of NRMM for local use, where all NRMM (apart from exempted NRMM) to be sold, leased or otherwise supplied for local use in Hong Kong, as well as those NRMM to be used locally in specified activities would be required to meet emission standard and obtain approval from the Director of Environmental Protection. Approved NRMM will be affixed with a label for identification. The NRMM in existing use in respect of which application for exemption has been made and exemption has been granted would be required to affix a label to show their exemption status.

## 9 | Conclusion

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**H**ong Kong needs to work doubly hard to improve air quality. We have many urban 'street canyons', we have a large and busy port with many shipping and trucking activities, we have an old DCV fleet, and the regional background pollution level is relatively high.

Our focus must be to reduce public health risk for local residents. The biggest health gains can be derived

The government has been investing heavily in improving air quality. In 2013-2014, the EPD will spend more than \$800 million in its air programme, accounting for a quarter of the total departmental expenditure. This is an increase of 41% over that in 2011-2012. The government has also funded various air quality improvement initiatives through revenue forgone in supporting the use of environmental-friendly vehicles and

within government, as well as with stakeholders, before new policies can be made, the public consulted, and financial resources assessed and allocated.

Beyond taking local measures, we must collaborate in research with the Guangdong authorities to better understand the complexity of our regional smog condition so as to implement more effective control measures. We are also actively exploring with our Guangdong counterparts on fuel switching at berth in PRD ports. While working across jurisdictions presents many challenges, this is a major aspect of our clean air policy going forward.

To implement new ideas, as well as to continue to conduct research and improve upon our AQM system, substantial financial resources and joint efforts must be made, and these will require public support. As ideas mature into policies, we will be bringing them to the public for deliberation and debate.

Improving air quality is a constant pursuit of this Administration. We will need the active support of stakeholders and the community to achieve the results we all wish to see.

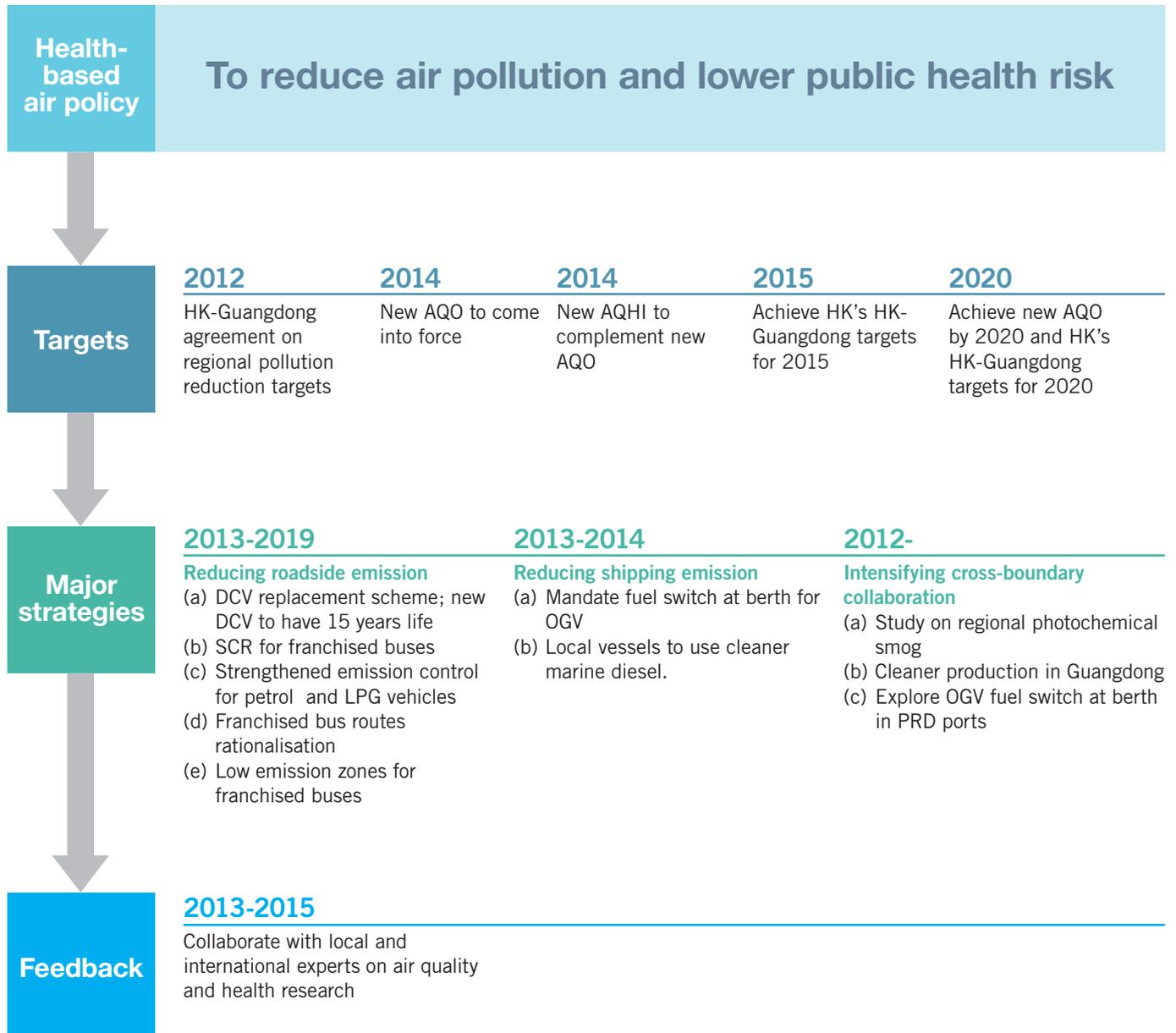
**In the longer-term, we recognize we will need to do more still but there needs to be internal discussion within government, as well as with stakeholders, before new policies can be made, the public consulted, and financial resources assessed and allocated**

from reducing roadside air emission through implementing aggressive end-of-pipe solutions (such as our DCV replacement programme), coupled with better transport management (such as rationalizing franchised bus routes, and improving vehicle testing of pollutants) and urban planning (such as creating pedestrian schemes), as well as reducing shipping emissions (through mandating fuel switch at berth).

the use of cleaner diesel. In this year's Policy Address, \$10 billion has been earmarked to support the early retirement of the pre-Euro IV diesel commercial vehicles. All these programmes underscore the importance the government attaches to air quality improvement.

In the longer-term, we recognize we will need to do more still but there needs to be internal discussion

**FIGURE 25** Timeline of Clean Air Plan



# 10 | Footnotes and abbreviations

- 1 The Pearl River Delta economic zone (PRD) is one of China's leading economic regions and a major global manufacturing centre. The zone is formed by 9 cities, namely Guangzhou, Shenzhen, Foshan, Zhuhai, Jiangmen, Zhongshan, Dongguan, four districts and counties of Huizhou and four districts and counties of Zhaoqing. Exports from the PRD make up about 25% of China's total, and this region contributes between 9%-10% of China's total GDP. The PRD is a part of Guangdong Province, which has ranked first in GDP terms in China for over 20 years, contributing 11%-12% of the national total GDP.
- 2 While it is not easy to estimate the number of factories in the PRD owned by Hong Kong companies, the number may well be in the region of 50,000.
- 3 See (a) Wong CM, McGhee SM, Yeung RYT, Thach TQ, Wong TW, Hedley AJ. Short term health impact and costs due to road traffic-related air pollution. Final Report submitted to Environmental Protection Department. Hong Kong Air Pollution and Health Joint Research Group. 2002; (b) Lai HK, Wong CM, McGhee SM, Hedley AJ. Assessment of the health impacts and economic burden arising from proposed new air quality objectives in a high pollution environment. *The Open Epidemiology*. 2011;4:106-122; and (c) Lee SL, Tinsley H, Chau J, Lai HK, Thach TQ, Ip Patrick, Chow CB, Hedley AJ. Review of air pollution and child health in Hong Kong. *HK Journal of Paediatrics* (in press).
- 4 Lai, HK, Tsang, H, Chau, J, Lee, CH, McGhee, SM, Wong, CM (2012). Health Impact Assessment of Measures to Reduce Marine Shipping Emissions, Final Report. Department of Community Medicine, School of Public Health, The University of Hong Kong.
- 5 For details, see "Air Pollutant Emission Reduction Plan up to 2020", ACE Briefing Paper 12/2012, [http://www.epd.gov.hk/epd/english/boards/advisory\\_council/files/ACE\\_Paper\\_12\\_2012.pdf](http://www.epd.gov.hk/epd/english/boards/advisory_council/files/ACE_Paper_12_2012.pdf).
- 6 For details about Hong Kong's air monitoring network, see [http://www.epd.gov.hk/epd/english/environmentinhk/air/air\\_quality/backgdf\\_2.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/air_quality/backgdf_2.html) and for the regional air monitoring network, see [http://www-app.gdpeb.gov.cn/raqi3/RAQI\\_en.htm](http://www-app.gdpeb.gov.cn/raqi3/RAQI_en.htm).
- 7 For details, see [http://www.cleanerproduction.hk/en\\_index.asp](http://www.cleanerproduction.hk/en_index.asp).
- 8 For details on the AQO, see [http://www.epd.gov.hk/epd/english/environmentinhk/air/air\\_quality\\_objectives/air\\_quality\\_objectives.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/air_quality_objectives/air_quality_objectives.html)
- 9 The new Air Quality Health Index (AQHI) reporting system is based on the recommendation of expert consultants, the report for which can be found at [http://www.epd.gov.hk/epd/english/environmentinhk/air/studyreports/air\\_studyreports.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/studyreports/air_studyreports.html). See also Paper CB(1)569/12-13(02) "Review of the Air Pollution Index Reporting System" for LegCo's Panel on Environmental Affairs for discussion on 25 February 2013, <http://www.legco.gov.hk/yr12-13/english/panels/ea/papers/ea0225cb1-569-2-e.pdf> and <http://www.legco.gov.hk/yr12-13/english/panels/ea/papers/ea0225cb1-569-3-e.pdf>.
- 10 Chief Executive Policy Address, paragraphs 135-136, 16 January 2013, and "2013 Policy Address, Policy Initiatives of Environment Bureau: Environment Protection", [http://www.epd.gov.hk/epd/english/news\\_events/legco/files/EA\\_Panel\\_20130128a\\_eng.pdf](http://www.epd.gov.hk/epd/english/news_events/legco/files/EA_Panel_20130128a_eng.pdf) issued on 16 January 2013.
- 11 The oldest batch of Euro 3 vehicles are now more than 10 years old.
- 12 There are 18,138 taxis in Hong Kong and only seven are not LPG-powered. There are 4,350 PLB, of which 66% are LPG-powered.
- 13 Chief Executive Policy Address, paragraph 139, 16 January 2013, and Paper CB(1)409/12-13(03) "Policy Address 2013: Transport-related Policy Initiatives of the Transport and Housing Bureau", <http://www.legco.gov.hk/yr12-13/english/panels/tp/papers/tp0118cb1-409-3-e.pdf>.
- 14 Chief Executive Policy Address, paragraph 177, 16 January 2013, and Paper CB(1)409/12-13(03) "Policy Address 2013: Transport-related Policy Initiatives of the Transport and Housing Bureau", <http://www.legco.gov.hk/yr12-13/english/panels/tp/papers/tp0118cb1-409-3-e.pdf>; and a three-month public consultation on the Proposed Measures to Improve the Traffic Distribution among the Road Harbour Crossings has commenced on 8 February 2013, see [http://www.thb.gov.hk/eng/policy/transport/policy/consultation/RHC\\_consultation\\_2013.eng.pdf](http://www.thb.gov.hk/eng/policy/transport/policy/consultation/RHC_consultation_2013.eng.pdf).
- 15 For the Pilot Green Transport Fund, see [http://www.epd.gov.hk/epd/english/environmentinhk/air/prob\\_solutions/pilot\\_green\\_transport\\_fund.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/pilot_green_transport_fund.html).
- 16 For tax incentives for environment-friendly vehicles in Hong Kong, see [http://www.epd.gov.hk/epd/english/environmentinhk/air/prob\\_solutions/environment\\_friendly\\_private\\_cars.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/environment_friendly_private_cars.html) for private cars and [http://www.epd.gov.hk/epd/english/environmentinhk/air/prob\\_solutions/environment\\_friendly\\_commercial\\_vehicles.html](http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/environment_friendly_commercial_vehicles.html) for commercial vehicles.
- 17 River trade vessels are mainly registered in the Mainland, and local vessels include ferries, pleasure vessels and locally-licensed fishing vessels.
- 18 If fuel quality was 0.1% sulphur, the reductions are estimated to be SO<sub>2</sub> 16%, RSP 7% and NO<sub>x</sub> 0.2%.
- 19 This image is taken from "A Price Worth Paying: The Case for Controlling Marine Emissions in the Pearl River Delta", published by Civic Exchange, September 2012, [http://dl.dropbox.com/u/2439304/civicexchange/201209/PriceWorthPaying\\_en.pdf](http://dl.dropbox.com/u/2439304/civicexchange/201209/PriceWorthPaying_en.pdf).
- 20 Ibid.
- 21 In 1897, Maximilien Ringlemann developed a simple set of grids for measuring the density of smoke, which has since been called the Ringlemann scale/chart and is still in use today.

API	Air Pollution Index	NO <sub>x</sub>	Nitrogen oxides
AQHI	Air Quality Health Index	NRMM	Non-road mobile machinery
AQM	Air quality management	O <sub>3</sub>	Ozone
AQO	Air Quality Objectives	OGV	Ocean-going vessels
CO	Carbon monoxide	Pb	Lead
DCV	Diesel commercial vehicles	PLB	Public light buses
DPF	Diesel particulate filters	PM	Particulate matter
ECA	Emission Control Area	PM <sub>2.5</sub>	Particulate matter less than or equal to 2.5 micrometers in diameter
EKE	Energizing Kowloon East	PM <sub>10</sub>	Particulate matter less than or equal to 10 micrometers in diameter
EPD	Environmental Protection Department	PRD	Pearl River Delta
EV	Electric vehicles	PRDEZ	Pearl River Delta Economic Zone
FRT	First Registration Tax	RSP	Respirable suspended particulates
IMO	International Maritime Organisation	SCR	Selective catalytic reduction devices
LEZ	Low emission zones	SO <sub>2</sub>	Sulphur dioxide
LED	Light-emitting diode	TEU	Twenty-foot container equivalent unit
LPG	Liquefied petroleum gas	WHO	World Health Organisation
MTR	Mass Transit Railway	WHO AQG	World Health Organisation Air Quality Guidelines
NO	Nitric oxide	VOC	Volatile organic compound
NO <sub>2</sub>	Nitrogen dioxide		