June 2021

CLEAN AIR PLAN for Hong Kong 2035

環境局
Environment Bureau

運輸及房屋局
Transport and Housing Bureau

食物及衞生局
Food and Health Bureau

發展局
Development Bureau

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Message from the Secretary for the Environment

To devise a comprehensive plan to improve the air quality, the Government launched the first *Clean Air Plan for Hong Kong* in 2013, which summarised the challenges of improving air quality in Hong Kong and introduced relevant policies and measures. A progress report was published in 2017. In the past few years, the Government continued to make steady progress, including the launch of the first *Hong Kong Roadmap on Popularisation of Electric Vehicles* in March this year. The Roadmap set out the Government's various policies, measures and plans to promote adoption of electric vehicles and put forward the goal of zero vehicular emissions before 2050.

In view of the challenges brought by climate change, it has become a global trend to explore the use of the latest green technologies to reduce carbon emissions. Environmental protection policies have also taken into account Hong Kong's transformation to a low-carbon city, in order to achieve carbon neutrality before 2050. In this connection, the Government has suitably considered the integration of long-term decarbonisation strategies in the *Clean Air Plan for Hong Kong 2035,* so as to improve Hong Kong's air quality while facilitating the attainment of carbon neutrality.

Improving the air quality is a challenging task that requires sustained effort. We are looking forward to working closely with the Guangdong-Hong Kong-Macao Greater Bay Area and various sectors of the community to implement policies and measures under the *Clean Air Plan for Hong Kong 2035*, with a view to enabling the general public to enjoy cleaner air and supporting Hong Kong to become an international metropolis and a smart city that is more environmentally friendly, liveable, and low-carbon, thus realising the vision of **"Healthy Living • Low-carbon Transformation • World Class"**.

Wong Kam-sing
Secretary for the Environment
June 2021

Summary of the Clean Air Plan for Hong Kong 2035

Vision

Healthy Living | **Low-carbon Transformation** | **World Class**

Target

BY 2035 Become a liveable city with air quality on par with major international cities

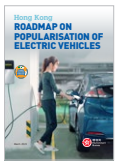
ULTIMATE GOAL Air quality to fully meet the ultimate targets under the Air Quality Guidelines of the World Health Organization

Six Major Areas of Action

Green Transport

EV Roadmap

Take forward measures set forth in the **Hong Kong Roadmap on Popularisation of Electric Vehicles** to attain zero vehicular emissions before 2050



Environmentally Friendly New Development Areas

Adopt environmentally friendly transport mode in new development areas

Green Transport Network

Expand railway network to meet development needs; and implement Free-flow Tolling System at government toll tunnels and Tsing Sha Control Area by 2022

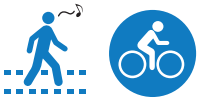
New Energy Ferries

Conduct trials for electric and hybrid ferries, and explore with ferry operators to progressively adopt new energy ferries by 2035

Liveable Environment

City Planning

Pedestrian-friendly and bicycle-friendly policies



Update professional practice notes to enhance air quality at public transport interchanges

Health Information

Update Air Quality Health Index

Embark on a research for the long term health impact of air pollution on the Hong Kong population

Comprehensive Emissions Reduction

Vehicular Emissions

Continue phasing out old diesel commercial vehicles

Subsidise franchised bus companies to conduct trials for emission reduction devices

Vessel Emissions

Explore to further tighten the sulphur content limit of locally supplied marine fuels to 0.001%, and impose emission standards for new petrol-powered outboard engines

Volatile Organic Compounds (VOCs)

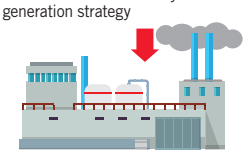
Tighten the VOC content limits of architectural paints before 2024 and extend the control to cleaning products

Clean Energy

Power Plant Emissions Reduction

New low-carbon electricity generation strategy under **Hong Kong's Climate Action Plan**

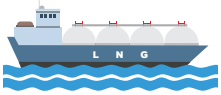
Continue to formulate Technical Memorandums to tighten emission limits of power plants under the new low-carbon electricity generation strategy



Green Energy

Inter-departmental working group to handle the work relating to the application of hydrogen energy in Hong Kong

Explore means to take forward the use of liquefied natural gas (LNG) in ocean-going vessels, and formulate technical requirements and related safety regulations and specifications for LNG bunkering in the next few years



Scientific Management

Information Dissemination

Develop a smart air quality monitoring system with integration of the Internet of Things, artificial intelligence, sensors and numerical models to provide more detailed district-based air quality information to the public

Advanced Monitoring

Adopt innovative instruments to monitor and analyse air pollutants in real time

Conduct district-based air quality monitoring to identify pollution distributions

Apply mini-sensors to monitor ambient and indoor air quality

Regional Collaboration

Regional Targets

Formulate regional emissions reduction targets for 2025 and 2030 with the Guangdong Province

Regional Monitoring and Analysis

Set up 5 monitoring sites for 3D air quality monitoring with LIDAR technology

Knowledge Exchange

Encourage exchanges among academics and talents in the Greater Bay Area to enhance technical standards

Integrate real-time VOC monitoring and conduct ozone pollution research to better understand ozone characteristics and formation

1 Vision

1.1. Air quality is closely connected to public health, and is one of the key factors for improving a city's living quality. We hope to create an environment with cleaner air to safeguard the public health, and at the same time work closely with other cities in the Greater Bay Area. With the good use of various innovative technologies and the synergies generated by our commitment to attaining carbon neutrality before 2050, Hong Kong will develop into a low-carbon and liveable city, realising the vision of **"Healthy Living • Low-carbon Transformation • World Class"**.

1.2. Policies on air quality improvement need to target at various pollution sources. In the past, the Government has implemented a series of measures on the basis of scientific measurements and assessments which have vastly reduced air pollutant emissions from road transport, marine transport and electricity generation. Coupled with our active collaboration with regions nearby, the local air quality has substantially improved in the past two decades. The concentrations of various major air pollutants recorded by our general air quality monitoring stations have dropped by 40-80% compared to their peak.

1.3. To relentlessly enhance the air quality and safeguard the public health, the Government has set out Hong Kong's Air Quality Objectives (AQOs), benchmarking against the Air Quality Guidelines (AQGs) of the World Health Organization (WHO). The Government reviews the AQOs every 5 years and has progressively tightened the AQOs according to WHO's AQGs where practicable. At present, half of the 12 AQOs have already adopted the ultimate targets of the WHO's AQGs.

Air Quality Guidelines of the World Health Organization

The AQGs promulgated by the WHO target 7 key air pollutants (including sulphur dioxide, respirable suspended particulates (PM_{10}), fine suspended particulates ($PM_{2.5}$), nitrogen dioxide, ozone, carbon monoxide and lead), and set out a set of interim and ultimate targets for these pollutants' short and/or long-term concentrations. Governments around the globe could, taking into account their local circumstances, adopt various interim targets for gradual improvement of air quality, with a view to advancing progressively towards the ultimate targets.

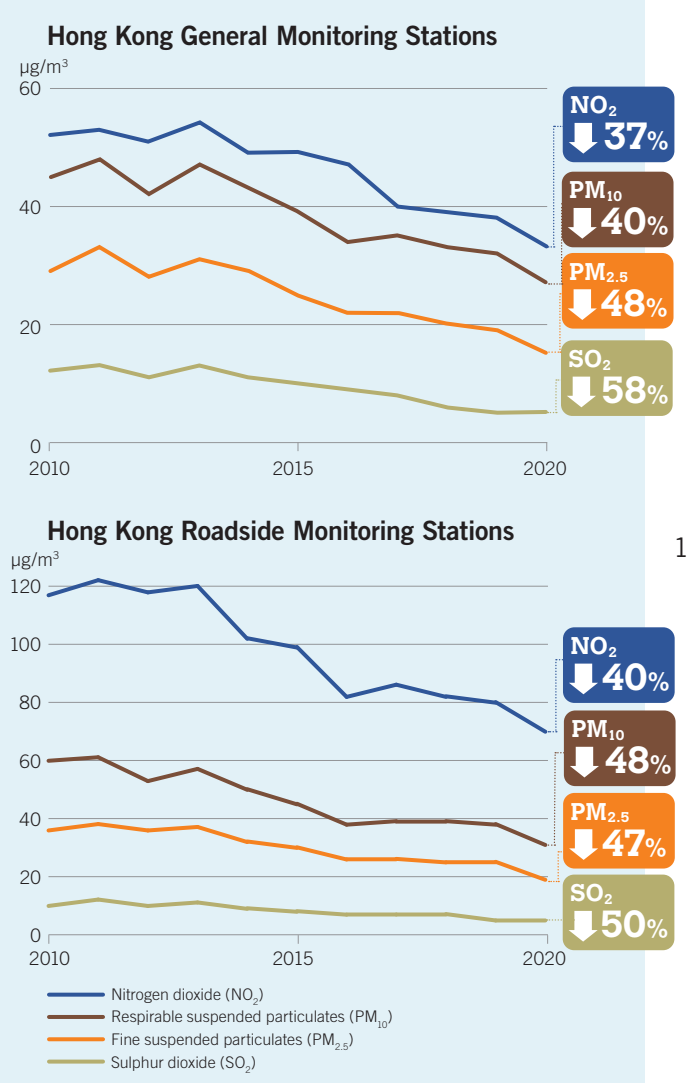
As the economic activities and meteorological environment vary from one place to another, the nature and formation of air pollution are different. The ultimate targets of AQGs are stringent, and currently, no country has fully adopted them as its statutory air quality standards.

Figure 1.1 WHO's AQGs and Hong Kong's AQOs

Pollutant	Averaging time	Average concentration targets of the WHO's AQGs (μg/m³)				No. of exceedance allowed in a calendar year
		Interim target-1	Interim target-2	Interim target-3	Ultimate target	
Sulphur dioxide (SO_2)	10 minutes	-	-	-	500	3
	24 hours	125	50	-	20	3
Respirable suspended particulates (PM_{10})	Annual	70	50	30	20	Not applicable
	24 hours	150	100	75	50	9
Fine suspended particulates ($PM_{2.5}$)	Annual	35	25	15	10	Not applicable
	24 hours	75	50	37.5	25	35
Nitrogen dioxide (NO_2)	Annual	-	-	-	40	Not applicable
	1 hour	-	-	-	200	18
Ozone (O_3)	8 hours	160	-	-	100	9
Carbon monoxide (CO)	1 hour	-	-	-	30 000	0
	8 hours	-	-	-	10 000	0
Lead (Pb)	Annual	-	-	-	0.5	Not applicable

New AQOs to be effective on 1 January 2022

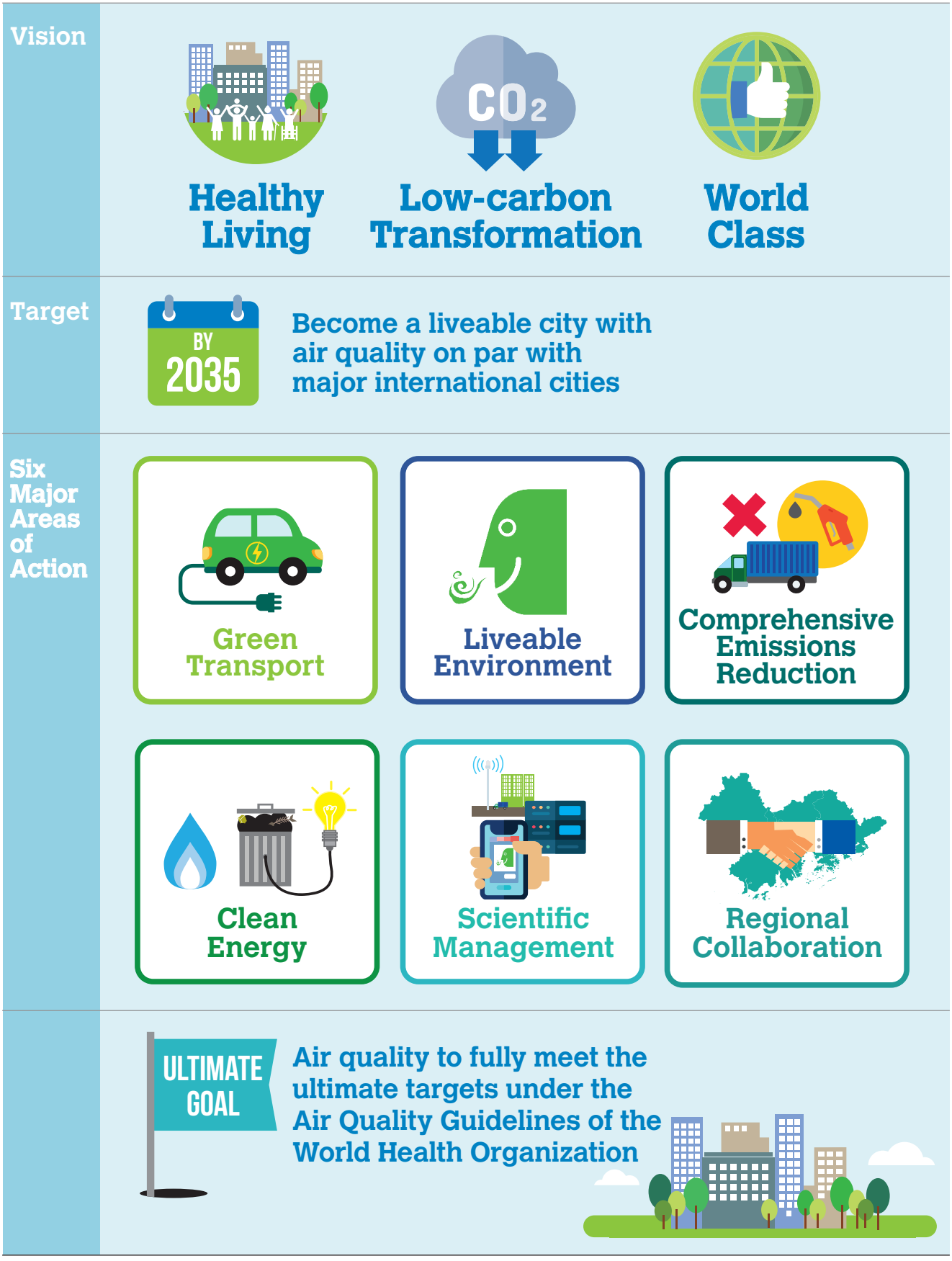
Figure 1.2 Air Quality Improvements (2010-2020)



1.4. The current concentrations of PM_{10}, $PM_{2.5}$ and NO_2 in Hong Kong remain at high levels, and ozone levels are also trending upwards due to the influence of regional photochemical smog. To further improve Hong Kong's air quality, the Government has formulated a comprehensive set of strategies. On one hand, we will implement a series of initiatives to continue reducing air pollutant emissions from road transport, marine transport and power plants, etc. On the other hand, we will promote research and adoption of innovative technologies, and develop a healthy urban lifestyle to boost low-carbon transformation. Besides, it is imminent to reduce regional emissions of air pollutants. In this connection, we will continue our efforts to work closely with other cities in the Greater Bay Area in research and measure implementation.

1.5. Against the above, we have formulated 6 major areas of action. We aim to **improve Hong Kong's air quality to a level on par with major international cities before 2035**, thus improving the quality of life and the public health. Our ultimate goal, in the long run, is for Hong Kong's air quality to fully meet the ultimate targets under the WHO's AQGs.

Figure 1.3 Vision and Target



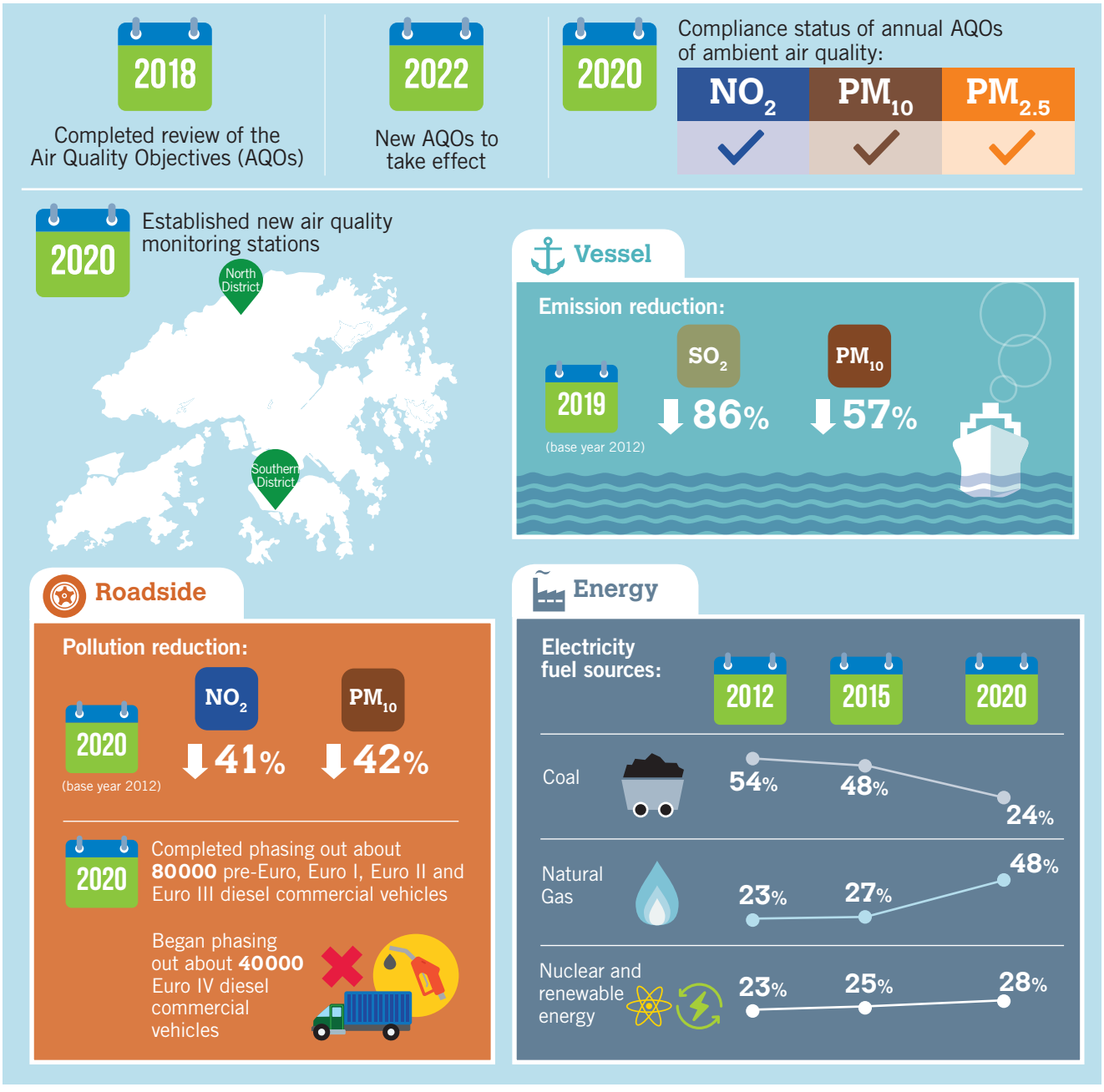
2 Progress and Challenges

Major Work Progress

2.1. The Government published the first *Clean Air Plan for Hong Kong* in 2013, outlining a series of policy directions and measures to tackle air pollution from major emission sources including vehicles, vessels and power plants, etc. The Government has also been determined to strengthen collaboration with the Mainland authorities to improve regional air quality. Subsequently, the Government published a progress report in 2017.

2.2. Since the release of the first *Clean Air Plan for Hong Kong*, the Government has taken a multi-pronged approach to implement various air quality improvement measures according to the policy directions set in the Plan, and has achieved the targets. The major progress is summarised as follows:

Achievements



Vehicular Emissions

1	**Phase out aged diesel commercial vehicles (DCVs)**	Implemented an $11.4 billion ex-gratia payment scheme to phase out pre-Euro IV (i.e. pre-Euro, Euro I, Euro II and Euro III) DCVs in phases between 2014 and 2020; and has launched a $7.1 billion ex-gratia payment scheme to phase out Euro IV DCVs. **Number of pre-Euro IV DCVs phased out: 80000** **Service life limit of new DCVs registered after February 2014: 15 years** 
2	**Control emissions from in-use vehicles**	Implemented a remote sensing programme to control emissions from petrol and liquefied petroleum gas (LPG) vehicles, and a smoky vehicle control programme to control emissions from diesel vehicles. We issue Emission Testing Notices to owners of vehicles with excessive emissions, requiring them to rectify the problem and pass a smoke test within 12 working days. **Number of Emission Testing Notices issued in the past 10 years: over 60 000**  
3	**Tax incentives for environmentally friendly vehicles**	Having provided first registration tax (FRT) concessions to environmentally friendly commercial vehicles with lower emissions since April 2008. Such vehicles include taxis, light buses, buses, goods vehicles, etc. **Tax concessions offered since implementation: about $2 billion**
4	**Tighten emission standards for first registered vehicles**	Tighten emission standards for first registered vehicles continuously. Current emission standards are: **Petrol private cars, taxis, light buses, buses and goods vehicles: Euro VI** **Diesel private cars: California LEV III** **Motorcycles: Euro IV**
5	**Subsidise installation of emission reduction devices**	Provided about $280 million of subsidy to retrofit or replace emission reduction devices. Covered over 1 000 franchised buses, as well as around 14 000 and 2 900 LPG taxis and light buses respectively.
6	**Set up franchised bus low emission zones**	Set up franchised bus low emission zones in 3 busy corridors in Causeway Bay, Central and Mong Kok in 2015. At present, franchised bus companies are required to deploy buses meeting Euro V or above emission standards to the above road sections.

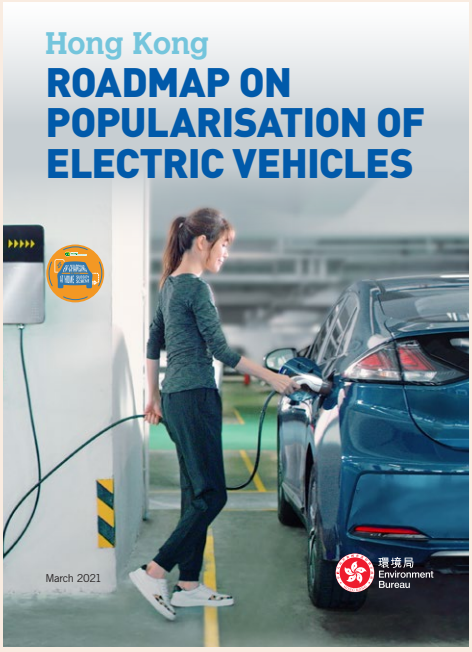
New Energy Vehicles

1 Roadmap on Popularisation of Electric Vehicles

The Government announced the first *Hong Kong Roadmap on Popularisation of Electric Vehicles* in March 2021, putting forward the vision of **"Zero Carbon Emissions • Clean Air • Smart City"**. The Roadmap set out the long-term policy objectives and plans to promote adoption of electric vehicles (EVs), in order to achieve the goal of zero vehicular emissions before 2050.

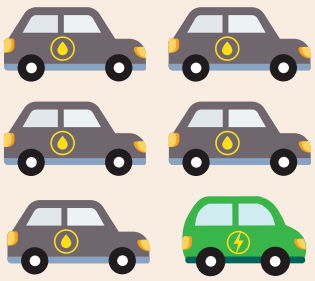
Key measures under the Roadmap include:

- No new registration of fuel-propelled private cars including hybrid vehicles from 2035 or earlier;
- Trials for electric public transport and commercial vehicles, with a view to formulating a concrete way forward and timetable around 2025;
- Expansion of the EV charging network and promote its marketisation;
- Training for EV technicians;
- Formulation of a producer responsibility scheme for retired EV batteries;
- Establishment of a task force to examine the high-end development of new decarbonisation technology globally; and
- A review of the Roadmap around every 5 years.

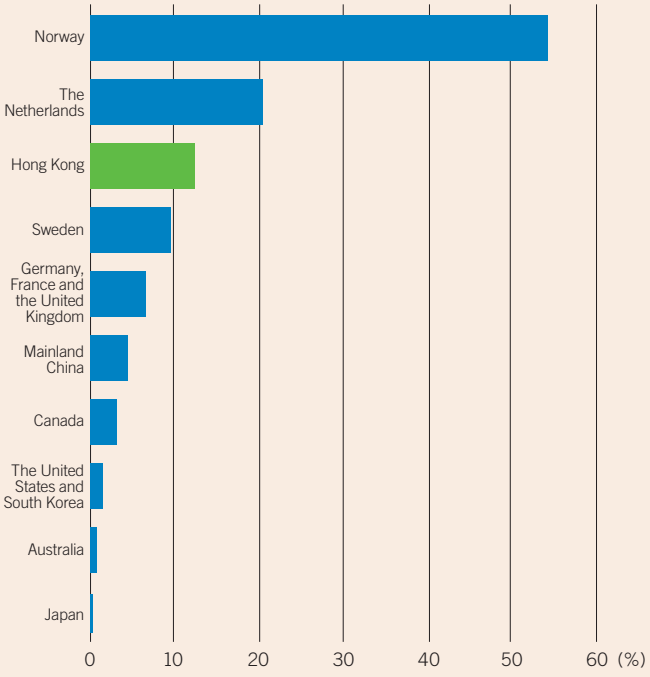


Electric vehicle adoption

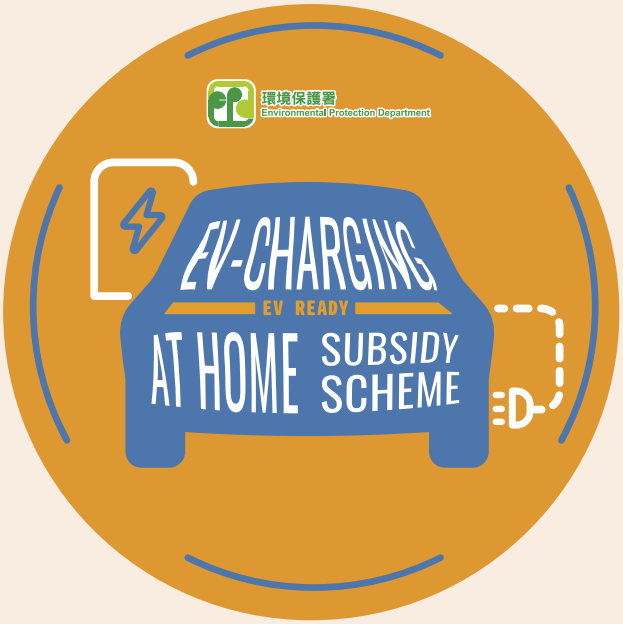
In the first 5 months of 2021, the proportion of electric private cars in newly registered private cars has further increased from 12.4% in 2020 to 18.4%, representing that more than 1 out of every 6 new private cars is electric.



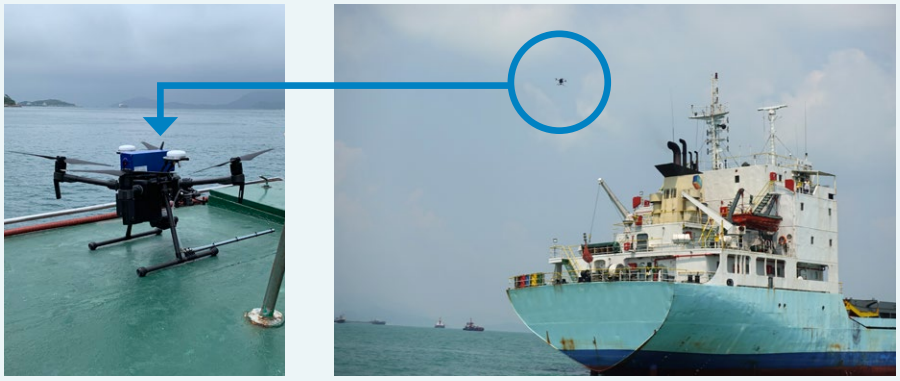
Market share of electric cars in new car sale in major economies in 2020



New Energy Vehicles (continued)

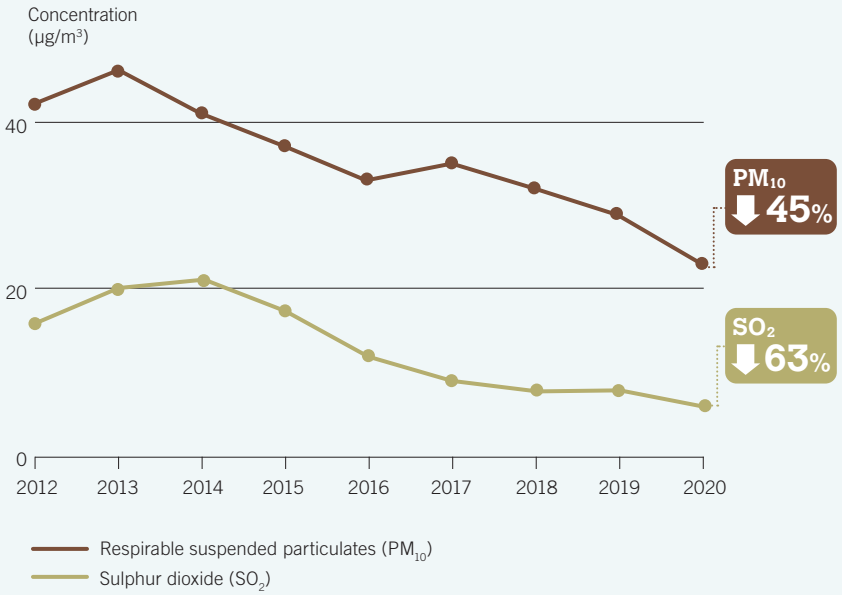
2	**Tax concessions for EVs and "One-for-One Replacement" Scheme**	Extended FRT concessions for EVs to March 2024. Private car owner who replaces his old car with an electric private car can enjoy a higher tax concession under the "One-for-One Replacement" Scheme, addressing the concern about the growing total number of private cars. **Proportion of new electric private cars participating in the "One-for-One Replacement" Scheme: 91%** **Tax concessions offered since 2015: Over $8.4 billion**
3	**EV-Charging at Home Subsidy Scheme**	Launched the $2 billion "EV-Charging at Home Subsidy Scheme" in October 2020 to subsidise installation of EV charging infrastructure in car parks of existing private residential buildings, aiming to cover 60 000 parking spaces in 3 years. **Since implementation of the scheme:** **Received over 440 applications, covering nearly 100 000 parking spaces** The power companies have assessed all applications and certified that the existing power supply of these car parks can support the installation of EV charging infrastructure. 
4	**New Energy Transport Fund**	Used the $1.1 billion New Energy Transport Fund (formerly named Pilot Green Transport Fund) to subsidise trial and application of various green innovative commercial transport technologies. Modes of transport covered include goods vehicles, taxis, light buses, buses, vessels, motorcycles, non-road vehicles, etc. **Number of trials approved since the inception of the Fund: 230**

Vessel Emissions

1	Marine emission control area	Hong Kong being the first port in Asia to mandate ocean-going vessels to switch to low sulphur fuel while at berth. The Governments of Hong Kong and the Guangdong Province then jointly established a Domestic Emission Control Area in the waters of the Pearl River Delta Region in 2019, and further tightened requirements for all vessels to use compliant fuel (i.e. low sulphur fuel with sulphur content not exceeding 0.5% or liquefied natural gas (LNG)), both in sailing or at berth.
2	Control of locally supplied marine light diesel	Imposed a statutory cap of 0.05% on sulphur content of locally supplied marine light diesel under the Air Pollution Control (Marine Light Diesel) Regulation (Cap. 311Y) in 2014.
3	Use of drones to enhance enforcement efficiency	Have made use of drones to monitor vessel emissions in real time since 2020. Together with computer analysis of sulphur content of vessel fuel, enforcement officers can take effective actions against vessels that are suspected of breaching relevant regulation. 

Improvement of coastal air quality

Reduction in vessel emissions has led to significant improvement in coastal air quality. Making reference to the Kwai Chung air quality monitoring station, which is located in the vicinity of container terminals, the reduction of annual average concentrations of sulphur dioxide (SO_2) and respirable suspended particulates (PM_{10}) recorded between 2012 and 2020 was as illustrated:

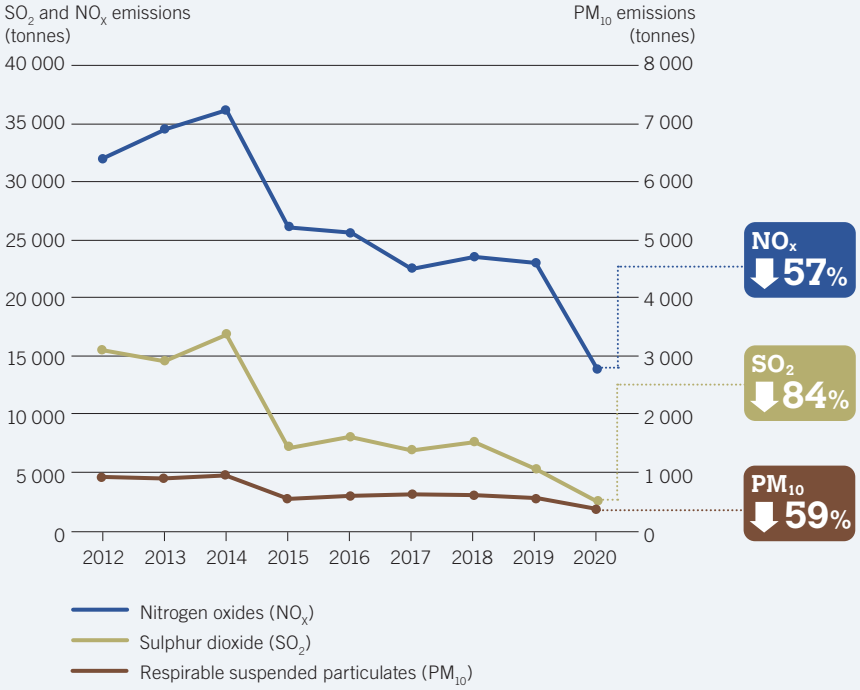


Public Electricity Generation

1	**Elimination of coal-fired power generation**	The proportion of coal in the fuel mix decreased from about half in 2015 to less than a quarter in 2020. Expect that the existing coal-fired generating units will no longer be used for day-to-day electricity generation in the 2030s due to replacement by natural gas-fired units and non-fossil fuel energy sources.
2	**Tightening of emission caps**	Technical Memoranda (TMs) regularly issued by the Government since 2008 to progressively tighten the emission caps of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and respirable suspended particulates (PM_{10}) for power plants. The ninth TM has been issued in 2021. Compared with the first TM, the ninth one further reduced the emission caps of SO_2, NO_x and PM_{10} by 89%, 74% and 71% respectively.
3	**Offshore LNG Terminal**	An offshore LNG terminal is being constructed jointly by the two power companies to supply natural gas to the power plants in Lung Kwu Tan and Lamma Island, enhancing diversity and security of gas supply. The terminal is expected to commence operation in 2022. 

Progress of emission reduction from power plants

Emissions from power plants between 2012 and 2020



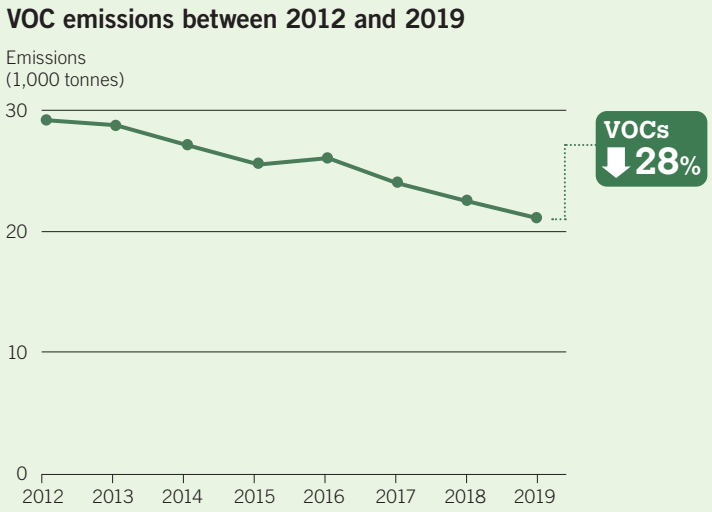
Other Measures

1 Control on products with volatile organic compounds (VOCs)

VOC emissions in Hong Kong are mainly from products commonly used in everyday life, such as air fresheners, hair sprays, insecticides, printing inks and paints, etc.

To control VOC emissions, the Government has been regulating the VOC content of a variety of products in phases since 2007. There are currently 172 types of regulated products.

Progress of VOC emission reduction



2 Indoor air quality

Updated the Indoor Air Quality Objectives under the "Indoor Air Quality Certification Scheme for Offices and Public Places" in 2019, to further enhance indoor air quality standards. The Government also plans to provide guidelines to schools and elderly homes in 2022 to continue promoting proper indoor air quality management.

3 Provision of real-time pollution information

Supported a local university to develop the "Personalised Real-Time Air Quality Information System for Exposure – Hong Kong" ("PRAISE-HK"), which combines sensor technologies, big data, air quality monitoring systems and relevant scientific data to analyse and forecast air quality in Hong Kong to street level. The system also provides personalised real-time air quality information to the public. The mobile app of PRAISE-HK was launched in June 2019.

PRAISE HK

(Provided by the Hong Kong University of Science and Technology (HKUST))

4 Supersite at Cape D'Aguilar

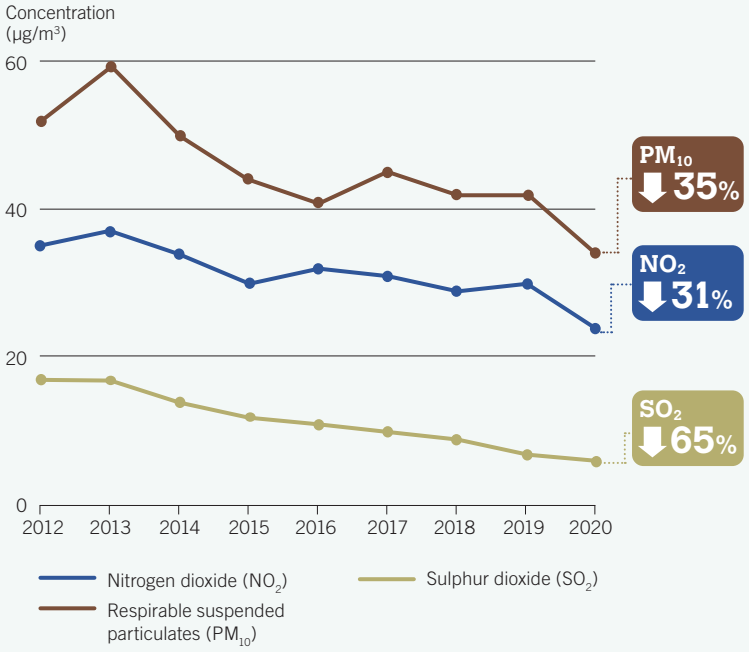
Set up the first super air quality monitoring station (the "Supersite") in Cape D'Aguilar in 2017. Apart from monitoring key air pollutants like other general monitoring stations, the Supersite is equipped with more advanced instruments to measure and collect real-time data of VOCs, gases and ions that may form fine particles, particles less than one micron (i.e. PM_1), black carbon, etc. for scientific studies. At the south-eastern tip of Hong Kong, Cape D'Aguilar is generally exposed to regional air. Hence, the data collected at the Supersite will also be used for regional joint studies.

Regional Emission Reduction

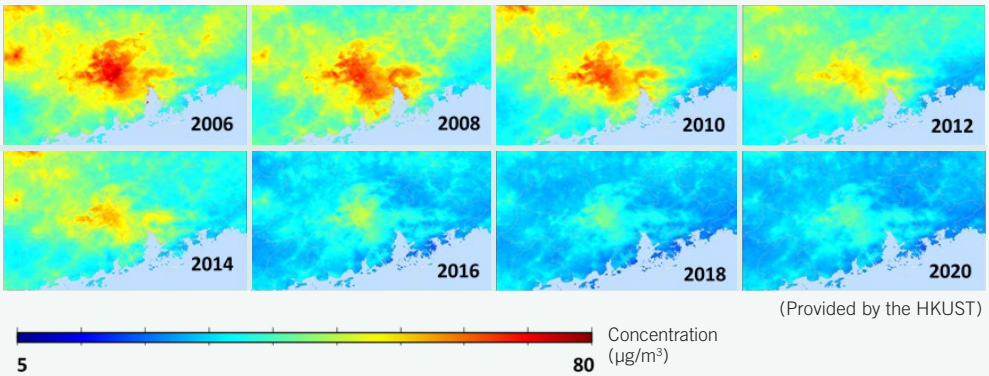
1	Regional cooperation framework	Hong Kong and the Guangdong Province established in 2000 the Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection, co-chaired by Hong Kong's Secretary for the Environment and the Guangdong Province's Director-General of the Department of Environmental Protection. There has been cooperation on multiple fronts to improve air quality by mainly reducing air pollutant emissions from power plants, vehicles, vessels and heavily polluting industrial processes.
2	Formulation of regional emission reduction targets	The Hong Kong and Guangdong Governments have been jointly setting a number of 5-year targets for air pollutant reduction and have generally met all targets. The two sides are reviewing the progress of reducing air pollutant emissions in 2020. Based on a preliminary assessment, both sides have achieved the 2020 targets.
3	Regional monitoring network	The Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network came into operation in end-2005. The network currently consists 23 air quality monitoring stations that collect regional air quality data, as well as monitor and assess the effectiveness of air quality improvement measures.

Progress

Improvements in air pollutant concentrations recorded by the regional monitoring network between 2012 and 2020



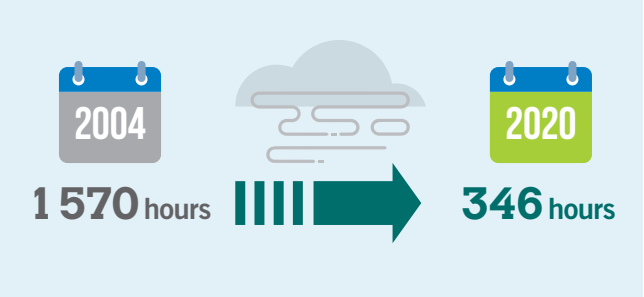
Improvement of fine suspended particulates ($PM_{2.5}$) concentration in the Pearl River Delta Region between 2006 and 2020



(Provided by the HKUST)

2.3. After the implementation of the above measures targeting various pollution sources, Hong Kong's air quality has been steadily improving, creating a healthier and more liveable environment for the public. The number of hours of reduced visibility recorded in Hong Kong has dropped from over 1 500 hours in 2004 to less than 350 hours in 2020, showing a reduction of nearly 80%.

Figure 2.1 Number of hours of reduced visibility in 2004 and 2020

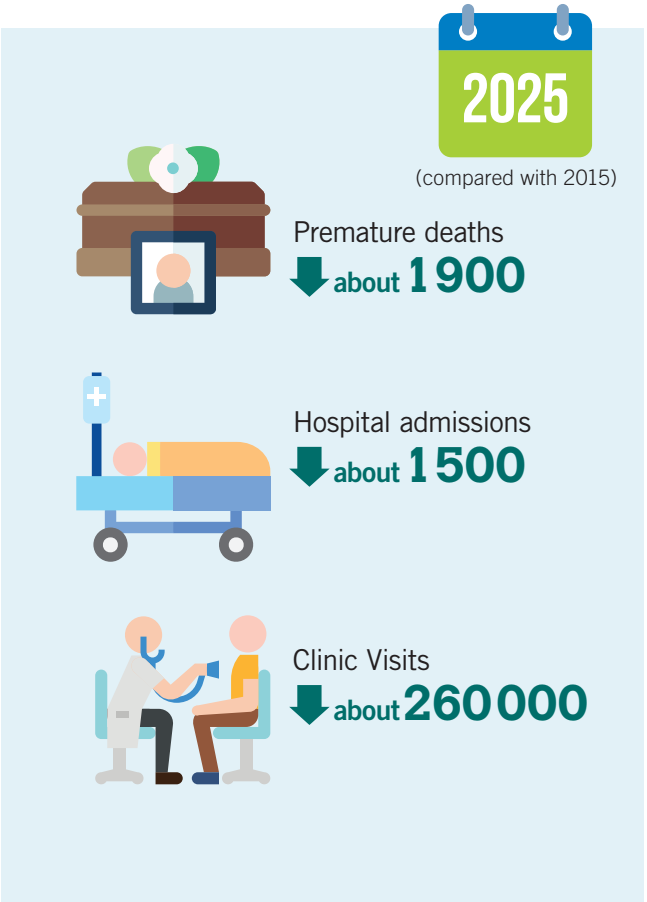


2.4. The Environmental Protection Department launched the Air Quality Health Index (AQHI) in December 2013 to inform the public of the short-term health risk and information associated with the concentrations of major air pollutants. The AQHI is divided into 5 health risk categories: low, moderate, high, very high, and serious. Compared with the data in 2014 when the AQHI was first launched, the number of days with low health risk recorded at general air quality monitoring stations has nearly doubled in 2020, while such number of days recorded at roadside monitoring stations has also significantly increased from 1 to 85 days. It is evident that health risk brought by air pollution to the public are being mitigated significantly.

空氣質素健康指數
Air Quality Health Index

2.5. Local experts also estimate that the number of premature deaths associated with long-term exposure to air pollutants in 2025 will be reduced by about 1 900 cases compared with 2015. About 1 500 hospital admissions and 260 000 clinical visits will also be saved. This will sustainably reduce Hong Kong's medical expenditure and indirectly contribute to the enhancement of productivity.

Figure 2.2 Estimation of reduced health risk in 2025 compared with 2015



Challenges

2.6. While Hong Kong's air quality is gradually on track towards the international level, we still have to accord high priority to improve the air quality and safeguard the public health. In order to enhance our air quality to a level comparable to major international cities by 2035, we have to tackle the following 3 key issues on top of conventional emission sources such as vehicles, vessels and power plants.

Roadside nitrogen oxides

2.7. In the past 10 years, the number of registered vehicles in Hong Kong has substantially increased by nearly 40%, from about 660 000 in 2010 to around 910 000 in 2020. The vehicle annual mileage has also increased by nearly 20%. Such increases, coupled with traffic congestions, resulted in more emissions of roadside air pollutants, especially nitrogen oxides. Furthermore, ageing of vehicles aggravates the nitrogen oxides emission problem. Meanwhile, closely packed high-rise buildings in Hong Kong commonly create "street canyon" effects and trap vehicular emissions, posing health risks to residents in the vicinity.

2.8. Although the annual average concentration of nitrogen dioxide (one of the major components of nitrogen oxides) at roadside has substantially reduced from 118 $\mu g/m^3$ in 2012 to 70 $\mu g/m^3$ in 2020 under the various measures, we will continuously implement measures on green transport and air pollution reduction. Together with other policies including that on improving urban planning, we could further improve roadside air quality with a view to meeting the air quality objectives of nitrogen dioxide.

Marine vessels becoming the major local pollution source

2.9. With the significant reduction in total emissions from electricity generation and vehicles, vessel emissions are becoming the major local emission source. In 2019, vessel emissions accounted for 28%, 35% and 28% of the total local emissions of sulphur dioxide, nitrogen oxides, and respirable suspended particulates respectively. Among them, ocean-going vessels are the major emission source as they account for about 40-90% of the total

Figure 2.3 Decreasing trend of roadside nitrogen dioxide since 2012 and the anticipated improvement

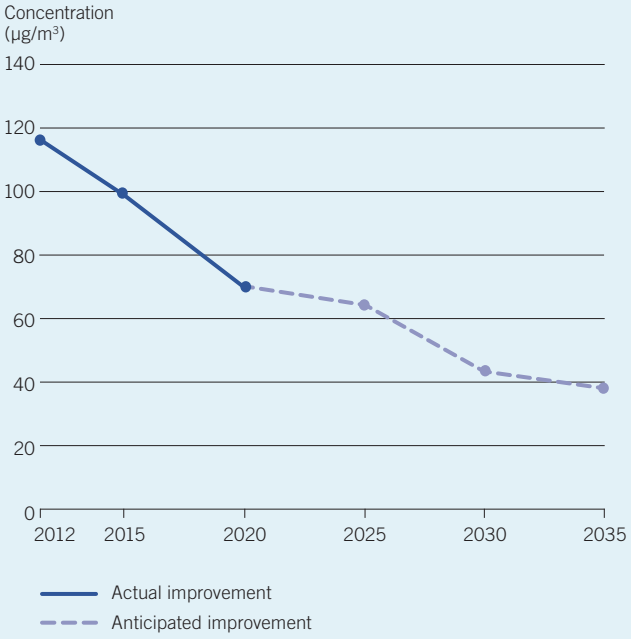
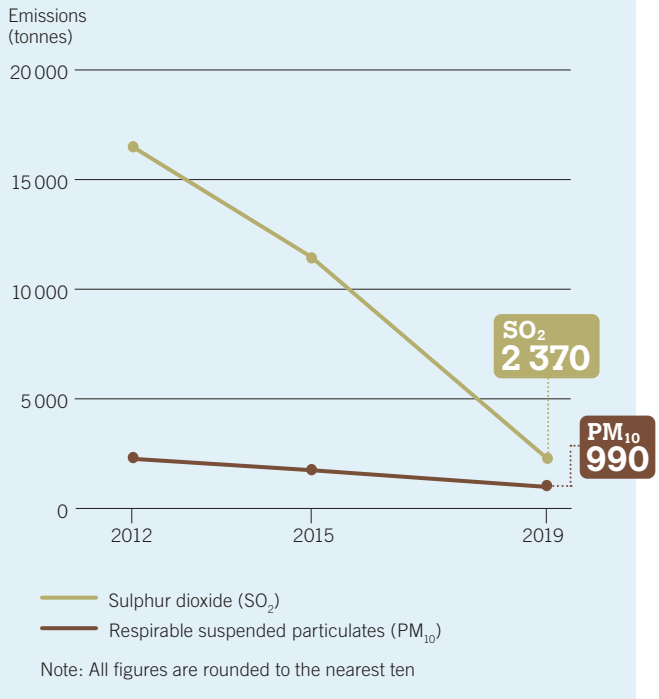


Figure 2.4 Vessel air pollutant emissions between 2012 and 2019



Note: All figures are rounded to the nearest ten

vessel emissions in these 3 types of air pollutants, followed by local vessels and river trade vessels. In view of above, we have to continue to explore and implement various measures relentlessly to target at different types of vessels and act in concert with the national authorities on the marine control measures implemented in the Greater Bay Area waters.

Managing ozone level

2.10. The overall air quality in Hong Kong has improved significantly in recent years. Nevertheless, the average concentration of ozone in ambient air still remains at a relatively high level. From 2012 to 2020, regional ozone concentration has remained unchanged, while the concentration in the urban areas of Hong Kong has increased by 35%.

2.11. Ozone will be consumed through chemical reaction with nitric oxide. However, policies related to road transport in recent years have significantly reduced the emission of nitrogen oxides from vehicles. As a result, less ozone was consumed through chemical reactions, which brought about the increase in ozone concentrations in urban areas. Resembling many other major cities tackling the ozone problem, it is anticipated that the ozone level in Hong Kong will first increase slightly, and then begin to decline after reaching the peak.

2.12. On the other hand, ozone is not directly emitted from pollution sources. It is formed by photochemical reactions between nitrogen oxides and VOCs under sunlight. VOCs are not a single substance but consists of hundreds of compounds from different sources, including both man-made and natural sources. Different compounds respond differently under photochemical reactions, and climate is also an influential factor. Therefore, we need to conduct in-depth studies on local photochemical reactions to identify the major compounds for ozone formation and their sources, so as to devise effective measures to reduce ozone.

2.13. Besides, ozone formation is via a process in which the air pollutants are prone to atmospheric transportation. Hence, we cannot solely rely on our own efforts to reduce ozone but should make concerted effort and cooperate with other regions as a wider area to tackle the ozone problem. In this connection, we are fostering more proactive regional collaboration and bringing in line with the policy directions and targets of curbing ozone concentration under the National 14th Five-Year Plan. The entire Greater Bay Area will be working closely to expedite the reduction of VOC emissions and examine the causes of regional ozone formation and transportation. Detailed actions are elaborated in the next chapter.

3 Strategies and Actions

Strategies

3.1.1. Policies to improve air quality in the past mainly focused on reducing emissions of air pollutants from various sources. This included tightening emission standards for newly registered vehicles, strengthening the control of emissions from in-use vehicles, mandating vessels to use cleaner fuels, phasing down coal in electricity generation, etc. However, with the gradual tightening of various air pollutant emission requirements in the past two decades, the most serious air pollution problems have been improved significantly, hence leaving less room for further control and tightening.

3.1.2. With the substantial improvement in air quality, the focus of the relevant policies in Hong Kong has shifted to enhancing air quality to foster a healthier and more liveable environment for the community. Therefore, in order to further improve air quality thus achieving the target of being on par with major international cities by 2035, we should not only continue to sustain our efforts to reduce emissions of different air pollutants, but also think outside the box and act creatively and boldly for greater accomplishments, and attain zero carbon emissions in the long run. This will help realise Hong Kong's target of achieving carbon neutrality before 2050.

3.1.3. Against the above, we have devised our strategies to tackle the current challenges of air quality improvements along three major directions.

Adopt green technologies to advance low-carbon transformation

3.1.4. The rapid development of green technologies is creating new modes of living, commuting, doing business, engineering and electricity generation, etc. These changes have brought about breakthroughs to overcome conventional limits and further reduce carbon and air pollutant emissions. To achieve the target of air quality on par with major international cities by 2035, Hong Kong has to switch to adopt new green technologies on multiple fronts in a bold and decisive manner.

3.1.5. In fact, all corners of the world are actively promoting research and utilisation of different green technologies including new energy vehicles and vessels, renewable energies, hydrogen energy, etc. Together with the application of information technologies including artificial intelligence, big data and Internet of Things, the application of green technologies has become a global trend.

3.1.6. The development and use of green transport are also booming. For example, different economies are setting targets to actively promote the adoption of electric vehicles (EVs). Hong Kong also announced the first *Roadmap on Popularisation of Electric Vehicles* in March 2021 which set out clear strategies for achieving the goal of zero vehicular emissions in the long run and **a target of no new registration of fuel-propelled private cars in 2035 or earlier**. Such transformation of transport technology can completely eliminate roadside emissions of nitrogen oxides in future. In addition, green transport initiatives such as various intelligent traffic management measures, autonomous driving technology, traffic and pedestrian network, urban planning, etc. will further alleviate road traffic congestion and improve roadside air quality. Hong Kong is also actively exploring the feasibility of using other new energy transport technologies, including those on vessels. Through this multi-pronged approach, we can create a more liveable environment, bringing Hong Kong to fully transform into a healthier and low-carbon city.

3.1.7. Furthermore, the application of green energy technologies can help make a breakthrough in reducing air pollutant and carbon emissions. For example, as the application of hydrogen energy is growing rapidly in recent years, the Government will keep abreast of its and other new energies' development. Taking into account economic benefits, stability of supply, safety considerations, etc., when the green energy technologies become relatively mature, we will seize the opportunity to introduce them into Hong Kong for trial and application. This will greatly facilitate the green transformation of the electricity generation and transport sectors.

3.1.8. In addition to applying green technologies to reduce air pollutant emissions, technological advancements also assist us in formulating policies for air quality improvement. We will use artificial intelligence to monitor, manage and analyse air quality, and continue to explore and adopt innovative monitoring technologies so as to gather more detailed, accurate and representative data. We will then better understand the sources, formation mechanism and transportation pathways of the air pollutants so that we have higher capability and accuracy to predict air quality, including the early prediction of acute pollution episodes. This certainly can help us provide the public with more detailed and accurate air quality information. Besides, we will examine the integration of the ground-based monitoring data, 3D monitoring data collected at higher altitudes and other areas, as well as modelling data to assist universities and academia to advance their researches in air quality.

3.1.9. The enhanced monitoring and analysis technology will allow us to more accurately make assessment of the improvements in air quality and its latest trend, evaluate the effectiveness of various improvement measures, and explore the practicality of the implementation of various new measures. This enables us to, in response to the latest development, flexibly introduce effective air quality management policies in due course.

Relentless efforts in emission reduction to build a liveable city

3.1.10. Promoting wider application of green technologies will become our major policy focus in the next decade or two. However, low-carbon transformation takes time. In the meantime, we must keep controlling and reducing emissions of air pollutants and improve our air quality continuously.

3.1.11. Road transport, vessels, electricity generation and products containing volatile organic compounds (VOCs) (e.g. air fresheners, hair sprays, insecticides, printing inks, paints, etc.) are all the primary local sources of air pollutants. Although the various measures implemented in the past 20 years have significantly reduced their emissions, we have to spare no effort to explore further measures to improve air quality. For vehicles, we will continue to launch comprehensive measures to reduce air pollutant emissions from existing vehicles, and attempt to enhance law enforcement by using new technologies. For vessels, we will examine ways to facilitate ocean-going vessels to use cleaner fuels such as liquefied natural gas (LNG), and consider tightening fuel standards, air pollutant emission standards and other controls. We will carry on tightening air pollutant emission caps for power plants and consider further regulating VOC emissions. These measures will help reduce emissions of air pollutants and improve air quality in a sustained manner.

Regional collaboration to tackle ozone problem

3.1.12. Apart from local emissions, air quality is also affected by meteorological factors including wind direction, wind speed, solar radiation and rainfall. The accumulation and transmission of air pollutants are not subject to regional restrictions. Therefore, while we are strengthening control of local air pollutant emissions, we must join hands with other cities in the Greater Bay Area to implement policies with a view to improving air quality of the entire region.

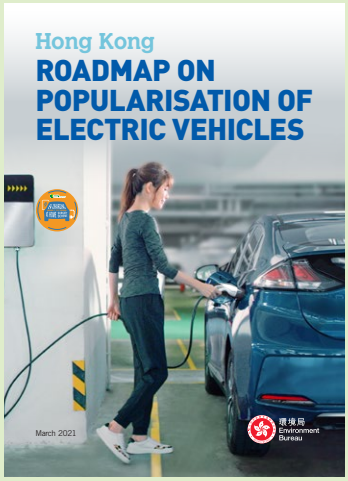
3.1.13. Air quality has always been the main focus of the "Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection" established by the governments of the Hong Kong Special Administrative Region (Hong Kong S.A.R.) and the Guangdong Province in 2000. Under this framework, we promulgate new targets of air pollutant emission reduction together with the Guangdong Province to jointly enhance air quality in the region. In tackling the ozone problem, we will also strengthen the monitoring and research on the formation, characteristics and transportation of ozone, and share data and information with each other. This will lay a more in-depth scientific foundation for jointly tackling the regional ozone problem. We will continue to collaborate with other cities in the Greater Bay Area to devise suitable measures to address and manage the ozone problem squarely.

Six Major Areas of Action

3.2.1. Against the above strategies, we have formulated six major areas of action to continuously improve Hong Kong's air quality, with a view to enhancing the air quality to a level on par with major international cities by 2035.

Green Transport

Take forward the *Roadmap on Popularisation of Electric Vehicles*



The Government published the first *Hong Kong Roadmap on Popularisation of Electric Vehicles* in March 2021, and the feedbacks are positive. Among others, franchised bus companies have indicated their plans on the procurement of electric buses and installation of charging facilities in new bus depots, or are actively assessing the feasibility of using hydrogen fuel cell buses in Hong Kong. We have also learned that a number of vehicle suppliers have devised detailed plans to introduce more EVs of different models and prices to Hong Kong. The Government's various policies and measures to promote the expansion of charging network are also welcomed by stakeholders. In particular, the responses to the "EV-Charging at Home Subsidy Scheme" are overwhelming. The number of parking spaces involved has reached almost 100 000, exceeding the anticipated number of 60 000 by more than 60%.

The Government will take forward the measures under the Roadmap in full speed, thus promoting the switch to EVs in different sectors of the society as soon as possible. This will certainly help improve air quality and promote low-carbon transformation.

Franchised bus companies are actively cooperating with the Government to study the feasibility of operating new energy buses in Hong Kong, and the Kowloon Motor Bus (KMB) and CityBus will put double-deck electric buses into trial under the New Energy Transport Fund. They will also bring in additional single-deck and double-deck electric buses and associated charging facilitates to test and evaluate the operational efficiency and technical feasibility of the electric buses. CityBus will also work with the Government to examine the application of other new energy buses, such as hydrogen fuel cell buses, in Hong Kong.

Further to the Government's introduction of the *Roadmap on Popularisation of Electric Vehicles*, KMB announced its proposed phased approach to procure more single-deck and double-deck electric buses, with the aim of having hundreds of electric buses in the fleet by 2025. KMB is also planning for a charging network covering various locations to support its electric fleets.

Develop green transport network

To cope with the additional traffic demand arising from the land-use development in a longer term beyond 2031, the Highways Department launched the *Strategic Study on Railways beyond 2030* in December 2020, with a view to ensuring that the planning of railway infrastructures can satisfy Hong Kong's overall long term development needs.

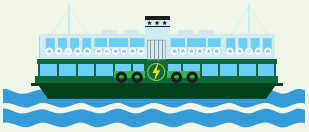
Besides, the Government is preparing to gradually implement a free-flow tolling system at government tolled tunnels and the Tsing Sha Control Area from late 2022 onwards, and continue facilitating the trial and usage of autonomous vehicles at suitable locations. We have has also embarked on a study on "Congestion Charging" to comprehensively review the hierarchy and level of tolls of all Government tolled tunnels and Control Areas. "Congestion Charging" will suitably adjust the tolls based on traffic management needs, with a view to regulating traffic flows and alleviating traffic congestion.

Adopt green features in new development areas

The railways will remain as the backbone of the public transport network, complemented by the various public transport modes, walking, cycling and other low-carbon transportation to reduce carbon emissions.

When planning new development areas and strategic growth areas (e.g. New Territories North Development), the Government will encourage green mobility, such as introducing green elements in the built environment designs and proactively installing EV charging facilities.

Promote the use of new energy ferries

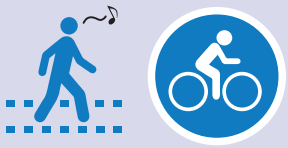


The Government has earmarked $350 million to provide subsidies for the construction and trials for electric ferries and associated charging facilities for 4 in-harbour routes. The trials, which aim at testing the technical and commercial viability of applying electric ferries in Hong Kong, are expected to commence in 2023. On the other hand, the Government will fully subsidise ferry operators of 6 major outlying island ferry routes to construct new hybrid ferries in the first phase of the new Vessel Subsidy Scheme for outlying island ferry routes, and carry out a 16-month trial.

The Government will evaluate the performance of these new energy ferries. Subject to the trial results and relevant technological development, the Government will explore with the ferry operators the possibility of progressively replacing traditional ferries with new energy ferries before 2035.

Liveable Environment

Pedestrian-friendly and bicycle-friendly policies



The Transport Department is taking forward the walkability enhancement measures for territory-wide applications. Suitable new development areas and built-up areas will be selected for the implementation of a comprehensive pedestrian planning framework. In addition, the Transport Department will develop a set of design standards for a pedestrian wayfinding signage system. The new wayfinding signage will be installed at suitable locations in the Central and Western District, Sham Shui Po and Tsim Sha Tsui in phases from end-2022.

In addition, cycle track design will be incorporated into 13 major harbourfront development projects, which will be completed in phases before 2030 to facilitate cycling.

Enhance air quality at public transport interchanges

The Government is updating the *Practice Note for Professional Persons – Control of Air Pollution in Semi-Confined Public Transport Interchanges*, and will consult the trade, relevant stakeholders and the Professional Persons Environmental Consultative Committee. The Government plans to release the new practice note in 2022 in order to further enhance air quality at public transport interchanges.

Update the Air Quality Health Index (AQHI)

The Government will embark on a study within this year to analyse the relationship between air quality and health statistics in recent years, in order to update the methodology for the compilation of the AQHI. This can provide more precise health risk forecast. Our target is to launch the updated AQHI in 2024.

Embark on a cohort study

The Government will commence the *Pilot Cohort Study to Assess the Long-term Health Outcomes from Exposure to Air Pollution for the General Population of Hong Kong* this year. The study will track about 6 000 residents of different age groups, with a view to understanding how exposure to different air pollution levels may affect their health and evaluating the risk of premature deaths for adults under long-term exposure to air pollutants. The study will facilitate an in-depth examination of the impact of air pollutions on human health.

Comprehensive Emissions Reduction

Phase out old diesel commercial vehicles (DCVs)

Further to the phasing out of 80 000 pre-Euro IV (i.e. Pre-Euro, Euro I, Euro II and Euro III) DCVs, the Government is progressively phasing out about 40 000 Euro IV DCVs before end-2027. After completion of the programmes, DCVs with high air pollutant emissions will be retired on the whole. Newer DCVs are set with a service life limit of 15 years and hence will be retired in due course.

Conduct trials for emission reduction devices for franchised buses

The Government will subsidise franchised bus companies for a trial in 2022, to retrofit Euro V double-deck diesel buses with enhanced selective catalytic reduction systems. The trial will ascertain the technical feasibility of deploying this type of air pollutant emission reduction device and its performances under local operating conditions. Subject to the outcome and resources required, we will discuss with the franchised bus companies the arrangements for retrofitting the systems to other suitable bus models.

Tighten the sulphur content limit of locally supplied marine fuels, and impose emission standards for new petrol-powered outboard engines

In order to encourage vessels to use cleaner fuels, the Government will explore further tightening the sulphur content limit of locally supplied marine light diesel from 0.05% to 0.001% in the coming few years.

For petrol-powered outboard engines commonly used on sampans and pleasure vessels, the Government will consider imposing air pollutant emission standards for the new engines in the next few years.

Extend the control of products containing VOCs

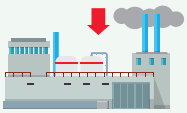
The Government will further tighten the VOC content limits of architectural paints, and extend the control to cleaning products. We have consulted the relevant trade and will consult the public later this year, with a view to implementing the new requirements before 2024.

Clean Energy

New low-carbon electricity generation strategy under the *Hong Kong's Climate Acton Plan*

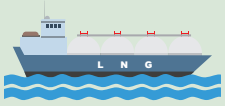
The Government is urging the power companies to phase out existing coal-fired units and replace coal with natural gas progressively from now to 2030. To further reduce electricity generation emissions from burning fossil fuels, the Government and power companies are discussing means to further develop and utilise more zero-carbon energy. We will update the *Hong Kong's Climate Action Plan* later this year and establish aggressive mid-term and long-term goals for the electricity generation sector, so as to formulate the overall strategy for the sector to achieve carbon neutrality before 2050.

Continue to tighten emission limits of power plants under the new low-carbon electricity generation strategy



The Government will review the Ninth Technical Memorandum that caps the air pollutant emissions from power plants by 2023. In line with the new low-carbon electricity generation strategy and fuel mix under the updated *Hong Kong's Climate Action Plan*, the Government will consider further tightening the air pollutant emission caps from the power plants in the review.

Take forward the use of LNG in ocean-going vessels



The Government will examine measures to take forward the adoption of LNG in ocean-going vessels, including actively exploring the use of the offshore LNG terminal newly constructed by the two power companies as a bunkering facility for ocean-going vessels, planning for LNG bunkering areas, and formulating technical requirements and related safety regulations and requirements for offshore LNG bunkering in the next few years.

Set up an inter-departmental working group to handle work relating to the application of hydrogen energy in Hong Kong

As the development of hydrogen energy is gaining traction in the Mainland and other places in recent years, the Government has started preparing to set up an inter-departmental working group to handle a range of work relating to the application of hydrogen energy in Hong Kong, including technical discussions, safety considerations, legislation, etc.

Scientific Management

Adopt innovative instruments to monitor compositions of VOCs and fine suspended particulates ($PM_{2.5}$) in real time

Starting from 2022, advanced instruments will be progressively deployed in air quality monitoring stations to analyse the composition and concentration of VOCs and $PM_{2.5}$ in real-time. The instruments will provide supplementary data that could not be collected by conventional monitoring stations, further assisting in policy formulation to improve air quality.

Conduct district-based air quality monitoring to identify pollution distributions

Short-term air quality monitoring will be conducted at different districts in addition to the existing air quality monitoring network in the coming 2 to 3 years, so as to collect more comprehensive data and identify pollution distributions. Tentatively, the northwest New Territories and Kowloon urban areas will be among the first locations to be monitored.

Apply micro-sensors to monitor ambient and indoor air quality

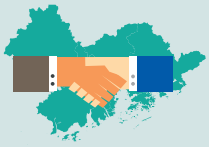
Micro-sensors will be installed at smart lampposts in new development areas, such as Tung Chung, to monitor air quality within a few years' time so as to collect real-time district-based data. These sensors are also capable of monitoring indoor air quality and the data can be fed back into the air-conditioning management system of buildings so as to improve indoor air quality.

Develop a smart air quality monitoring system to provide more detailed district-based air quality information to the public

To provide the public with more detailed district-based air quality information, the Government will develop a smart air quality monitoring system within the next few years with the integration of the Internet of Things, artificial intelligence, existing monitoring stations, sensors installed at specific locations such as lampposts, and numerical models.

Regional Collaboration

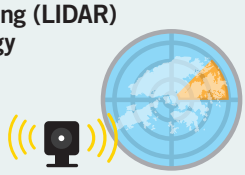
Formulate regional emission reduction targets for 2025 and 2030 with the Guangdong Province



In line with the air quality targets set in the National 14th Five-Year Plan, the Hong Kong S.A.R. Government and the Guangdong Provincial Government will explore ways in the joint study on *Post-2020 Regional Air Pollutants Emission Reduction Targets and Concentration Levels* to control the annual average concentrations of $PM_{2.5}$ at the Greater Bay Area to below 25 μg/m^3, and gradually lower the ozone level after reaching its peak.

We will base on scientific information from researches, and work with the Guangdong Provincial Government in the coming year to formulate regional air pollutant emission reduction plans and targets for 2025 and 2030, with a view to further improving regional air quality.

Conduct 3D air quality monitoring with light detection and ranging (LIDAR) technology



Unlike conventional air quality monitoring that is close to the ground level, Hong Kong and Guangdong plan to make use of the LIDAR technology to measure real-time concentrations of air pollutants (such as ozone and particulate matters) up to several kilometres above ground as well as the vertical and 3D distribution of wind directions. The Government will set up 5 LIDAR monitoring sites in Hong Kong, which are anticipated to come into operation in 2023.

The monitoring will be useful for tracking the transportation of air pollutants and their impact on Hong Kong's air quality, and at the same time enhancing the accuracy of air quality forecasts.

Collaboration in the Greater Bay Area to study and monitor ozone pollution

To tackle the regional ozone problem, the governments of Guangdong, Hong Kong and Macao have launched a 3-year joint study on *Characterisation of Photochemical Ozone Formation, Regional and Super-Regional Transportation in the Greater Bay Area* in 2021 to monitor air quality at sea, land and air for an in-depth understanding on the formation and transportation characteristics of ozone in the Greater Bay Area. This study provides a scientific foundation for formulating policies to improve regional ozone pollution.

In addition, the 3 governments will integrate regular monitoring of VOCs[1] into their regional air quality monitoring network in phases so as to collect real-time data. Guangdong and Hong Kong have completed relevant preliminary monitoring. Hong Kong is actively preparing for the full-scale operation of 3 monitoring stations at Tung Chung, Tsuen Wan and Yuen Long in 2022.

Encourage training and technical exchanges

To further promote regional collaboration, the governments of the Hong Kong S.A.R. and other cities in the Greater Bay Area will hold seminars and workshops at appropriate times to gather scientists, technical personnel and government officials to exchange knowledge of monitoring technology developments and inspect advanced monitoring instruments, so as to enhance technical standards of air monitoring in the Greater Bay Area.

1. VOCs and nitrogen oxides will form ozone through photochemical reaction.

Concluding Remarks

Improving the air quality is one of the key environmental protection work that the Government will continue to press ahead. The *Clean Air Plan for Hong Kong 2035* summarises the long-term overall strategy to enhance Hong Kong's air quality and enable us to proceed progressively to enhance the air quality of Hong Kong to a level on par with major international cities.

As green technologies advance rapidly, more diverse policies and measures for improving air quality emerge, which allows us to improve the air quality while reducing carbon emissions, filling two needs with one deed. The Government will remain open-minded to the application of novel technologies, so that we can keep abreast with the times and seize the green opportunities brought by technological advancements.

We will review the Hong Kong Air Quality Objectives every 5 years to evaluate the effectiveness of our various measures, and adjust the Objectives and relevant policies accordingly with flexibility. We will also keep up with the environmental protection progress of the Guangdong-Hong Kong-Macao Greater Bay Area, strengthen exchange and collaboration and improve the air quality as a whole.

The Government will continue to provide resources to facilitate Hong Kong's development into a greener and more liveable city, generating green employment opportunities at the same time. Following the *Waste Blueprint for Hong Kong 2035* and the *Hong Kong Roadmap on Popularisation of Electric Vehicles* published in February and March 2021 respectively, as well as this *Clean Air Plan for Hong Kong 2035*, we will soon release the *Hong Kong's Climate Action Plan 2050*. The Plan will elaborate on Hong Kong's overall goals, strategies and measures combating climate change. This series of blueprints will lay a stronger foundation for the more intense transformation of Hong Kong into a green city, and support the attainment of carbon neutrality before 2050.

Abbreviations

AQGs	Air Quality Guidelines
AQHI	Air Quality Health Index
AQOs	Air Quality Objectives
CO	Carbon monoxide
DCV	Diesel commercial vehicle
EV	Electric vehicle
FRT	First registration tax
HKUST	Hong Kong University of Science and Technology
Hong Kong S.A.R.	Hong Kong Special Administrative Region
KMB	Kowloon Motor Bus
LIDAR technology	Light detection and ranging technology
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O_3	Ozone
Pb	Lead
$PM_{2.5}$	Fine suspended particulates
PM_{10}	Respirable suspended particulates
PRAISE-HK	"Personalised Real-Time Air Quality Information System for Exposure – Hong Kong"
SO_2	Sulphur dioxide
TM	Technical Memorandum
VOC	Volatile organic compound
WHO	World Health Organization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