Clean Air Network

CAN

健康空氣行動

Citizen Clean Air Plan 2021
Clean Air Network

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INTRODUCTION

Amid a global pandemic, countries, and cities are struggling to rebuild economically, socially, and environmentally. Aggressive plans were unveiled by governments around the world to make gigantic investments to support green recovery initiatives. More ambitious targets were committed by global powers to decarbonise.[1]

Since late 2020, several moves have been made by the Hong Kong Special Administrative Region (HKSAR) Government. After pledging to achieve carbon neutrality by 2050 in the Policy Address of October 2020,[2] the Government announced Hong Kong's first roadmap to popularise the use of electric vehicles in March 2021.[3] It is expected that the new Climate Action Plan will also be published in 2021.

It is under such a backdrop that the HKSAR Government is going to announce the new *Clean Air Plan* in mid2021. There is a reasonably strong expectation from the public to see a more ambitious Plan.

Since the launch of '*A Clean Air Plan for Hong Kong* in 2013,[4] the Government has taken a number of measures to improve the air quality. These measures include the launching of an incentive-cum-regulatory programme worth HK$10 billion to progressively phase out all pre-Euro IV diesel commercial vehicles[5] and to impose a mandatory requirement on oceangoing vessels to use cleaner fuel at berth.[6] Hong Kong was the first Asian port to do so.[7] These measures have delivered significant progress in reducing the concentration level of sulphur dioxide, particulate matter and nitrogen dioxide. However, the concentration of nitrogen dioxide remains at a dangerous level, especially at street level.[8] The concentration of ozone has reached a record-breaking height in recent years.[9]

As an affluent global city, Hong Kong is still, lagging behind its global counterparts on the actual air quality level. The vulnerable groups are largely unaware of the environmental health risk. During high pollution episodes, the city remains business as usual. All these insufficiencies contribute to huge societal, public health, and economic costs for generations to come.

The Citizen Clean Air Plan aims to develop a conversation with the Government, and inspire discussion among different sectors, including the business, professional, academic, and the community to collate their views on how they can do their parts to clean air.

EXECUTIVE SUMMARY

With unprecedented global and regional momentum on green recovery, the society at large has a strong expectation of the HKSAR Government's new Clean Air Plan.

Since the launch of the Clean Air Plan ("CAP 2013"), by the Environment Bureau in 2013, it has provided a vision and strategic framework for the society to progress towards the goal of clean air.

With varying degrees of success to control multiple air pollutants and initiate systemic changes, new and fundamental problems have also emerged since the launch of the CAP 2013. Key questions being asked are, what is still inadequate to achieve clean air, and how should we define the success of the next phase of initiatives to clean the air of Hong Kong?

Clean Air Network drafted the Citizen Clean Air Plan with the purpose to illustrate our perspectives and findings on the pressing questions. There are two parts of the Citizen Clean Air Plan.

The first part will review how the HKSAR Government has tackled air pollution since the launch of the CAP 2013, to determine where progress has been made, and where it has not.

The findings in the first part will help us to identify the gaps where we need to pay stronger attention to, in order to achieve bigger impacts. The second part will set out the aspiration and conditions to define the success of the next phase of initiatives towards cleaning the air.

We have mapped two routes to make further achievements on cleaning the air.

Firstly, we urge the HKSAR Government to establish ambitious clean air goals which are comparable to global cities and complying with the most stringent standard of the World Health Organization's Air Quality Guidelines, to contribute to a truly liveable super region with cleaner air and lower carbon, and to migrate to an exposure-based air pollution management paradigm, that will more effectively protect public health.

Secondly, we also call for the civil society, including the professionals, the academics, the public and private sectors, to work hand in hand, and address specific issues that affect the community on a daily basis but are currently out of reach by the Government policy.

SUMMARY OF REVIEW

REVIEW OF CAP2013

CAP2013 aimed to reconcile some of the disconnections observed in the past administrations (including disconnections in policymaking and science) by changing the system. Major efforts on systemic change included:

- the launch of the CAP 2013 by Environment Bureau in collaboration with Transport and Housing Bureau, Development Bureau and Food and Health Bureau;
- the amendment of Air Pollution Control Ordinance(APCO) to mandate the review of the Air Quality objectives(AQO) at a minimum of once every 5 years; strengthen communication through replacement of the old API with AQHI;
- strengthen the regional control mechanism including regional collaborations of Guangdong, Hong Kong and Macau;
- modernising the Air Quality Management System using scientific evidence-based approach;

EXECUTIVE SUMMARY

There were varying degree of impact achieved on the above systemic changes. Some of the gaps observed:

- Unclear roles and lack of measurable goals to be achieved by Transport and Housing Bureau, Development Bureau and Food and Health Bureau;
- Weaknesses of Air Pollution Control Ordinance and Environmental Impact Assessment Ordinance on protecting public health were unaddressed
- Controversial mechanism of AQOs Review
- Ineffective AQHI's to transform individual behaviour
- Not able to translate regional reduction effort to health terms as regional reduction targets are not set in terms of level of pollution concentration
- Insufficient coverage of street-level air pollution monitoring network

REVIEW OF GOVERNMENT POLICY MEASURES 2013-2020

- Insufficient progress made to accelerate transformation to zero emission road transport, especially the commercial vehicles and public transport; limited improvement on pedestrianisation policy;
- Insufficient progress made to tackle nitrogen oxides emission from ocean-going vessels, and volatile organic compound emission from river vessels and local vessels;
- Insufficient progress made to tackle regional ozone, not able to identify precursors of the formation of ozone;
- Insufficient progress made in formulation of a clean energy policy that will achieve clean air and 2050 carbon neutrality;

REVIEW OF AIR & HEALTH DATA 2013-2020

- In summary, health outcomes due to air pollution declined by up to 50%. Concentration of major air pollutants largely reduced except ozone. Roadside nitrogen dioxide and ambient ozone remain a key public health risk;
- During this period, air pollution had caused approximately 16,500 premature deaths, 1,096,000 avoidable hospital bed days, and 25 million avoidable doctor visits;
- In taking a year-on-year review, the number of deaths attributable to air pollution had fallen from a high of 3,365 in 2013 to 1,686 in 2018 which represented a 50% decline. However, in 2019, the number of deaths had climbed again, to 1,745;
- The figures for other health impacts depict a similar trend;
- Concentration of particulate matter, nitrogen dioxide, and sulphur dioxide had dropped by 30%;
- Concentration of ambient ozone has reached a historic record in recent years;
- The annual concentration of roadside nitrogen dioxide and particulate matter still exceed WHO's most stringent level by 60%-90%.

SUMMARY OF RECOMMENDATIONS

In the Citizen Clean Air Plan, CAN has set out the aspiration and conditions to define how the next phase of success of clean air of HKSAR, is to be measured for the upcoming decade.

The definitions of success are:

A) Whether the air quality of HKSAR will become one of the best in 2030.

Specifically, whether the air quality of HKSAR will be levelled with other global cities, like London, New York, Singapore by 2030; and whether Hong Kong's Air Quality Objectives will be levelled with WHO's most stringent Air Quality Guidelines by 2035.

B) Whether HKSAR will migrate to exposure-based management paradigm.

For information - currently, the HKSAR Government adopts an emission-based air pollution management. Success of policy measures are defined by the level of emission reduced, and policy measures are prioritized to tackle the highest emitters to maximize gain on emission reduction.

If HKSAR will migrate to adopt exposure-based management as the key approach, specifically, success of the policy measures should be measured by the level of exposure (contact of air pollution on human)/ health risk reduced; and the Government should deploy a mechanism to prioritize policy measures that maximize the gain on exposure / health risk reduction.

C) Whether regional pollution can be significantly controlled thus Greater Bay Area becomes a truly liveable city with clean air and low carbon.

Specifically, there are 4 aspects of work to be clarified by the Government:

- How can a regional institution be set up to strengthen effective coordination and legislation?
- How will the gap on regional ozone, nitrogen oxides emission from ocean going vessels, volatile organic compound emission from river vessels (including Macau and PRD Ferries) be narrowed?
- How will the emission standard of PRD waters be tightened further – through application to become one of the designated Emission Control Area (ECA) under International Maritime Organization (IMO) or tighten the emission standard under Domestic Emission Control Area (DECA)?
- How a clean energy policy will be adopted in Greater Bay Area that will achieve both clean air and decarbonisation goals?

D) Whether an informed and mobilised citizenry will be fostered

The key objectives and principles

This paper sets out principles and recommended measures to achieve the above objectives, and proposes a framework that requires actions from both the Government and the civic society.

EXECUTIVE SUMMARY

Objective A.

Become the place among the best air qualities by 2030 (comparable to other first tier global cities and metropolitans) and achieve WHO AQGs by 2035

Principles to achieve the key objectives:

Principle A1. Emphasize accountability and communication to ensure achievement of specific and time-bound targets.

Principle A2. Integrated bureau efforts to tackle air pollution.

Principle A3. Transition to zero emission vehicular fleet to minimize roadside pollution.

Principle A4. Establish new marine emission standards and facilitate transitions to cleaner vessels.

Principle A5. Develop an open, transparent, independent AQOs review mechanism.

Objective B.

Become the place with the best knowledge on exposure management

Principles to achieve the key objectives:

Principle B1. Standardize the protocol to define “exposure hot spots”.

Principle B2. Develop an integrated Data Management System.

Principle B3. Oversight of exposure / health risk management under the Secretary for Health.

Principle B4. Make progress on Transport Management Solutions.

Principle B5. Strengthen Indoor Air Quality Management.

Objective C.

Become the Bay Area which is truly liveable with clean air and low carbon

Principles to achieve the key objectives:

Principle C1. Strengthen regional collaboration.

Principle C2. Institutionalize a regional air quality agency.

Principle C3. Achieve clean air and decarbonisation goals together.

Principle C4. Collaboration with other Bay Areas.

Objective D.

Foster an informed and mobilized citizenry

Principles to achieve the key objectives:

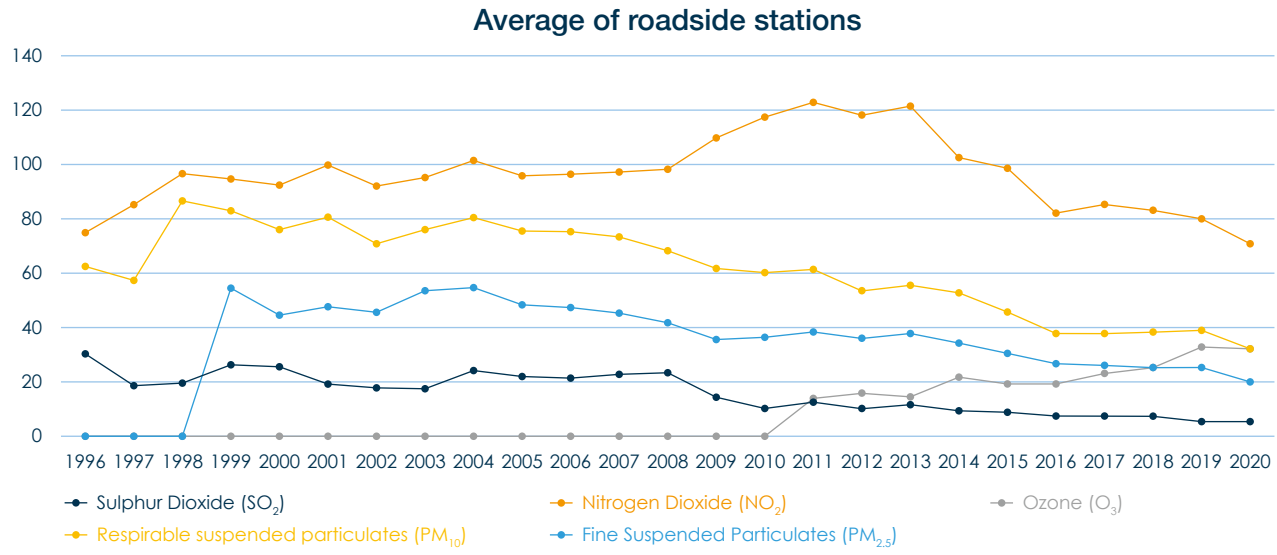
Principle D1. Develop a relatable public education programme that involves both schools-based and community-based education.

Principle D2. Participation of relevant professional and business sectors.

1. REVIEWING THE AIR AND HEALTH

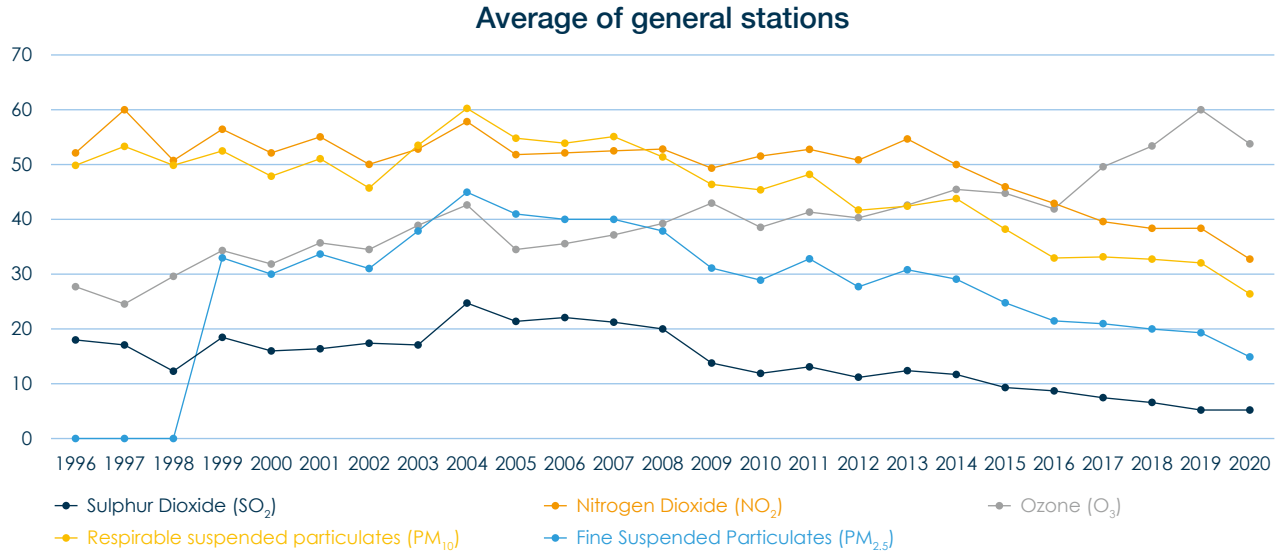
The starting point is to review air pollution levels from 2013, when the *Clean Air Plan* was published, to the end of 2020.[10] The results are mixed. Data collected by the Environmental Protection Department (EPD)'s roadside and general stations shows that, the concentration of particulate matters (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2) have dropped, and that of ozone (O_3) has increased.

Figure 1: Annual average concentrations of major air pollutants in Hong Kong - roadside stations
(all units in microgram per cubic metre)



Source: EPD and Hedley Environmental Index

Figure 2: Annual average concentrations of major air pollutants in Hong Kong - general stations
(all units in microgram per cubic metre)



Source: EPD and Hedley Environmental Index

1. REVIEWING THE AIR AND HEALTH

To put these trends in context, at the ambient level, the O_3 has reached a historic record in recent years (except in 2020). At the street level, the annual concentrations of NO_2, PM_{10}, and $PM_{2.5}$ still exceed the standards stated in World Health Organization's Air Quality Guidelines (WHOAQG) by 60% to 90%. The WHOAQG is the most current global standard for protecting human health based on the latest evidence in health and medical science.

The public health impacts, attributable to the concentrations noted above reflect the seriousness of the threat posed by air quality in Hong Kong. The Hedley Environmental Index,[11] which uses a peer-reviewed methodology to indicate the impact of air pollution on public health shows that between 2013 and 2020, these pollution levels have caused 16,479 premature deaths, 1,095,812 avoidable hospital bed days, and 25 million avoidable doctor visits.

Figure 3: Comparison of WHOAQG and annual average concentrations of general stations and roadside stations (all units in microgram per cubic metre

Annual Average of General Stations	2013	2020	Changes	WHOAQG	Compare 2020 to WHOAQG
Sulphur Dioxide (SO_2)	12	5	-60%	N/A	N/A
Nitrogen Dioxide (NO_2)	55	33	-40%	40	-18%
Ozone (O_3)	43	54	27%	N/A	N/A
Respirable Suspended Particulates (PM_{10})	42	26	-38%	20	32%
Fine Suspended Particulates ($PM_{2.5}$)	31	15	-51%	10	51%

Annual Average of Roadside Stations	2013	2020	Changes	WHOAQG	Compare 2020 to WHOAQG
Sulphur Dioxide (SO_2)	11	5	-56%	N/A	N/A
Nitrogen Dioxide (NO_2)	121	70	-42%	40	75%
Ozone (O_3)	14	32	129%	N/A	N/A
Respirable Suspended Particulates (PM_{10})	55	32	-42%	20	60%
Fine Suspended Particulates ($PM_{2.5}$)	37	19	-49%	10	90%

Note: WHOAQG for SO2 are 10 minutes and 24 hours average, WHOAQG for O3 is 8 hours average. According to WHOAQG, the limit of O3 for 8 hours average is 100 µg/m3. Under Hong Kong's AQOs, the concentration limit of O3 is 160 µg/m3, number of exceedances allowed is 9 times. Based on EPD's data in 2020, 5 general stations recorded exceedances more than 9 times, including Tuen Mun (11), Tung Chung (11) and Tai Po (14).

According to WHOAQG, the limit of SO2 for 24 hours average is 20 µg/m3. Under Hong Kong's AQOs, the concentration limit of SO2 is 125 µg/m3, number of exceedances allowed is 3 times. Based on EPD's data in 2020, all stations' concentration of SO2 met the HKAQOs.

Source: EPD, WHO

Figure 4: Health and economic loss due to air pollution

Year	Premature Deaths	Hospital Bed Days	Doctor Visits	Total Economic Loss (HKD)
2013	3,365	208,815	5.50 million	$41 billion
2014	2,664	172,857	4.18 million	$29 billion
2015	2,382	152,298	3.71 million	$29 billion
2016	1,508	98,684	2.26 million	$18 billion
2017	1,866	126,499	2.71 million	$22 billion
2018	1,686	115,802	2.39 million	$20 billion
2019	1,745	127,140	2.30 million	$21 billion
2020	1,264	93,717	1.59 million	$15 billion
Total	16,479	1,095,812	25 million	$195 billion

Source: Hedley Environmental Index Version 4.0

The number of deaths attributable to air pollution fell from a high of 3,365 in 2013 to 1,686 in 2018. This 50% drop appeared to be encouraging, but in 2019, the number of deaths climbed again to 1,745. The figures for other health impacts depict a similar trend.

To better understand these figures, it is necessary to look at the measures taken by the HKSAR Government to address air pollution, and to study any changes that have been made to the legislative framework under which air quality is administered.

2. THE LEGAL FRAMEWORK

Air quality is managed under the Air Pollution Control Ordinance (APCO),[12] and the Environmental Impact Assessment Ordinance (EIAO) in Hong Kong. The APCO is a succession of the Clean Air Ordinance, which was the first air pollution control legislation enacted in 1959 for controlling fuel combustion emissions. Enacted in 1983, it extends the control to air pollution of non-combustion processes.

Following the launch of the *Clean Air Plan* in 2013, the most notable change of the legal framework was the amendment of the APCO, which stipulates that a periodic review of the Air Quality Objectives (AQOs) is required at least once in every five years.[13] The EPD is tasked to achieve these objectives and to maintain the quality so achieved with a view to promoting the conservation and best use of air in the public interest.[14]

The First Review of AQOs after the amendment of APCO in 2013

The APCO also requires the Director of Environmental Protection (DEP) to set AQOs, establishing targets for the maximum acceptable levels of specific pollutants across the whole territory. The AQOs are not standards which must be met, but e targets to be aimed for. The difference is that failure to meet a standard is a breach of the law, while failure to meet an objective or target carries no legal penalty.

Hong Kong's AQOs were established in 1987 and despite several updates of WHOAQG, on which they were originally based, they remain unchanged. The AQOs had been reviewed from 2006 to 2008 and new AQOs were proposed for public consultation in 2009. The AQOs were not updated until 2014.[15]

In 2013, the APCO was amended to mandate a minimum of one review of AQOs every 5 years. Under the amended APCO, the first review of AQOs was conducted from 2016 to 2018. During the review, the Under Secretary for the Environment (USEN) led an AQO Review Working Group (Working Group) to engage relevant stakeholders and gathered their views via four dedicated sub-groups on key aspects of the review, namely; Air Science & Health, Road Transportation, Marine Transportation, and Energy & Power Generation.[16] Members of the Working Group include representatives from the field of air science, health, green groups, chambers of commerce, professional bodies, relevant trades, and representatives from relevant Government bureaux and departments.

Methodology of the 2016-18 Review

The proposal for tightening the AQOs for various pollutants was formulated in regard to the 2025 air quality assessment results, which were based on the territory-wide air quality modelling outcome.

Members of the Working Group were invited to propose air quality improvement measures. Based on the analysis of "practicability", the measures were prioritised into short, medium, and long term.

Latest Development

In 2019, a three-month consultation of the proposed new AQOs was launched. The Legislative Council (LegCo) Panel on the Environmental Affairs (EA Panel), and the Advisory Council on the Environment (ACE) were consulted in late 2019 and early 2020 respectively, on the findings of the public consultation and final recommendations of the review. However, even after one year (as of March 2021), the proposed new AQOs have not yet been made effective.

Figure 5: Hong Kong's Air Quality Objectives (AQOs) and World Health Organization's Air Quality Guidelines (AQGs)

Pollutants	Averaging Time	WHO AQGs (μg/m^3)				No. of Exceedances Allowed in Hong Kong's Prevailing AQOs per calendar year
		Interim Targe-1	Interim Targe-2	Interim Targe-3	Ultimate Target	
Sulphur Dioxide (SO_2)	10-minute	-	-	-	500	3
	24-hour	125	**50**	-	20	3
Respirable Suspended Particulates (RSP/PM_{10})	1-year	70	50	30	20	Not applicable
	24-hour	150	100	75	50	9
Fine Suspended Particulates ($FSP/PM_{2.5}$)	1-year	35	**25**	15	10	Not applicable
	24-hour	75	**50**	37.5	25	9 **35**
Nitrogen Dioxide (NO_2)	1-year	-	-	-	40	Not applicable
	1-hour	-	-	-	200	18
Ozone (O_3)	8-hour	160	-	-	100	9
Carbon Monoxide (CO)	1-hour	-	-	-	30 000	0
	8-hour	-	-	-	10 000	0
Lead (Pb)	1-year	-	-	-	0.5	Not applicable

Notes: XX *Prevailing AQOs are indicated in blue cells*

XX *Proposed new AQOs and allowable number of exceedances are indicated in light blue cells*

Source: Air Pollution Control (Amendment) Bill 2021 gazetted[17]



Controversies

A number of controversies were observed during the 2016-18 review of AQOs.

i) Policy measures were not prioritised based on benefits of public health:

- The Health Economic Impact Assessment was ready only at the latter stage of the review.[18]

- The Assessment tool was barely used to identify the health benefits of various policy measures proposed by the members of the Working Group.

ii) Information gaps were observed during the 2016-18 review:

- Data gap on transport and health existed.

- Quantifiability of the policy options was unclear.

- The data was unavailable for quantifying the benefits of policy options

- Some policies were judged impracticable, but they were not well discussed based on data.

- The area of improvement of modelling capacity was uncertain.

iii) Improvements have been achieved but targets were not tightened:

- Arguably, the proposed new objectives have already been met for $PM_{2.5}$ in the whole territory of Hong Kong in 2018.

- The actual concentration level of PM_{10} has reached interim target 2 (IT-2). However, after the 2016-18 review process, there were no proposals to further tighten the AQOs for both pollutants to the next interim target level.

iv) There was an oversight on adjusting the number of allowable exceedances:

- After the 2016-18 review, the Government proposed to tighten the standard of the $PM_{2.5}$ from interim target 1 (IT-1) to the next (IT-2), however, the Government also proposed to increase the number of allowable exceedances for air pollutant $PM_{2.5}$, from 9 times to 35 times a year.

- Under the Government's prediction, the $PM_{2.5}$ level will exceed the proposed new standard (IT-2) for 33 times in 2025. Currently, there is no guideline on how the allowable exceedances should be reviewed and tightened.

- Arguably, the Government's proposal set a precedence that shows no matter to what degree the concentration limit of the AQOs is tightened, there can be an infinite number of allowable exceedances.

v) The was no mechanism to guarantee an update of AQOs:

- As described, after the establishment of AQOs in 1987, a new set of AQOs were proposed in 2009. However, the AQOs were not made effective until 2014.

- Despite the fact that the APCO was amended to mandate a review of AQOs once every five years, there is no mechanism to guarantee an update of AQOs.

- After the AQOs review was completed in 2018, the proposed new AQOs have not been made effective as of [March] 2021.

APCO

Certain weaknesses in APCO to protect public health still exist despite the amendment in 2013.[19]

The issues left unaddressed include:

i) **public health is not directly referenced in the process of setting up AQOs;**

ii) **the AQO stated in APCO is not updated with adherence to international standards or local health research; and**

iii) **the process and tools in APCO fall short of the ability to ensure the accountability for performance and monitor if enforcement action is taken.**

In 2018, a Multi-Jurisdictional Comparative Study on Air Pollution Control Regulations (June 2018)[20] was conducted by Clean Air Network in collaboration with Linklaters and facilitation by Thomson Reuters Foundation.

The report is a comparative study of the air pollution control strategies and legislation at both national and state/city levels in the jurisdictions of Hong Kong, the United Kingdom, the city of London, the European Union, the United States, California, Japan, the city of Tokyo, and Singapore.

Five parameters were set to investigate the status of different jurisdictions:

i) **whether public health protection is cited as an express legal and policy objective;**

ii) **whether there is a clear legal standard or objective that relevant authority must be accountable for;**

iii) **whether there is an authorised body or commission to develop programs or roadmaps to protect public health;**

iv) **whether there is a timeline for compliance with the legal limit or a target to reduce adverse health impact; and**

v) **whether the government and other parties are held accountable for failing to achieve air quality objectives.**

The study showed that Hong Kong's regulation presents a negative answer to all the above parameters – public health is neither a legal nor policy objective; AQOs are non-binding and only aspirational targets to be achieved; there is no specific body to develop roadmaps to protect public health in regard toair pollution; there is no specific timeline for compliance; and, the government is not accountable for failing to achieve the AQOs.

EIAO

There is also a weakness in the Environmental Impact Assessment Ordinance (EIAO) to protect public health. Under the current EIAO, public health impact assessment is not mandatory.[21]

There were projects which conducted public health impact assessment. For example, the EIA for the integrated waste management facilities to be built in Shek Kwu Chau has included a human health impact assessment. However, the inclusion of such an assessment is not a mandatory practice. Since 2013, there is no major discussion on the possible amendment of EIAO.

3. REVIEW OF *A CLEAN AIR PLAN FOR HONG KONG* (2013)

A Clean Air Plan for Hong Kong (CAP2013) was published by the Environment Bureau of the HKSAR Government in 2013, in collaboration with the Transport and Housing Bureau (THB), Food and Health Bureau (FHB), Development Bureau (DevB) as well as other relevant departments.

In summary, the stated targets in the *CAP2013* were largely achieved except, for AQO for nitrogen dioxide (annual average concentration) which has not yet been achieved. The sections below also review the development of other key areas of the air quality management system outlined in the *CAP2013*.

Some of the Stated Targets in the *CAP2013*[22]

2012 Hong Kong-Guangdong agreement on regional pollution reduction targets

Latest status: The Hong Kong and Guangdong governments drew up the P*earl River Delta Regional Air Quality Management Plan* under which, both sides have been pursuing emission reduction measures targeting power plants, motor vehicles, and heavily polluting industrial processes.

2014 New AQOs to come into force

Latest status: New AQOs became effective on 1 January 2014

2014 New Air Quality Health Index (AQHI) to complement the new AQOs

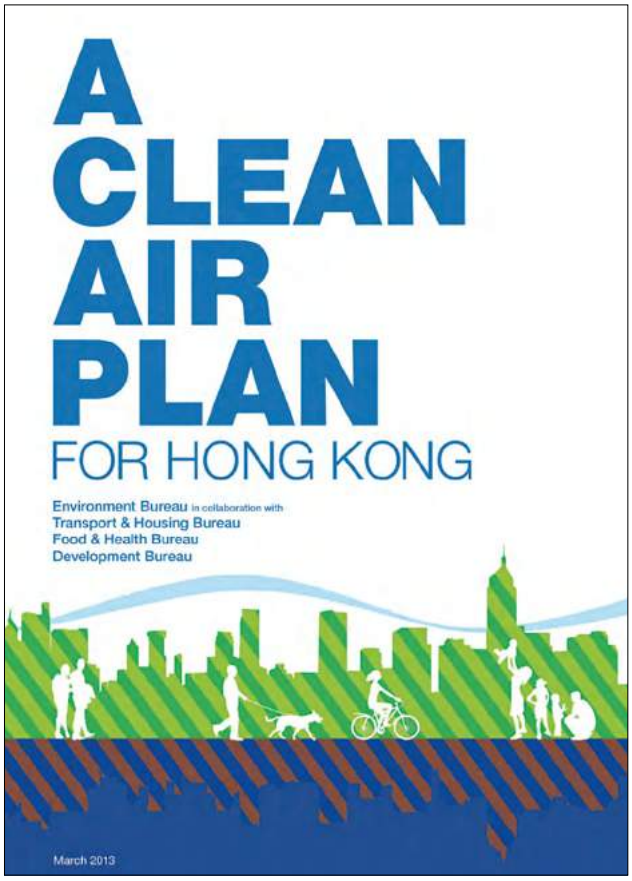
Latest status: The new AQHI became effective in late 2013.

2015 Achieving Hong Kong's Hong Kong-Guangdong targets for 2015

Latest status: Hong Kong achieved 2015 reduction targets, which were measured in tonnage for SO_2, nitrogen oxides (NO_x), respirable suspended particulates (RSP), and volatile organic compound (VOC)

2020 Achieving new AQOs by 2020 and Hong Kong's- Hong Kong-Guangdong targets for 2020

Latest status: Annual concentration levels of roadside NO_2 was 70 μg/m^3 in 2020, which were still exceeding the AQO. The HKSAR Government has not released official data to show whether the emission reduction target in 2020 was achieved.



Air Quality Monitoring System

During 2013-2020, three new general stations were set up in Tseung Kwan O, the North District, and the Southern District.

However, while the academia and scientists expressed the frustration of the lack of street-level air pollution monitoring stations,[23] there has been no progress in setting up new air quality monitoring stations at the roadside.

A Multi-functional Smart Lamp posts pilot scheme[24] was implemented in 2018. The lamp posts include sensors that are able to collect real-time data on air pollution, weather, temperature, people, and vehicular flow.

The three-year programme aims to install some 400 smart lamp posts in phases in four districts with higher pedestrian and traffic flow, namely Central/Admiralty, Causeway Bay/Wan Chai, Tsim Sha Tsui, and Kwun Tong/Kai Tak Development Area. The pilot scheme was paused in 2019 due to privacy concerns.

Air Quality Health Index

In late 2013, the EPD launched the AQHI to replace the Air Quality Index. The AQHI focuses on informing the public of the short-term health risks of air pollution. The reason for the government to introduce the AQHI is, to change the behaviour of individuals with substantial health risks during high pollution episodes, and reduce their exposure to air pollutants.

However, a study conducted by HKU School of Public Health[25] suggested that the AQHI does not have a significant impact on reducing the rate of emergency admissions for cardiovascular diseases for the elderly in Hong Kong.[26] The introduction of the AQHI also failed to reduce the rate of emergency admissions for respiratory diseases for both the elderly and children. The policy intervention by introducing the AQHI has no statistically valid impact on the change of emergency admissions for both cardiovascular and respiratory diseases.

Unaddressed Systemic Disconnections

Air pollution has remained a serious problem in Hong Kong for so long, even though Hong Kong is is prosperous and institutionally mature. This suggests that there must be underlying causes that make tackling air pollution difficult. Major disconnections had been identified by a local research institute in 2012.[27] However, when most of the goals and measures of the *CAP2013* expired in 2020, these major disconnections in policymaking and scientific and political areas still exist.

i) Disconnection in policymaking

The *CAP2013* was published by the Environment Bureau in collaboration with the THB, FHB and

3. REVIEW OF A CLEAN AIR PLAN FOR HONG KONG (2013)

DevB. The roles of THB, FHB, and DevB were not clarified in the delivery of the *CAP2013*. There was also a lack of measurable goals for the three bureaux.

ii) Science disconnection

Since 2013, there have been more studies conducted by EPD on public health impacts.

One critical study conducted was on "Developing an Instrument for Assessing the Health and Economic Impacts of Air Pollution in Hong Kong".

However, there is no government body or official responsible for measuring or preventing the public health impacts of air pollution yet. For example, there is a lack of open data sharing by the Hospital Authority on the number of doctor visits or hospital bed days caused by high air pollution episodes.

iii) Political disconnection

Since 2013, the Government has been more successful in winning political support from the Legislative Council on emission control solutions. For example, a fund of over HK$10 billion was secured by the Government in 2014 to phase out some 82,000 pre-Euro IV diesel commercial vehicles.

However, there was still a lack of significant progress on transport management solutions. The THB has proposed measures to relieve congestion in recent years but they have been unsuccessful. For instance, repeated attempts to rationalise bus routes were opposed by District Councils. The proposal to implement Electronic Road Pricing[28] has been stalled for years. Even for relatively mild measures, such as the improvement of the pedestrian environment to reduce reliance on cars, challenges may be anticipated, given the lack of support on the ground.

4. REVIEW OF CONTROL MEASURES SINCE 2013

Emission from Road Transport

In Hong Kong, the roadside air pollution level has consistently been beyond the acceptable level of the most stringent WHOAQGs. Commercial vehicles and franchised buses account for over 90% of roadside air pollution. A study shows that Heavy Duty Diesel Vehicles (HDDV, buses and trucks) and Light Duty Gasoline Vehicles (LDGV, taxis and minibuses) account for over 40% of respiratory mortality and lung cancer cases in the population of Hong Kong due to NO_x emissions.[29]

The roadside air pollution is mainly caused by 4 groups of road vehicles, including diesel commercial vehicles, franchised buses, LPG taxis and minibuses, and non-road mobile machinery.

Since the launch of the *CAP2013*, the Government has taken several measures[30] which achieved various degrees of success. Overall, there was a 30% decline in the concentration level of major air pollution at the roadside from 2013 to 2017.

Phasing Out Pre-Euro IV Diesel Commercial Vehicles

In 2012, diesel commercial vehicles (DCVs), which comprise about 20% of the total road vehicle fleet, account for 76% of NO_x and 88% of RSP emissions from all road vehicles.

In 2014, the Government launched a landmark incentive-cum-regulatory programme to phase out 82,000 pre-Euro IV DCVs. A fund of over HK$10 billion was allocated by the Government to subsidise the vehicle owners to purchase new vehicles or scrap the old and polluting ones. The

Government also limits the service life of DCVs registered on or after 1 February 2014 to 15 years. With its success to control the levels of roadside particulate matter (PMs) and nitrogen dioxide, the Government has extended the scheme in 2020 to phase out another 40,000 Euro IV DCVs.

Summary

The incentive-cum-regulatory approach adopted by the Government was effective in phasing out the old and polluting DCVs. As a result, the levels of roadside PMs and NO_2 has declined.

Controlling Emission from Franchised Bus Fleet

Since the launch of CAP2013, the Government has relied on 3 primary approaches to manage emissions from the franchised bus fleet.

i) Retrofitting bus vehicles with Selective Catalytic Reduction (SCR) Devices:

The EPD embarked a programme which was worth HK$400 million in 2013 to subsidise franchised bus operators to retrofit SCR devices in Euro II and III diesel buses. The buses would then be upgraded to achieve an emission standard comparable to that of Euro IV or Euro V standards.

It is noteworthy, however, when compared to the latest Euro VI or hybrid models, the Euro IV and Euro V standards are still very lenient. Euro V buses emit 4 times more NO_x and 1 time RSP than Euro VI, whereas Euro IV models emit 9 times more NO_x and 1 time RSP than Euro VI.[31]

ii) Franchised Bus Low Emission Zones

In 2015, there were 3 Low Emission Zones (LEZs) officially set up in the districts of Causeway Bay, Central, and Mong Kok. Within the LEZs, franchised bus companies were required to deploy low emission buses meeting Euro IV or above emission standards in 2015. In 2019, the zones were renamed as Franchised Bus Low Emission Zones (FBLEZs) and the standards have been tightened to Euro V.

It is believed that the original purpose of setting up the LEZs in 2015 was to promote the deployment of cleaner franchised buses. Since 2015, the Government has not expressed any intention to expand the LEZs. Apparently, the only indicator that measures the success of the programme is the compliance rate of the deployment of low emission buses. There is no specific emission reduction target measured in terms of the concentration level of air pollutants in those 3 LEZs.

iii) Franchise agreement

The Public Bus Service Ordinance (PBSO) requires the retirement of all buses after 18 years from the date of manufacture. As the older buses are retired, the bus operators will need to purchase new vehicles.

Under PBSO, the franchises were granted to Franchise Bus Operators, under various conditions, including environmental requirements. The Section 26 (for KMB, Citybus F1, New Lantao Bus, and New World First Bus)[32] or Section 27 (for Citybus F2 and Long Win Bus)[33] of the Franchise state that:

> *"When acquiring new buses and setting specifications for such acquisition, the Grantee shall, as far as reasonably practicable:-*
>
> *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."*

However, it is unclear who is responsible for determining whether the conditions were met and how to do so.

Summary

In 2011, franchised buses accounted for about 20% of NO_x emissions and 6% of RSP emissions amongst the whole vehicular fleet.[34] However, latest Government figures in 2019 showed that franchised buses still accounted for nearly one fifth of key pollutant emissions, including the emissions of RSP (19%), fine suspended particulates (FSP) (19%), and NOx (18%). [35]

It appears that the strength of the control measures adopted by the Government since 2013 were not sufficient to significantly reduce emissions from franchised buses.

Controlling Emission from LPG Vehicles

i) Replacement of catalytic converters

In 2013, the Government introduced a programme which was worth HK$80 million to subsidise owners of some 17,000 LPG and petrol taxis and light buses to replace their worn-out catalytic converters and oxygen sensors.

A scientific study found that the catalytic converters of high-mileage vehicles, such as taxis and light buses, should be replaced every 18 months. Studies also showed that poorly maintained petrol and LPG vehicles can emit up to 10 times more pollutants and worsen the roadside air quality.

As the subsidy scheme was not extended, questions emerged as to whether LPG vehicle owners would pay for the replacement of the parts. In 2014, EPD responded by implementing a new and strengthened vehicle emissions control regime for LPG vehicles, to enforce vehicle emission standards of carbon monoxide, hydrocarbons, and nitrogen oxides.

ii) Strengthening remote sensing system and enforcement

In 2014, EPD announced a new programme which deployed mobile remote sensing equipment at the roadsides to identify petrol and LPG vehicles with excessive emissions. It was considered as a new measure under the regulatory regime.

If a vehicle is found to have exceeded its applicable emissions standards, the owner must have the vehicle tested and pass a dynamometer-based emission test at a Designated Vehicle Emission Testing Centre (DVETC) within 12 working days.

The EPD claimed that the programme was very effective in tackling excessive emission problems of petrol and LPG vehicles.[36] Between 2014 and 2016, gross emitters in the petrol vehicle fleet have been reduced from about 10% to 5% and those in LPG vehicle fleet from about 80% to 20%.

Non-road Mobile Machinery

Non-road mobile machinery (NRMM) include a wide range of mobile machines or vehicles powered by internal combustion engines used primarily off-road. As NRMMs could be operated in construction sites that are located in close proximity to residential and commercial areas, their emission is a public health concern.

Since 2015, the Government has been making an effort to control emissions from NRMMs by optimising the labelling system, tightening the emission standards, and broadening the scope of the New Energy Transport Fund to cover new energy non-road vehicles.

4. REVIEW OF CONTROL MEASURES SINCE 2013

Impacts of the Road Transport Emission Control Programme

A scientific study showed that the measures achieved various degree of success in controlling roadside air pollutants, especially PM2.5 and PM10. However, as roadside NO2 emission is still a major issue, questions arise as to whether aggressive measures are needed to make a transition into the use of vehicles with a new energy mode.

Figure 6: Correlation between observed concentration changes, wind changes and control policies

$PM_{2.5}$	Roadside	Ambient
Observed Concentration Changes	-10.7±2.4	-6.7±1.8
Conc. change due to wind changes	-1.1±0.4	-0.3±0.2
Conc. change NOT related to wind changes	-10.7±1.6	-6.7±1.2
Conc. change due to Control Policies	-4.5±0.8	-2.8±0.1
Catalytic Converter Replacement (15%)	-0.7±0.1	-0.4±0.4
Pre-Euro IV DCVs Replacement (76%)	-3.5±0.6	-2.2±0.0
SCR retrofit (9%)	-0.4±0.1	-0.3±0.5
Non-local changes	-4.7±2.7	

PM_{10}	Roadside	Ambient
Observed Concentration Changes	-15.4±4.8	-9.9±2.6
Conc. change due to wind changes	-0.9±0.3	-0.6±0.2
Conc. change NOT related to wind changes	-15.4±3.4	-9.9±1.9
Conc. change due to Control Policies	-6.8±1.4	-4.36±0.9
Catalytic Converter Replacement (12%)	-0.79±0.2	-0.51±0.1
Pre-Euro IV DCVs Replacement (80%)	-5.41±1.2	-3.47±0.7
SCR retrofit (9%)	-0.59±0.1	-0.38±0.1
Non-local changes	-6.6±5.6	

Source: Alexis K.H. Lau (2017). 'Air Quality in Hong Kong Past, Present and Future' [Power Point presentation at RAQM-5 Hong Kong Forum][87].

Transitioning into the Use of New Energy Vehicles

To further reduce roadside air pollution, it is critical to transform road vehicles into vehicles with zero direct emission modes. Among all vehicles, commercial vehicles (CV) and public transport (PT) account for over 90% of the roadside air pollution.[38] Therefore, it is imperative to formulate a strategy with CV and PT as the focus.

However, during the period from 2013 to 2020, the impact achieved by the Government to promote electric vehicles for private, commercial, or public transport in Hong Kong was limited.

In 2009, the Steering Committee on Promotion of Electric Vehicle, chaired by the Financial Secretary, was set up with the objective to "recommend a strategy complementary with specific measures to promote the use of electric vehicles in Hong Kong, having regard to the resulting energy efficiency, environmental benefits and the creation of business opportunities."[39]

However, since its establishment, the Committee has presented no clear target, strategy, or timeline to achieve the objective. There is no public record of meeting agenda or minutes - as the Government claimed: "the Committee's meetings were conducted confidentially to encourage frank and open discussion"[40] – thus it is challenging for the public to demand accountability of any plans developed by the Committee.

Moreover, the Government provides a subsidy for operators to trial new energy vehicles. In 2011, the Pilot Green Transport Fund was established by the EPD to drive research, development, and trial of new energy vehicles in Hong Kong.

However, the impact achieved has been minimal. For example, by the end of 2020, there were only 36 electric buses in service, which accounted for only 0.5% of all 6,000 franchised buses in Hong Kong.[41] There was a smaller number of other types of commercial vehicles which were fuelled by new energy modes.42 The Pilot Green Transport Fund was renamed as the New Energy Transport Fund with its scope expanded in September 2020.[43]

Emission from Vessels

In 2012, a scientific study found that emissions from ocean- going vessels (OGVs) were an emerging issue causing significant environmental and health impacts in Hong Kong. Particularly, the OGVs, primarily the container vessels and the cruise ships, accounted for the majority of the emissions of the whole shipping sector.[44]

Of all the emissions from OGVs, about 42 per cent of SO2, 30 per cent of NOX and 33 per cent of PM10 were emitted when the vessels were at berth due to the burning of bunker fuel when the auxiliary engines and boilers were in operation. Emission hot spots found include the container terminals in Kwai Chung and Tsing Yi Island and the cruise terminals in Tsim Sha Tsui. Strong health concerns arose for population living and working in these communities as they were likely to have constant exposure to much higher concentration of air pollutants.[45]

Since 2013, the Government has taken a number of measures to control emissions from both OGVs and local vessels. Most significantly, a landmark regulation was made in 2015 to require OGVs to use cleaner fuel at berth. The impact was significant and immediate.

Controlling Emission from OGVs

On 1 July 2015, HKSAR became the first port in Asia to mandate 'Fuel Switch at Berth' to regulate OGVs to use fuel with a maximum of 0.5% sulphur content m/m (mass by mass) at berth.

By EPD's estimates, this switch will enable Hong Kong to reduce its total SO_2 and PM emissions by 12% and 6% respectively. The reductions are even greater at the main berthing locations, reaching over 70%. Subsequently, from 1 January 2019 onwards, HKSAR extended the regulations to cover all HKSAR waters.[46]

International Maritime Organization (IMO) has set the same limit for sulphur content (fuel with maximum 0.5% sulphur content m/m) for ships operating outside designated Emission Control Areas (ECAs) and it is effective from January 2020.[47] Questions remain as to when Hong Kong and the Pearl River Delta (PRD) ECA will further tighten its standards (maximum 0.1% sulphur content m/m).

Controlling Emission from Local Vessels

The first hybrid (diesel-electric) ferry trial was launched in July 2020. A study showed that, if all the ferries operating in the seven in-harbour routes are replaced by electric ferries, the biggest environmental benefit will be the achievement of zero emission of air pollutants from these ferries in the Victoria Harbour.[48]

It is anticipated that both SO_2 and NO_x concentration levels will be lowered significantly, especially the portion contributed by the outlying island ferry operations. Also, air quality improvement will be more noticeable during high air pollution days with weak or no wind, as a major source of air pollution in the harbour area will be eliminated.

Summary

Since 2015, the HKSAR Government has taken an effective approach to control SO_2 emitted by vessels. Hong Kong became the first port in Asia to mandate fuel switch at berth. The success provided valuable experiences for the PRD region to follow suit.

With the advancement of technology, electric vessels have become more technologically and commercially viable. In fact, the HKSAR Government had conducted a feasibility study of the provision of onshore power supply at Kai Tak Cruise Terminal.[49] In 2015, however, the plan was not carried out by the Government as it was considered a costly system to build.

Electricity Generation

The APCO (Cap. 311) was amended in 2008 to empower the Government to cap the emissions of power plants for improving air quality. The Secretary for the Environment was delegated to allocate emission allowances to power plants for three specific pollutants, namely SO_2, NO_x, and RSP, by way of a Technical Memorandum (TM).

The TM was reviewed by the EPD a couple of times from 2014 to 2019.[50] The latest TM, which is the seventh TM, was issued in 2017 to further tighten the power sector's emission caps for SO_2, NO_x, and RSP, compared to the emission caps set under the first TM in 2010 by around 60 to 80% from 2022 onwards.

The Government has also entered into a new Scheme of Control Agreements (SCAs) with the two power companies in 2018. Under the new SCAs, incentive and penalty schemes will be revamped to better encourage the power companies' performance in supply reliability, operational efficiency, customer services, promotion of energy efficiency, and conservation (EE&C), as well as the development of Renewable Energy.

Decarbonisation

In addition to emission of air pollutants, over 70% of carbon emission is from the energy sector.[51]

In 2017, the HKSAR Government announced the *Hong Kong's Climate Action Plan 2030+*, outlining the Government's longer-term action in combating climate change. In *Policy Address 2020*, the Chief Executive further pledged to achieve carbon neutrality by 2050.

It is important for the Government to formulate a green and clean energy policy that will achieve the twin goals of decarbonisation and clean air. Currently, though , there is a lack of a time-bound target for reaching a certain portion of non-coal or renewable energy sources.[52]

Regional Collaboration

In 2012, the Hong Kong and Guangdong governments set the 2015 emission reduction targets and the 2020 emission reduction ranges for 4 major air pollutants (SO_2, NO_x, RSP, and VOC) in the RPD Region. By the end of 2017, both sides confirmed the attainment of the emission reduction targets in 2015 and finalised the reduction targets for 2020.[53]

4. REVIEW OF CONTROL MEASURES SINCE 2013

Figure 7: Emission reduction targets for Pearl River Delta (PRD) Region

Pollutants	Region	2015 Emission Reduction Targets *	2020 Emission Reduction Targets *
Sulphur dioxide (SO_2)	Hong Kong	-25%	-55%
	PRD Economic Zone	-16%	-28%
Nitrogen oxides (NO_x)	Hong Kong	-10%	-20%
	PRD Economic Zone	-18%	-25%
Respirable suspended particulates (RSP)	Hong Kong	-10%	-25%
	PRD Economic Zone	-10%	-17%
Volatile organic compound (VOC)	Hong Kong	-5%	-15%
	PRD Economic Zone	-10%	-20%

*Reductions are relative to 2010 emission levels

Source: The Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection

In 2018, the two governments launched a study on post-2020 regional air pollutant emission reduction targets and concentration levels for Hong Kong and Guangdong.[54] It was clear that both Governments had the intention to establish a regional emission reduction target based on concentration after 2020. However, the target has not been released yet as of March 2021.

One key issue observed recently is the alarming long-term upward trend of ambient ozone.[55] A scientific study showed that regional collaboration through an evidence-based approach is the key to control ozone.

In 2020, the governments of Hong Kong, Guangdong, and Macao launched a three-year joint study on "Characterization of photochemical Ozone formation, regional and super-regional transportation in the Greater Bay Area"[56] to understand the sources of precursors of ozone, including VOCs.

RECOMMENDATIONS FOR THE GOVERNMENT AND THE SOCIETY (2021-2030)

Introduction

Globally, air pollution is the single greatest environmental threat to public health. Many of the causes of air pollution are major contributors to climate change, which also impacts the population's health.

In Hong Kong, a majority of the population is likely to be exposed to roadside air pollution on most days of the year. Roadside NO_2, roadside PMs, and ground-level ozone are the air pollutants causing concern today.

It is estimated that, in one year alone (2019), over 1,700 premature deaths, over HK$20 billion in economic losses, 130 thousand additional hospital bed days, and 2.3 million additional doctor visits were caused by air pollution in Hong Kong.[57] Air pollution has been linked to cancer, asthma, cardiovascular disease, diabetes, obesity, and dementia.[58]

The effects of air pollution can be lifelong. They can start before birth and are shown to have a greater impact on babies, children, young people, and the elderly. People with chronic diseases, including respiratory and circulatory diseases, are especially vulnerable. The more deprived districts experience worse air quality, hence further driving health inequalities.[59]

RECOMMENDATIONS FOR THE GOVERNMENT AND THE SOCIETY (2021-2030)

Our message is clear: air pollution is a modifiable and avoidable cause of morbidity and mortality and as such, action can and should be taken to reduce or remove this harm.

In order to maximise public health gain, respond to climate urgency, and fulfil the United Nations development goals as pledged by the HKSAR Government, this paper proposes a framework and measures that can be adopted in the Government's new Clean Air Plan and the concerned sectors of the society.

Our Aspiration

The goal is for Hong Kong to be among the top-ranked Asian metropolises and world financial centres for air quality by 2030.[60]

With a significant portion of road vehicles to be transformed into electric vehicles or vehicles of other zero emission modes, a fairer share of road spaces among different commuters, more walkable streets, ample green spaces, minimised ship emissions, and expected improvement in the regional air quality, the targets of Hong Kong's AQOs should be tightened to levels in line with the WHOAQGs by 2035.

By achieving significant progress in improving air quality, Hong Kong will become a much healthier city that fosters the physical, mental, and social well-being of the population.

Our vision for 2030 can be briefly summarised as follows.

Commuting by Cleaner Vehicles and Healthier Modes

By 2030 the transportation sector will be transformed. People will travel by a combination of public and private electric vehicles. There will be autonomous vehicles running. More importantly, the distance travelled by vehicles will be reduced, due to changing patterns of living and working. A larger share of trips, especially of the last mile, will be conducted by all kinds of healthier active transport modes, including walking, biking, and newer types of light-weighted and personalised commuting tools.

An infrastructure development goal is to be established for 2025 for the construction of a dense charging station network to support the use of electric vehicles.[61] Feasible financial, operational, and technological models are to be demonstrated.

A portion of the commercial vehicle fleet will become zero emission. More heavy-duty vehicles, including buses and trucks, will be powered by electricity and other energy modes. Electric minibuses will be popularised and used in major routes. There will be showcases of successful electric taxis. New service models will reduce the need for personal vehicle ownership.

With technology development that optimises the operation of loading and unloading activities, the safety and walking experience of commuters will be further enhanced.

Enjoying a World-class Green Harbour

In the upcoming decade, the emission standard of the ECA covering the waters in PRD and Hong Kong will be further strengthened to cover NO_x. There will be more OGVs, including container vessels and cruise lines, which can switch to the 'use electricity when berthing or entering.' Only the OGVs installed with a selective catalytic reduction system will be allowed to enter the ECA. The air quality of the whole Greater Bay Area (GBA) will be benefited as Hong Kong strives to become one of the greenest ports.

In Hong Kong waters, we will commute by electric ferries for in-harbour and outlying island routes. With other developments along the harbour coastlines, Hong Kong residents and visitors will be able to enjoy a world-class harbour and harbour front.

Minimising the Outdoor and Indoor Exposure Health Risk

With a stronger dedication to scientific research, Hong Kong will be one of the places with the best knowledge of exposure and health risk management.

Hong Kong will move towards an exposure control paradigm. Our policy success will be measured not only by concentration but also by reduced exposure or health risk. Policies tailor-made for minimising vulnerable groups' exposure to air pollution will be designed and implemented. The overall reduced risk and health outcomes due to the population exposure will be quantified.

Not only will outdoor exposure hot spots be identified in each district of Hong Kong, but there will also be more related information for indoor environment. Guidelines and regulations will be updated to safeguard the health of the population. Members of the general public will be alerted whenever they are close to the exposure hot spots so that they can make choices on their behaviour accordingly. Mitigation measures, such as the designation of Low Emission Zones 2.0

that cover more geographic areas and regulate more vehicle types, will be experimented to control the risk of exposure.

As more knowledge and experience are accumulated, our R&D will become more mature. Solutions that tackle problems at various stages of the exposure control paradigm will be made available in other cities in the region and the world.

Becoming a Genuine Smart City

In the next decade, environmental health risk factors will be examined and tackled holistically. Data on air pollution, health, transport, and urban planning streams will be integrated to support a 360-degree, evidence-based management system that supports cross-sectoral issues policymaking. In order to achieve this, a wide network of air pollution monitoring devices of superior quality will be deployed across the territory of Hong Kong.

The information will be useful to strengthen the public's awareness and understanding of the risks they are exposed to in their daily routines. Clinics, sports grounds, transport nodes, schools, and the elderly and children care centres will be equipped with monitoring devices. Air pollution audits will be conducted regularly in neighbourhoods and indoor environments to ensure that the users are sufficiently protected.

Being Part of an Informed and Mobilised Citizenry

All this will pave the way for building a more informed and mobilised citizenry. Tailor-made education curriculum on air pollution will be popularly used in secondary and primary schools. Citizens, of all backgrounds, will become more willing to be engaged in issues concerning clean air at work or in a voluntary capacity. Well-informed discussions, deliberations, and debates will form the basis for new organisations, ideas, and actions to emerge.

The general public will have a stronger understanding of the limitations and potentials of current approaches to clean air. Under such vibrant landscape, there is a stronger momentum to pass policies that were proven successful elsewhere but seen controversial in the past.

There will be a lot more local and global talents who will excel in roles in the environmental health arena or other well-being related industries and support the next wave of green economy in Hong Kong.

Recommendations

In order to achieve the aspiration, it is suggested that the HKSAR Government and the society consider the following objectives, principles, and measures to clean the air.

FOUR KEY OBJECTIVES:

A. Become the place among the best air quality by 2030 and achieve WHO AQGs by 2035

B. Become the place with the best knowledge on exposure management

C. Become the Bay Area which is truly liveable with clean air and low carbon

D. Foster an informed and mobilized citizenry

In order to achieve the above key objectives, the below framework and measures are proposed.

Objective A. Become the place among the best air quality by 2030 and achieve WHO AQGs by 2035)

Figure 8: Comparison of air pollution level among selected cities

City	Population (million)	GDP per capita (US$)	PM2.5 level (WHO 2018) (microgram per cubic meter)	Compared to Hong Kong's PM2.5 level
Stockholm	1.0	76,993	5	-78%
New York	8.4	31,417	7	-70%
San Francisco	0.8	60,300	8	-65%
Melbourne	4.5	72,600	8	-65%
London	9.0	75,467	12	-48%
Hamburg	1.7	80,087	14	-39%
Paris	12.2	69,139	16	-30%
Tokyo	13.7	70,225	17	-26%
Singapore	5.7	65,233	18	-22%
Hong Kong	7.5	48,713	23	N/A
Shenzhen	13.4	30,523	27	+17%

Source: The World Bank, U.S. Census Bureau, National Institute of Statistics and Economic Studies, France, Census and Statistics Department of Hong Kong

The goal is for Hong Kong to be among the top-ranked Asian metropolises and world financial centres for air quality by 2030.

In addition, with expected improvement in regional pollution, and significant development in terms of controlling roadside and ship emission, the HKSAR Government should strive to level HK AQOs with WHO AQGs for all pollutants by 2035.

Principle A1. Emphasize accountability and communication to ensure achievement of specific and time-bound targets

A1.1 The Government should commit to review the new Clean Air Plan and publish progress reports regularly.

RECOMMENDATIONS FOR THE GOVERNMENT AND THE SOCIETY (2021-2030)

A1.2 The public should be well informed on the progress and achievement of various goals and milestones. To achieve this, the Government should broaden and deepen its engagement with all citizens.

Principle A2. Integrated bureau efforts to tackle air pollution

A2.1 As the limitation of emission control measures will arrive shortly, it is crucial to have a joint effort from other bureaux and departments of the HKSAR Government to lead, and to deliver integrated solutions from transport demand management and urban planning approaches. It requires coordinated cross-bureau efforts to significantly reduce air pollution further.

A2.2 It is recommended to set measurable goals for the Transport and Housing Bureau, Development Bureau and Food and Health Bureau, with a joint vision to clean up Hong Kong's air and thus minimize public health cost.

Principle A3. Transition to zero emission vehicular fleet to minimize roadside pollution

A3.1 Due to Hong Kong's congested cityscape, emission from road transport is usually in close proximity to a large group of the population who commute, work or even reside by the roadside. It is therefore of high priority to minimize roadside air pollution from the public health perspective.

A3.2 Despite the declining trend of street level particulate matter, the roadside nitrogen dioxide presents a severe health risk to individuals. Phasing out diesel vehicles, including all commercial vehicles, public transport, and private vehicles, will be the key to further control roadside air pollution.

Deep-lying issues to be addressed to transition to zero-emission vehicles

A3.3 Currently, new energy vehicles only occupy a neglectable fraction out of the total fleet among commercial vehicles (CV) and public transport (PT).

A3.4 The Roadmap on Popularisation of Electric Vehicles (Roadmap) published by the Environment Bureau in March 2021 failed to address long-entrenched, deep-lying issues that hinder the progress of transitioning to new energy vehicles, especially for commercial vehicles and public transport.

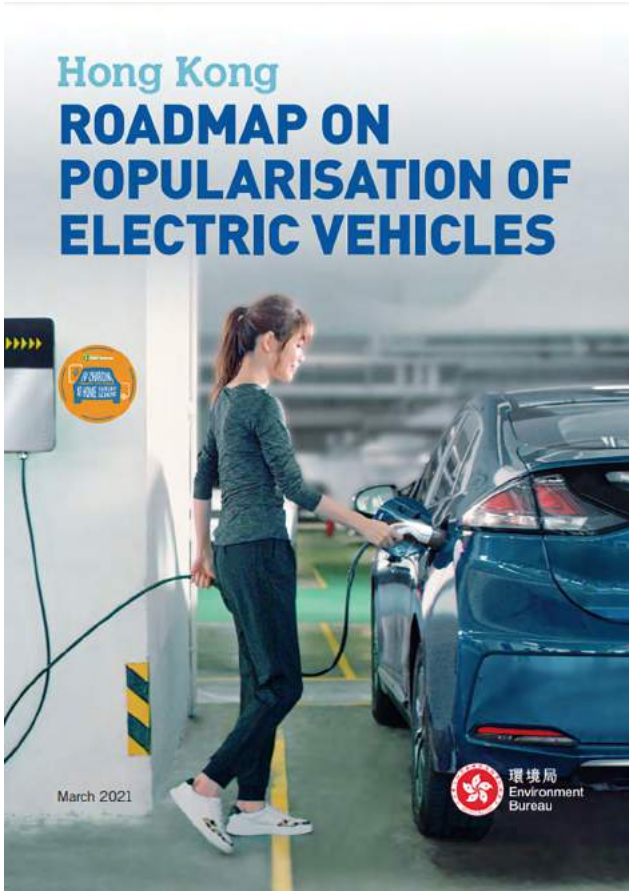
- policy direction - there is no clear deadline for phasing out or banning registration for conventional ICE CV and PT

- infrastructural - there is no infrastructure development goal for charging electric or other new energy CV and PT

- financial support - there is no injection of additional financial resources to support purchase or switch to new energy CV and PT

- vehicles technology (range and reliability) - the Roadmap emphasised the importance of having further trials of electric CV and PT in the near term. However, there is no new approach to ensure a better trial design.

- operational / business model - the Roadmap failed to elaborate on the possibility of alternative operations or business models that could make electric CV and PT work in the short/medium terms.



A3.5 It is recommended the next version of the Roadmap (to be announced by the Government in 2025) should address all of the above issues. The HKSAR Government should strategize to phase out all diesel buses by 2040, taking reference from other global cities,[62].

Franchise Agreement Negotiation

A3.6 Currently, under the franchise agreement for public bus service, there is an environmental section[63] that regulates the 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.

A3.7 However, it is unclear how such feasibility is determined. For instance, the Government's New Energy Transport Fund, requires the franchise bus operators to apply for the fund and conduct the trials. It may be under such trials that the technological feasibility is determined.

A3.8 It is even more difficult to understand the mechanism for commercial feasibility to be determined. It is generally understood that the cost of purchase of new energy vehicles is higher. The operation model may also be adjusted to accommodate the use of new energy vehicles, which require additional costs.

A3.9 It maybe worth noting that the cost of operations may be lower than conventional vehicles due to incentives provided on fuel cost. It may be helpful if the commercial feasibility is measured by the duration of the payback period.

A3.10 It is recommended to establish an independent, transparent and systematic mechanism to determine the technological and commercial feasibility of new energy vehicles prior to the next phase of negotiation of the franchise agreement which starts from 2025 onwards.

Transforming franchised bus fleet to boost confidence

A3.11 If it is demonstrated successful to electrify public franchised bus fleets, there would be a strong boost of public confidence in transforming other vehicle types, including minibus, taxi and other goods vehicles.

Principle A4. Establish new marine emission standard and facilitate transitions to cleaner vessels

A4.1 Shipping emission accounts for the largest quantity of air pollutants in Hong Kong. With thousands of people residing and working close to one of the busiest container ports and shipping routes in the world, Hong Kong should step up its effort to become the greenest port and part of the greenest waters in the world.

A4.2 Based on the latest marine vessels emissions inventory, it appears that the policymakers need to develop a strategy to target all OGVs, RVs, and LVs in order to reduce the emissions from marine vessels.

Figure 9: Total Projected Marine Vessel Emissions in Percentage Share, Selected Years

	Vessel Type	2007	2008	2009	2010	2015	2020
SO_2	OGVs	79%	81%	79%	80%	81%	84%
	RVs	12%	11%	12%	11%	11%	10%
	LVs	9%	8%	9%	9%	8%	7%
NO_x	OGVs	44%	46%	43%	44%	46%	48%
	RVs	24%	24%	25%	25%	25%	24%
	LVs	32%	31%	32%	31%	30%	28%
PM_{10}	OGVs	68%	70%	68%	70%	72%	75%
	RVs	13%	13%	13%	13%	12%	11%
	LVs	19%	17%	19%	17%	15%	14%
$PM_{2.5}$	OGVs	66%	69%	67%	68%	71%	74%
	RVs	14%	13%	14%	14%	13%	12%
	LVs	20%	18%	20%	18%	16%	14%
VOC	OGVs	18%	20%	16%	19%	21%	25%
	RVs	7%	7%	6%	7%	8%	7%
	LVs	75%	74%	78%	74%	71%	68%
CO	OGVs	13%	14%	12%	14%	15%	18%
	RVs	8%	8%	7%	8%	8%	9%
	LVs	78%	77%	81%	78%	76%	74%

Source: Study on Marine Vessels Emission Inventory, Institute for the Environment, HKUST (2012)

Abbreviations:
OGVs – Ocean-Going Vessels RVs - River Vessels LVs - Local Vessels

A4.3 Overall strategy

There are multiple possible measures to further reduce emissions from marine vessels with varying estimated effects.

Such measures include retrofit technique (installation of diesel particulate filters (DPF), selective catalytic reduction (SCR), exhaust gas scrubbers, etc), applying on-engine modification, using diesel fuel alternatives, and deploying operation strategies.

Figure 10: Selected emissions control measures

Technology	General Emissions Control Technologies				
Name	Diesel Oxidative Catalysts (DOC)	Diesel Particulate Filters (PDF)	Selective Catalytic Reduction (SCR)	Exhaust Gas Scrubbers	Shore power
Application	Trucks CHE (>750hp) Marine & CHE (>750hp) Locomotives	Trucks CHE (>750hp) Marine Locomotive	Trucks CHE (>750hp) Marine Locomotive	CHE Marine Locomotive	Marine
Targeted Air Pollutant	PM 20-30% HC 50-90% CO 70-90%	PM up to 90% HC, CO 60-90%	NOx 70-90%	SOx 90-99% PM 60-80%	Net emissions reductions
Technology	On-Engine Modification			Diesel Fuel Alternatives	Operational Strategies
Name	Exhaust Gas Recirculation (EGR)	Engine Replacement, Repower, Rebuild	Slide Valves	Ultra Low Sulphur Diesel (ULSD)	Vessel Speed Reduction (VSR)
Application	Trucks Marine Locomotive	Trucks CHE Marine Locomotive	Trucks CHE Marine Locomotive	Trucks CHE Marine Locomotive	Marine
Targeted Air Pollutant	NOx 40-50% PM 70% (with DPF)	NOx up to 90% PM up to 90%	PM 10-50% NOx 10-25%	PM 5-15% SOx 99%	net reductions in NOx, PM

Starcrest Consulting Group (2012) Developing Port Clean Air Programs

Source: Simon K W NG (2013). 'Green Ports and Shipping in Asia' [Power Point presentation at 7th UNCRD EST Forum].[64]

A4.4 Ocean Going Vessels (OGVs)

A4.41 OGVs dominated the emission of SO_2 and NO_x. While the mandatory fuel switch at berth policy in effect from 2015 might have significantly reduced the level of SO_2, the NO_x emission is largely unaddressed.

A4.42 To further reduce NO_x emission from OGVs, one of the proven measures is to apply selective catalytic reduction (SCR) technology. With more ports providing incentives, it is more likely that the OGVs will invest to install SCR. It is recommended for the GBA to develop collaboration with other bay areas to make this happen. Further elaboration in section C4.

A4.43 Besides, based on current international and domestic frameworks, there is still room for advancement of tightening emission standards of OGVs to further reduce SO_2 and other pollutants.

A4.44 In Hong Kong, since 2015, it was made mandatory for OGVs to switch to cleaner fuel, with sulphur limited at 0.5% mass by mass (m/m). There has been no further tightening since then.

A4.45 On the domestic level, in 2019, a Domestic Marine Emission Control Area (DECA) was established in the Hong Kong waters in conjunction with the rest of the Pearl River Delta (PRD) waters. The DECA regulated all PRD waters to comply with the 0.5% rule.

A4.46 On the international level, following an amendment to Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Maritime Organisation (IMO) set a new rule in effect from 2020 that limits the sulphur in the fuel oil used for OGVs outside Emission Control Areas (ECAs) also to 0.5% m/m.

A4.47 In order words, the DECA (where PRD and Hong Kong waters are bounded by) is not applying different regulations (in terms of limit of sulphur in fuel oil) from all waters outside IMO's ECAs.

A4.48 To further control sulphur emissions, in this upcoming decade, Hong Kong should pro-actively plan with neighbouring ports in PRD for the next step.

A4.49 There are at least two options - either for PRD waters to become one of the designated Emission Control Areas (ECAs) under IMO, and therefore further tightening the sulphur limit of fuel to 0.1% m/m; or upgrade the requirement of DECA (which Hong Kong and the rest of PRD waters are bound by). The DECA 2.0 should then include the regulations of not only SO_x but also NO_x emissions.

A4.5 Local Vessels (LVs) and River Vessels (RVs)

A4.51 LVs contributed the most in terms of VOC and second, to NO_x, both pollutants are the main precursors of ground-level Ozone – which was not controlled over the last few years.

A4.52 RVs also account for a significant (1/4) portion of NO_x emission. Among all RVs, the passenger RVs, most notably the Macau Ferry and PRD Ferry, account for the high level of NO_x emissions. In total, the Macau Ferry and PRD Ferry account for double of the emissions of NO_x when compared to the the RV Fully Cellular Container Vessels (RV FCCV).

A4.53 With technology advancement, it is more possible to switch to alternative cleaner ferries, including hybrid, electric, hydrogen fuel cell, or other technology, for both LVs (that serve in-harbour and the outlying island routes) and RVs (including Macau ferry and PRD ferry).

A4.6 The roles of HKSAR Government

A4.61 Based on the aforementioned international and domestic frameworks, the HKSAR Government should work with the Guangdong Government to identify the roadmap (to either IMO ECA or DECA 2.0) to establish the emission standards.

A4.62 To comply with the standards, the HKSAR Government should serve in a leadership role to work with stakeholders to overcome barriers to facilitate the adoption of cleaner ferries as soon as possible. The possible barriers include: i) the financial cost required to trial the new ferries, ii) the additional financial cost required to purchase new ferries, iii) the new facilities, operation models, and personnel training required to deliver ferry service using the new ferries.

Figure 11: Projected RV Emissions of NOx (tonne) by Vessel Type, Selected Years

	2007	2008	2009	2010	2015	2020
Macau Ferry	2,248 29%	2,840 37%	3,501 44%	3,886 45%	4,633 50%	4,174 43%
Fully Cellular Container Vessel	2,640 28%	2,326 24%	2,189 21%	2,412 21%	2,424 20%	3,109 25%
PRD Ferry	1,341 17%	1,109 14%	995 12%	995 12%	909 10%	817 8%
Conventional Cargo Vessel	406 4%	334 3%	318 3%	291 3%	292 2%	375 3%
Lighter / Barge / Cargo Junk	374 4%	358 4%	274 3%	246 2%	248 2%	317 3%
Tug	446 5%	394 4%	322 3%	310 3%	311 3%	399 3%
Others	324 3%	342 3%	408 4%	479 4%	481 4%	617 5%
Total NO_x	7,779	7,703	8,007	8,619	9,299	9,808

Source: Study on Marine Vessels Emission Inventory, Institute for the Environment, HKUST (2012)

Principle A5. Develop an open, transparent, independent AQOs review mechanism

A5.1 A Review of the 2016-18 AQOs Review is needed. Special emphasis should be made on how data will be made available ahead of the next AQOs Review cycle.

A5.2 The future AQO Review should be health based. In the 2016-18 AQO Review, the policy measures proposed by the experts group appointed by the Government were prioritized into short, medium, and long term based on the practicality of implementing these measures. In order to maximize public health, it is recommended to develop a mechanism that prioritizes policy measures based on the impact on public health.

A5.3 An open, transparent, independent review mechanism needs to be developed and the citizens should be well informed.

Objective B. Become the place with the best knowledge on exposure management

The goal is to migrate Hong Kong's air quality management system to a new paradigm based on exposure/health risk management.

In the past, Hong Kong endured two phases of managing air pollution, each comes with a significant downside. The first "source control" phase was considered ineffective at tackling certain pollutants, for example, the ozone and particulate matter, which are formed through secondary reaction. The second "emission management" phase, arguably where we are now, is considered ineffective at preventing high end exposure to sensitive populations. Taking reference from trajectories experienced by other cities, there is a potential for Hong Kong to migrate to a new paradigm - exposure management.

Nowadays, people may spend over 80% of their time in enclosed microenvironments, such as homes, buses, schoosl, etc. On other occasions, people could be exposed to a very high level of pollution outdoors. The actual exposure of an individual is determined by targetable factors including emissions, dispersion, built environment, infiltration, and activity patterns.

With technology, it is more possible to track all these factors which opens up more ways to better manage exposure beyond managing emission. By better management of exposure, our public health will be better safeguarded.

Hong Kong can become one of the places with the best knowledge of exposure control. By doing so, we will contribute further to exposure science in the world and make an impact on the local population. Not only scientific, regulatory, and societal challenges can be better addressed, a larger population can be provided with exposure information - which is critical to individual and public health.

Principle B1. Standardize the protocol to define "exposure hot spots"

B1.1 Currently, there is no official definition of "exposure hot spots" provided by the Government. Moving forward, the Government needs to develop a definition scientifically and standardize the protocol to identify outdoor and indoor "exposure hot spots".

B1.2 Also, with the support of academia, it is possible for the Government to consider establishing an **exposure-based** index that communicates with the general public on the risk of exposure hot spots.

B1.3 In theory, the exposure-based index takes into account: a) the pollution levels; b) the proximity of humans; c) and the density of humans. In comparison, the current Air Quality Health Index (AQHI) takes into account pollution level and theoretical health impacts based on statistics.

B1.4 Whereas the current AQHI will provide theoretical health risk if any individual is at a particular location. The proposed exposure-based index will enable the policymaker to assess the actual extent of impact on human health at a particular location.

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Principle B2. Develop an integrated Data Management System

B2.1 Data on air pollution, health, transport, buildings, and urban planning streams should be integrated to support a 360-degree, evidence-based management system that supports cross-sectoral issues policymaking, benchmarking, and progress monitoring.

B2.2 The infrastructure for data collection of air pollution should be improved.

B2.3 Firstly, the density of roadside air pollution monitoring stations operated by the EPD should be enhanced. It is not only for scientific research but also to better inform the citizens about the quality of air at street level. Even during the COVD-19 period when there were more remote working and schooling practices, a lot of the population still commute, work, or reside by the roadside.

B2.4 Secondly, a stronger resourced R&D plan is required to improve air pollution micro-sensing technology until it becomes more affordable to build and operate, and provides more superior data quality. A dense network of high-quality micro-sensing devices will better inform policymakers and the general public about the risk of exposure to hot spots in the territory. Strategic locations, including potential exposure hot spots-such as public transport interchanges, sports grounds, residential buildings, and schools, should be deployed with micro-sensing devices.

Principle B3. Oversight of exposure / health risk management under the Secretary for Health

B3.1 Locations of outdoor and indoor exposure hot spots may cover a wide range of facilities under the management of multiple departments of the HKSAR Government, including public transport interchanges (TD), sports grounds that are close to road traffic (LCSD), residential buildings (BD), and schools (EDB).

B3.2 Public health can be one of the best drivers for aligning the goals of relevant bureaux and departments of the Government. The Secretary for Food and Health has much stronger authority to speak about public health impacts, such as premature deaths, hospitalizations, and doctor visits that are attributable to exposure to air pollution.

B3.3 As demonstrated in the policymaking process to address COVID-19, not only the Secretary for Food and Health is able to coordinate works among the local public health institutions, including the Hospital Authority, the Department of Health and the Centre for Health Protection also serve as the external touchpoints with World Health Organization and National Health Commission of PRC; and also manage efforts of other departments of the HKSAR Government.

B3.4 The exposure hot spots should be managed under the leadership of the Secretary for Health. In addition, health outcomes (such as premature deaths, hospital bed days, doctor visits) due to air pollution should be administered with the support of the Hospital Authority and published regularly by the Government to inform the public and vulnerable groups on health impacts due to exposure to air pollutants.

Principle B4. Make progress on Transport Management Solutions

B4.1 At particular areas and traffic peak hours, when a large number of population meet with a large number of road vehicles, the individuals are exposed to a high level of air pollution. Science shows a strong correlation between the significant increase in cancer risk with a sudden increase of human exposure to air pollution.

Set up Low Emission Zone 2.0 to reduce population exposure

B4.2 Low Emission Zone ("LEZ") is an area where vehicle entry into the zone is restricted unless the vehicle meets specified emission standards. Any vehicles that fail the standards may be either excluded from entering the zone or discouraged from entering by charging.

B4.3 In the 2015 Policy Address, the Chief Executive announced that the Government would set up three low emission zones (it was later renamed as Franchised Bus Low Emission Zones "FBLEZs") by the end of 2015 to improve roadside air quality. Under the plan, franchised bus operators will deploy only low emission buses (i.e. buses meeting Euro IV or higher emission standards or Euro II and III buses retrofitted with selective catalytic reduction devices and diesel particulate filters) to run in major corridors in Central, Causeway Bay and Mong Kok districts.

B4.4 From 31 Dec 2019, franchised bus companies were required to deploy buses meeting Euro V or above emission standards to routes running through the three FBLEZs.

B4.5 Evidence from Europe LEZs shows well-designed Low Emission Zones (LEZ) is effective in reducing concentration of air pollution.[65] Indirectly, the level of exposure of residents of particular districts, implemented with LEZ, can be reduced.

There are a couple of principles for designing an effective LEZ:

Territory covered

B4.6 The size of the LEZ is considered to be an important factor because it determines the residents who will be directly impacted, and what share of the vehicle fleet will be concerned. The FBLEZs should be extended to cover more bus routes in Central, Mong Kok and Causeway Bay Districts, and expanded to more busy districts, for example, Kwun Tong, Sham Shui Po, etc.

Equity

B4.7 Poorer districts suffer disproportionately, with higher pollution levels than the wealthy areas. LEZ could be seen as a solution to reduce residents' exposure to traffic pollution, hence the medical expenses due to air pollution. It is important for the Government to design policies in a way that additional costs for LEZ will not be borne by commuters alone.

Level of stringency

B4.8 Study shows that more restrictive zones that only allow the cleanest vehicles into a district are driving much of these results. In addition to regulating franchised buses, the Government should conduct a study to investigate how the emission requirement should be extended to other types of vehicles, including medium or heavy goods vehicles, minibuses, taxis, and non-franchised buses.

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Enforcement of policies

B4.9 Proper enforcement and penalties are key. In the Policy Address of 2020, the Government announced a conduction of further studies on Electronic Road Pricing and Toll Charge schemes. The infrastructure required to implement ERP and TC will provide an opportunity for strong enforcement of LEZ policies.

Exemptions granted to users

B4.10 Exemptions for certain groups or types of vehicles are important to consider but should be granted carefully and follow a strict timeline. Otherwise, there is a risk of opening loopholes.

Clarity and predictability of policies

B4.11 For users to adapt their behaviour and switch to cleaner vehicles or forms of mobility, a clear and predictable calendar must be established and communicated. An effective community engagement process is needed to identify real-life problems and solutions for securing support from various stakeholders.

Improve Walkability - Publish the official Walkability Study Report and follow- through

B4.12 In December 2017, the Transport Department commenced a 30-month consultancy study on enhancing walkability in Hong Kong, aiming at formulating, planning, and designing standards based on pedestrian-first principles for developing Hong Kong into a more walkable city.

B4.13 In 2019, the Walkability Study has selected Central & Western District and Sham Shui Po District as two pilot areas to test and showcase the various walkability improvement measures. If the pilot is successful, the standards and guidelines will be applied to other parts of Hong Kong.

B4.14 The Study report should have been completed by June 2020 but it has not been published till date (March 2021). It is recommended that the Government publish the Walkability Study Report and follow through with the recommendations within.

Improve Walkability – Trial new initiatives "Healthy Street" and "Play Street"

B4.15 Commuters are exposed to a high concentration of air pollution emitted from road vehicles. In a congested streetscape, air pollution is not dispersed easily, and often compounded by the Street Canyon Effect, which is commonly observed in Hong Kong.

B4.16 There are a number of initiatives under trial in different parts of the world aiming to better manage road space in busy areas where large groups of pedestrians meet a high volume of traffic.

B4.17 At a policy-making level, the Healthy Street's Approach[66] redefines the purpose of the street to enable not only commuting but also to achieve a number of positive health outcomes. Some of the more popular indicators of a healthy street include levels of clean air, noise, safety, and social well-being. By the Healthy Street's Approach in the walkability programme, it is possible to create a healthier, more inclusive city where people choose to walk, cycle and use public transport.

B4.18 Whereas the Play Street concept[67] emphasizes closing off a street to vehicular traffic either permanently or temporarily during certain hours so that it can be open for pedestrians or re-defined as a play area. In some cities, the concept is especially popular to be implemented in school zones.

B4.19 During 2018-2020, both initiatives were experimented with the participation of the community, experts, NGOs and officials from multiple bureaux and departments of the HKSAR Government.[68] It is recommended to see some of the initiatives to be implemented as a trial under the Government's walkability enhancement programme.

Principle B5. Indoor Air Quality Management

Legislation for IAQ

B5.1 There are current regulations and guidance related to indoor air quality, such as Building (Ventilating Systems) Regulations. However, there is no sign of the HKSAR Government to introducing legislations specifically addressing IAQ.

IAQ Certification Scheme

B5.2 Since establishment in 2003, the IAQ Objectives under the IAQ Certification Scheme for Offices and Public Places were finally updated in 2019.[69]

B5.3 The updates include tightening of concentration limits of certain air pollutants, including carbon monoxide, respirable suspended particulates and radon; adding new short-term objectives for formaldehyde and nitrogen dioxide; adding and removing other parameters.

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B5.4 An audit report published by the Audit Commission in 2011 found that there were no IAQ certification schemes for households, schools, elderly homes, or child care centres. Unfortunately, the situation has remained the same over the years.

Practice Notes for Public Transport Service Facilities

B5.5 There were in total 3 sets of practice notes[70] issued by the EPD to manage IAQ in air-conditioned facilities of buses, railways and ferries. The first two were issued in 2003 and the last was issued in 2015. Since 2015, there has been no review or new issue of practice notes.

B5.6 Carbon dioxide (CO2) is selected as the only surrogate indicator. The stated reason is that the "CO2 concentration in an indoor environment is a good indicator of the effectiveness of the ventilation system and the adequacy of ventilation". However, In addition to the adequacy of ventilation, it is also crucial to provide information on the concentration of various air pollutants, as it directly affects the health of commuters who stay in the facilities.

B5.7 It is not entirely clear as to which Government body is responsible for publishing the information of the level of indoor air quality of the public transport service facilities.

B5.8 There were Legislative Councilors, District Councillors, NGOs and commuters who voiced out the concern of high level of air pollution within Semi-indoor PTIs.[71]

B5.9 In addition to EPD, the Transport Department is involved to conduct regular monitoring of air pollutants (nitrogen dioxide) in semi-indoor public transport interchange over the years. The information was published upon questions filed by Legislative Councillors.[72]

Objective C. Become the Bay Area which is truly liveable with clean air and low carbon

Hong Kong and the neighbouring cities share the same air shed. We will be affected by the regional pollutants. With a population of 70 million and a GDP of USD1.6 trillion (2019), a cleaner GBA fulfils the common aspirations across all cities.

Currently, the regional Ozone and $PM_{2.5}$ remain problematic. Since 2013, there has been a continuous improvement in terms of $PM_{2.5}$ concentration in PRD regions. However, the level of $PM_{2.5}$ is still a major concern. In addition, there is a worsening trend of ground-level ozone, which is alarming.

There was a consensus among academia and the Governments to address the problems through an evidence-based approach. It requires scientific studies to lead the research and control work where Hong Kong can contribute.

By contributing to achieving a cleaner Bay Area, it is possible to reduce the frequency and severity when Hong Kong is affected by regional pollution episodes. At the same time, there is potential to achieve a stronger decarbonisation impact through a regional framework in sustainable energy and green finance.

Principle C1. Strengthen regional collaboration

C1.1 Currently, the regional emission reduction targets are based on tonnage.[73] Going forward, it is recommended that the regional target should be **concentration-based**.

C1.2 The ambient Ozone has been on a growth for consecutive years. It reaches a record high since 2011.[74] Data should be shared among the cities within GBA in order to identify the sources of precursors, including volatile organic compounds (VOC) and NOx. In addition to further study, an action plan is needed asap to mitigate the problem of Ozone.

C1.3 Meanwhile, with the new pledge to achieve carbon neutrality by 2050, the Government should clarify the target for the gradual shift to renewable energy supply in Hong Kong from now on towards 2050.

C1.4 A feasibility study is required to investigate the possibility of using cleaner energy sources across GBA.

Principle C2. Institutionalize a regional air quality agency

C2.1 With the establishment of a regional air pollution control agency, it is more effective for a high level collaboration and management across cities in GBA to coordinate scientific research and control work.

C2.2 Based on the current foundation of regional collaboration, such as the Cooperation Agreement on Regional Air Pollution Control and Prevention among Guangdong, Hong Kong, and Macao, which came into effect in 2014, a regional air pollution control agency can be established.[75]

C2.3 Possibility of regional legislation should be explored to identify the responsibilities and the authorities of the regional air pollution control agency, and clarify its relationship with the authorities of Guangdong Province, Macau, and Hong Kong.

C2.4 The regional air pollution control agency should be accountable for the achievement of the regional air pollution reduction target. The target should be set in terms of concentration of pollution and should be reviewed periodically.

C2.5 The other roles served by the regional air pollution control agency should include

- Policymaking
- Budgeting
- Identifying best practices
- Hub of information and network resources
- Fostering partnership among cities in GBA

Principle C3. Achieve clean air and decarbonisation goals together

C3.1 The regional air pollution control strategy should also prioritise measures that will achieve both clean air goals and decarbonisation goals.

C3.2 There are common root causes that lead to air pollution and climate emergency. With a stronger regional and local focus on decarbonisation, it is recommended that the authorities identify plans that will tackle both problems in terms of power generation, buildings, and transportations.

Principle C4. Collaboration with other Bay Areas

C4.1 Marine emission is the major emission source in Hong Kong. According to the 2018 Emission Inventory Report, the emissions of SO2, NOx, RSP and FSP from marine vessels accounted for 49%, 37%, 34%, and 41% of the total emissions, respectively. Among all vessels, the ocean-going vessels (OGVs) were the major emitters.

C4.2 It is unclear how the OGVs emission of NOx is to be controlled by the authority of a specific port. Currently, there is no incentive or regulatory scheme to control emissions of NOx from OGVs when they are sailing or berthing in Hong Kong waters.

C4.3 The IMO established a set of three-tier standards for NOx emissions from marine engines of OGVs. The IMO Tier I and II are global standards that apply to new oceangoing ships built in or after 2000 and 2011 respectively.

C4.4 The IMO Tier III standards apply within four ECAs designated by the IMO, to ships built after the ECA standards were implemented. In the North America ECA and the U.S. Caribbean Sea ECA, ships constructed from 2016 and onwards are subject to the IMO Tier III standards. In the North Sea and Baltic Sea ECAs, the affected ships are those built in or after 2021. The Tier III standards are 80 percent lower than the Tier I standards. Reduction of NOx can also help lowering secondary particulates and ground-level ozone.

C4.5 The emission of nitrogen oxide (NOx) by ocean-going vessels is currently unaddressed. The policy gap can be narrowed by the inter-Bay Areas collaboration.

C4.6 As the service life of existing ocean-going vessels is around 20 years or longer, the phase-out of old vessels can be too slow to create a significant improvement of NOx emissions. However, apart from improved engine design on new vessels, technologies and devices can still be applied to retrofitting existing vessels to tackle NOx emissions, such as Selective Catalytic Reduction (SCR) and Exhaust Gas Recirculation (EGR).

C4.7 To accelerate the improvement of marine emissions, some countries adopt incentive programs to subsidise the retrofit of vessels. Southern California of the United States is seeking partnership with Asian cities, including the Great Bay Area to implement Pacific Rim Initiative for Maritime Emission Reductions (PRIMER), an incentive program to incentivize cleaner vessels on the shared shipping routes, by retrofits and adoption of greener technology.

Objective D. Foster an informed and mobilized citizenry

Principle D1. Develop a relatable public education programme that involves both schools based and a community based education.

D1.1 One of the potentials is to integrate air pollution curriculum in the STEM and Liberal Study programme of secondary schools

Green School Initiative

D1.2 Under the current Green School Initiative[76] organized by the HKSAR Government, it is recommended to expand the subsidy scope to support primary and secondary schools to purchase hardware and software that will monitor and reduce students' exposure to air pollution in the school environment.

Healthy City Project

D1.3 The first Healthy City Project[77] (HCP) of Hong Kong was initiated in Sai Kung District in 1997. This first-ever HCP was featured by its bottoms-up approach where tremendous efforts have been made in engaging the community in promoting health awareness and to make collaborative efforts in building a healthy community. A cohesive partnership infrastructure across sectors conducive to sustainable development has also been built.

D1.4 It is recommended to review the scope of the HCP, and invest financial and human resources to re-energize the HCP across all District Councils. The purpose is to transform HCP to become a cross-district platform that supports the overall health policies of Hong Kong, including the public education programme currently conducted by the Department of Health.

D1.5 It is recommended to set up a steering committee to steer the progress of the HCP in each district. Air pollution, as one of the top environmental health risks, should become one of the key themes. Under the platform, members of NGOs, schools, local communities and general public are invited to participate in activities.

NGOs

D1.6 Air pollution affects everyone, especially some of the more vulnerable groups, including the children, the elderly, chronic patients of respiratory and circulatory diseases.

D1.7 With the advancement of technology, it is possible to develop air pollution audits (indoor and outdoor) of the NGO's venue to ensure a safe and clean environment.

D1.8 In addition, the vulnerable groups, the caretakers, and their families should be better informed. One way the NGOs can help, is to conduct educational programmes that caters to the needs of the vulnerable groups.

Principle D2. Participation of relevant professional and business sectors

D2.1 It requires cross-disciplinary efforts to further reduce air pollution at different levels. The participation of professional sectors will be important to transfer knowledge and identify mitigation solutions.

D2.2 Especially, participation of the professional and business sectors, including the Public Health, Urban Planning, and Business Sectors is important to achieve the purpose.

D2.3 Besides, it is recommended for the private, academic and professional sectors to strategize human resource management to meet new challenges on addressing air pollution, decarbonisation and sustainability issues, and new potentials on ESG compliance, green finance, and the demand for multi-disciplinary problem-solving. This will be beneficial for nurturing the local and attracting global talents to drive the future economy.

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Spotlight: Unmanaged air pollution at school environments in Hong Kong

The context

With the congested cityscape, many schools are located in close proximity to traffic roads. Exposure to toxic exhaust of road transport for several hours per day would bring short-term health impacts on youth and preschool children and imply long term health consequences in their different stages of life.

CAN estimates that 10% - 15% of the primary schools, secondary schools, and kindergarten in Hong Kong are located within 300 meters from major trunk roads and highways. Other than school campuses, students may also spend considerable time in transportation, leisure, and sports facilities. Some of these locations are close to traffic pollution sources.

Identifying pollution and exposure hot spots of a community

In early 2021, CAN conducted a monitoring study, to identify possible pollution hot spots in Tuen Mun District. Concentrations of the pollutants were measured at 50 monitoring spots located in Tuen Mun to understand the roadside air pollution that the community is exposed to.

Despite the limitation on the equipment, the study was able to indicate, the relative pollution levels of locations where students frequently visited.

Findings:

It was found that the most polluted spots included the bus stops, light rail stops, and school zones.

The 3 most polluted bus stops are those that are semi-confined or covered. It is possible that the weak flow of air may limit the dispersion of pollutants in such micro-environments. The more polluted light rail stops are located adjacent to the polluted semi-confined bus stops, thus sharing the same micro-environment. The 3 most polluted school zones are located close to road traffic. Classrooms of one of the schools are located less than 10 metres from the highway.

Implications:

It is very likely that pollution or exposure hot spots do exist in the community but are unmanaged. There are no sufficient resources (knowledge and equipment) to systematically address the issue.

With the availability of more robust air pollution, vehicular and pedestrian traffic monitoring equipment, it is possible to identify exposure hot spots in a community where air pollution levels and people's (including users of different facilities) duration of stay are both relatively high.

The challenge

The current air pollution monitoring network operated by the HKSAR Government is far from identifying potential exposure hot spots in different neighbourhoods including school areas.

Figure 12: Density of Air Quality Monitoring Network– comparing HKSAR and selected cities

City	Area (km^2)	Population (million)	No of air pollution monitoring stations	Area coverage per station	Population coverage per station	No of air pollution monitoring stations at roadside	Area per once roadside station	Population per one roadside station
London	1,570	8.9	130	12 km^2	68,000	79	20	113,000
Paris	110	2.2	44	3 km^2	50,000	14	8	157,000
Seoul	610	9.8	25	24 km^2	392,000	14	44	700,000
Singapore	730	5.7	22	33 km^2	259,000	4	183	1,425,000
Hong Kong	1,100	7.5	18	61 km^2	417,000	3	367	2,500,000

Source: National Environment Agency of Singapore, Seoul Solution[78]

RECOMMENDATIONS FOR THE GOVERNMENT AND THE SOCIETY (2021-2030)

Over 80% of the monitoring stations are set up at a height of 11-28 metres from the ground. The information provided by these stations may not reflect the air quality that the people breathe on the ground.

As a result, schools, parents, students, and the general public are not well informed on the potential risks that they and their families are exposed to, on a daily basis.

As the patterns of air pollution may vary depending on the micro-environments, it requires a dense network of high quality air pollution monitors to be built at school campuses and throughout the community to fill the information gap.

The opportunity

With advancement in micro-sensing and data processing technology, it is highly possible to develop a dense network of high quality air pollution monitors at an affordable cost.

Paris and London's initiatives to better inform public and policymakers

In Paris and London, there were initiatives to install over a hundred units of air pollution monitors of professional-grade across the cities.

Both initiatives were led by the Mayors of the city governments with collaboration between the academia and philanthropic funders. The purposes are similar, which are to identify and reduce sources of air pollution exposed by general public and vulnerable groups in the cities. With a denser network of air pollution monitoring devices in place, the policymakers will then be more informed of the mitigation measures to be taken to reduce pollution.

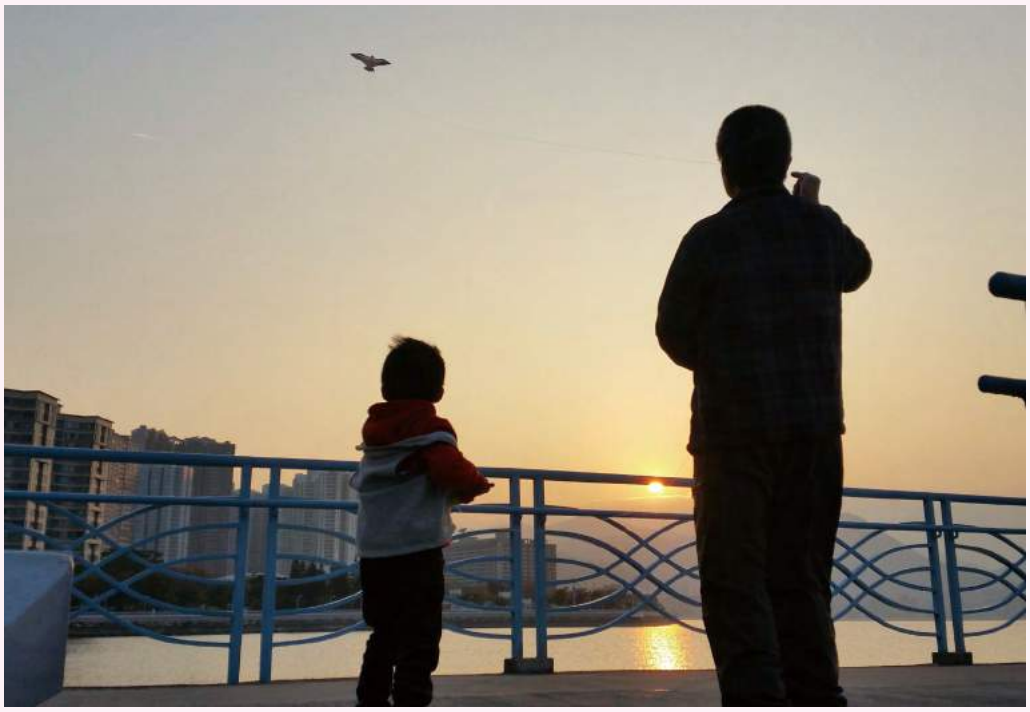
With more relatable air pollution information, the overall level of awareness and knowledge on the issue will be enhanced. It is possible for the community as a whole to act on emission reduction or mitigation measures that would better protect the health of children.

Fostering a more informed and mobilized citizenry – starting from schools

There are a number of ways to foster a more informed and mobilized school community:

- **Install professional air pollution monitors and communication platforms.**
- **Conduct city wide audit of air pollution and health status of students in all school campuses to collect baseline data.**
- **Organize and communicate health risks to students, parents, and the wider community**
- **Organize health and clean-air themed community events to further arouse awareness.**
- **Discuss potential mitigation measures.**
- **Explore options to reduce the level of air pollution in the school campuses and reduce the duration of stay of students at high pollution hot spots in the neighbourhood. Some options are**
    - Encourage the use of electric vehicular fleet among the school staff, parents, and service providers
    - Time specific Zero Emission Zone that allows pedestrian or no emission commuting mode,
    - Measure and compare air pollution levels and the health status of pre and post intervention to identify the effectiveness.
    - It requires close collaboration between government departments (incl. Environmental Protection Department, Education Bureau), school bodies, and the wider community (family, caretakers, stakeholders in districts).

RECOMMENDATIONS FOR THE GOVERNMENT AND THE SOCIETY (2021-2030)



Study on preschool children in Hong Kong

Air pollution exposure during early childhood causes lung damage and leads to asthma, pneumonia, and chronic pulmonary diseases. A local study conducted by Kwong Wah Hospital analysing data of over 46,000 preschool children patients from 2004 to 2015 in Hong Kong. The findings showed that there is a strong correlation between air pollution and asthma. The high level of concentration of Nitrogen Dioxide (NO_2, is a major air pollutant in Hong Kong) is a significant risk factor for the increase in hospitalizations for preschool wheeze in Hong Kong.

ENDNOTES

1 BBC (22 September 2020), Climate change: China aims for 'carbon neutrality by 2060', https://www.bbc.com/news/science-environment-54256826. Accessed 26 March 2021.

2 HKSAR Government (25 November 2020), 2020 Policy Address, https://www.policyaddress.gov.hk/2020/eng/p125.html. Accessed 26 March 2021.

3 Environment Bureau (March 2021), Hong Kong Roadmap on Popularisation of Electric Vehicles, https://www.enb.gov.hk/sites/default/files/pdf/EV_roadmap_eng.pdf. Accessed 26 March 2021.

4 Environment Bureau (March 2013), A Clean Air Plan for Hong Kong, https://www.enb.gov.hk/en/files/New_Air_Plan_en.pdf. Accessed 26 March 2021.

5 Environmental Protection Department website (March 2021), Phasing Out Pre-Euro IV Diesel Commercial Vehicles, https://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/Phasing_out_diesel_comm_veh.html. Accessed 26 March 2021.

6 Environmental Protection Department website (March 2021), A Guide to the Air Pollution Control (Fuel for Vessels) Regulation, https://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/guide-air-pollution-control-fuel-for-vessels-regulation.html. Accessed 26 March 2021.

7 Civic Exchange (19 September 2018), Fair Winds Charter: How Civic Exchange Influenced Policymaking to Reduce Ship Emissions in Hong Kong 2006-2015.

8 HKSAR Government website (8 January 2021), EPD announces 2020 air quality monitoring results, https://www.info.gov.hk/gia/general/202101/08/P2021010800609.htm. Accessed 26 March 2021.

9 Clean Air Network (30 July 2020), Deterioration of air quality in PRD Region as Ozone level continues to break record high, http://www.hongkongcan.org/hk/wp-content/uploads/2020/07/Press-Release_Clean-Air-Network_Regional-Air-Quality-Monitoring-Network.pdf. Accessed 26 March 2021.

10 Limiting the review to the present day, rather than the future, allows Clean Air Network to present empirical information, rather than estimating air quality and the likely public health impacts.

11 School of Public Health, The University of Hong Kong, http://hedleyindex.hku.hk/historical. Accessed 29 March 2021.

12 Civic Exchange (1 February 2009), APCO-101: A Review of the Air Pollution Control Ordinance, https://civic-exchange.org/wp-content/uploads/2009/02/127-200902AIR_APCO101_en.pdf. Accessed 29 March 2021.

ENDNOTES

[13] Environmental Protection Department website (March 2021), Review of Air Quality Objectives, https://www.epd.gov.hk/epd/english/environmentinhk/air/air_quality_objectives/aqoreview2016.html. Accessed 29 March 2021.

[14] Cap. 311 Air Pollution Control Ordinance, https://www.elegislation.gov.hk/hk/cap311!en-zh-Hant-HK. Accessed 29 March 2021.

One of the identified weaknesses of the APCO to protect public health is that public health is not directly referenced. Instead, "public interest" is the term used under APCO.

[15] Civic Exchange (January 2012), Report Card of the Donald Tsang Administration (2005 -2012), https://civic-exchange.org/wp-content/uploads/2012/01/201201AIR_AirQualityReportCardDonaldTsang_en.pdf. Accessed 29 March 2021.

[16] Environmental Protection Department website (March 2021), Review of Air Quality Objectives, https://www.epd.gov.hk/epd/english/environmentinhk/air/air_quality_objectives/aqoreview2016.html. Accessed 29 March 2021.

[17] HKSAR Government website (March 2021), Air Pollution Control (Amendment) Bill 2021 gazetted, https://www.info.gov.hk/gia/general/202103/19/P2021031900473.htm?fontSize=1. Accessed 29 March 2021.

[18] School of Public Health and Primary Care, The Chinese University of Hong Kong (Oct 2016), Developing an Instrument for Assessing the Health and Economic Impacts of Air Pollution in Hong Kong, https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/studyrpts/files/instrument_impacts_air_pollution.pdf. Accessed 29 March 2021.

[19] On 15th June, 2018, CAN held a roundtable discussion among public health, legal, environmental experts and groups, and representatives from the business sector and Legislative Council. The roundtable, titled "In the Name of Public Health - Air Pollution Control Ordinance Review Roundtable Discussion", was convened to explore how to improve public health through legislative approach. Summary of the Roundtable Discussion: http://www.hongkongcan.org/hk/wp-content/uploads/2019/03/Digest-of-Seminar_APCO-roundtable.pdf

[20] Clean Air Network and Linklaters (June 2018), Multi-Jurisdictional Comparative Study on Air Pollution Control Regulations.

[21] Clean Air Network (June, 2018), Summary of Seminar: In the Name of Public Health: Air Pollution Control Ordinance Review Roundtable Discussion, http://www.hongkongcan.org/hk/wp-content/uploads/2019/03/Digest-of-Seminar_APCO-roundtable.pdf. Accessed 29 March 2021.

[22] Environment Bureau (March 2013), A Clean Air Plan for Hong Kong, page 38, https://www.enb.gov.hk/en/files/New_Air_Plan_en.pdf. Accessed 26 March 2021.

[23] The Standard (21 Nov 2017), Call for more coverage over air quality, https://www.thestandard.com.hk/section-news/section/4/189847/Call-for-more-coverage-over-air-quality. Accessed 26 March 2021.

[24] Office of the Government Chief Information Officer website (March 2021), "Multi-functional Smart Lampposts" Pilot Scheme, https://www.ogcio.gov.hk/en/our_work/strategies/initiatives/smart_lampposts/ Accessed 26 March 2021.

[25] Mason, T. G., Schooling, C. M., Ran, J., Chan, K. P., & Tian, L. (2020). Does the AQHI reduce cardiovascular hospitalization in Hong Kong's elderly population?. Environment International, 135, 105344.

[26] Mason, T. G., Schooling, C. M., Chan, K. P., & Tian, L. (2019). An evaluation of the air quality health index program on respiratory diseases in Hong Kong: An interrupted time series analysis. Atmospheric Environment, 211, 151-158.

[27] Civic Exchange (January 2012), Report Card of the Donald Tsang Administration (2005 -2012), https://civic-exchange.org/wp-content/uploads/2012/01/201201AIR_AirQualityReportCardDonaldTsang_en.pdf. Accessed 29 March 2021.

[28] Transport Department website (March 2021), ERP in Hong Kong, https://www.td.gov.hk/mini_site/erpgovhk/erp_in_hk.html. Accessed 29 March 2021.

[29] Xingcheng Lu, Teng Yao, Ying Li, Jimmy C.H. Fung, Alexis K.H. Lau (2016), Source apportionment and health effect of NOx over the Pearl River Delta region in southern China, Environmental Pollution, Volume 212, 2016, Pages 135-146.

[30] Environmental Protection Department website (March 2021), Air Pollution Control Strategies, https://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/strategies_apc.html. Accessed 29 March 2021.

[31] Environment Bureau (December 2018), Progress on Improving Roadside Air Quality, page 2, https://www.legco.gov.hk/yr18-19/english/panels/ea/papers/ea20181219cb1-319-4-e.pdf. Accessed 29 March 2021.

[32] Transport Department website (March 2021), Franchised Buses, https://www.td.gov.hk/filemanager/en/content_389/kmb%20franchise%202017-2027%20(gn1773).pdf. Accessed 29 March 2021.

[33] Transport Department website (March 2021), Franchised Buses, https://www.td.gov.hk/filemanager/en/content_390/lw%20franchise%202013-2023%20(gn3181).pdf. Accessed 29 March 2021.

ENDNOTES

[34] Legislative Council Secretariat (July 2013), Report of the Panel on Environmental Affairs for submission to the Legislative Council, page 4, https://www.legco.gov.hk/yr12-13/english/panels/ea/reports/ea0717cb1-1476-e.pdf. Accessed 29 March 2021.

[35] HKSAR Government (2020), Examination of Estimates of Expenditure 2020-21, Reply Serial No. ENB041, https://www.legco.gov.hk/yr19-20/english/fc/fc/w_q/enb-e.pdf. Accessed 29 March 2021.

[36] Environment Bureau (May 2017), Improvement of Roadside Air Quality, page 4, https://www.legco.gov.hk/yr16-17/english/panels/ea/papers/ea20170522cb1-949-3-e.pdf. Accessed 29 March 2021.

[37] Alexis K.H. Lau (2017). 'Air Quality in Hong Kong Past, Present and Future' [Power Point presentation at RAQM-5 Hong Kong Forum]. https://envr.ust.hk/files/RAQM5HK_03_Alexis.pdf. Accessed 26 March 2021.

[38] HKSAR Government website (8 January 2021), EPD announces 2020 air quality monitoring results, https://www.info.gov.hk/gia/general/202101/08/P2021010800609.htm. Accessed 26 March 2021.

[39] Environmental Protection Department website (March 2021), Steering Committee on the Promotion of Electric Vehicles, https://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/sc_promotion_of_electric_vehicles.html. Accessed 26 March 2021.

[40] HKSAR Government website (8 January 2021), LCQ15: "One-for-One Replacement" Scheme, https://www.info.gov.hk/gia/general/201810/24/P2018102400326.htm. Accessed 26 March 2021.

[41] Environmental Protection Department website (March 2021), Promotion of Electric Vehicles in Hong Kong, https://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/promotion_ev.html. Accessed 26 March 2021.

[42] Transport Department website (March 2021), Monthly Traffic and Transport Digest 2020, https://www.td.gov.hk/en/transport_in_hong_kong/transport_figures/monthly_traffic_and_transport_digest/2020/202012/index.html. Accessed 26 March 2021.

[43] Environment Bureau (January 2020), A Series of Measures to Improve Environment and Air Quality, https://www.legco.gov.hk/yr19-20/english/panels/ea/papers/ea20200122cb1-336-4-e.pdf. Accessed 26 March 2021.

[44] Civic Exchange (1 February 2009), APCO-101: A Review of the Air Pollution Control Ordinance, https://civic-exchange.org/wp-content/uploads/2009/02/127-200902AIR_APCO101_en.pdf. Accessed 29 March 2021.

[45] Civic Exchange (1 February 2009), APCO-101: A Review of the Air Pollution Control Ordinance, https://civic-exchange.org/wp-content/uploads/2009/02/127-200902AIR_APCO101_en.pdf. Accessed 29 March 2021.

[46] Civic Exchange (1 February 2009), APCO-101: A Review of the Air Pollution Control Ordinance, https://civic-exchange.org/wp-content/uploads/2009/02/127-200902AIR_APCO101_en.pdf. Accessed 29 March 2021.

[47] International Maritime Organization website (March 2020), IMO 2020 sulphur limit implementation - carriage ban enters into force, https://www.imo.org/en/MediaCentre/PressBriefings/Pages/03-1-March-carriage-ban-.aspx#:~:text=The%20IMO%202020%20regulation%20limits,sulphur%20oxides%20in%20the%20air. Accessed 30 March 2021.

[48] Simon K W Ng, Sunny Lam (December 2017), https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/studyrpts/files/GFS_summary%20report_eng.pdf. Accessed 30 March 2021.

[49] Environmental Protection Department (May 2015), Provision of on-shore power supply at Kai Tak Cruise Terminal, https://www.legco.gov.hk/yr14-15/english/panels/ea/papers/ea20150602cb1-895-3-e.pdf. Accessed 30 March 2021.

[50] HKSAR Government website (December 2019), Government to further reduce emissions from power plants, https://www.info.gov.hk/gia/general/201912/10/P2019121000319.htm. Accessed 30 March 2021.

[51] Environment Bureau (January 2017), HONG KONG'S CLIMATE ACTION PLAN 2030+, page 16, https://www.enb.gov.hk/sites/default/files/pdf/ClimateActionPlanEng.pdf. Accessed 30 March 2021.

[52] Council for Sustainable Development (November 2020), Report on Public Engagement on Long-term Decarbonisation Strategy, https://www.susdev.org.hk/download/report/council_report_e.pdf. Accessed 30 March 2021.

[53] HKSAR Government website (December 2017), Guangdong and Hong Kong release mid-term review results on PRD air pollutant emission reduction targets for 2015 and 2020, https://www.info.gov.hk/gia/general/201712/15/P2017121500417.htm. Accessed 30 March 2021.

[54] Environment Bureau (December 2019), Overall strategy for improving air quality, https://www.legco.gov.hk/yr19-20/english/panels/ea/papers/ea20191216cb1-233-3-e.pdf. Accessed 30 March 2021.

[55] HKSAR Government website (8 January 2021), EPD announces 2020 air quality monitoring results, https://www.info.gov.hk/gia/general/202101/08/P2021010800609.htm. Accessed 26 March 2021.

[56] Environment Bureau (December 2019), Overall strategy for improving air quality, https://www.legco.gov.hk/yr19-20/english/panels/ea/papers/ea20191216cb1-233-3-e.pdf. Accessed 30 March 2021.

[57] School of Public Health, The University of Hong Kong, http://hedleyindex.hku.hk/historical. Accessed 29 March 2021.

[58] American Chemical Society (31 October 2018), The when, where and what of air pollutant exposure, www.sciencedaily.com/releases/2018/10/181031080551.htm. Accessed 30 March 2021.

ENDNOTES

[59] Wong, Chit-Ming & Ou, Chun-Quan & Chan, King-Pan & Chau, Yuen-Kwan & Thach, Thuan-Quoc & Yang, Lin & Chung, Roger & Thomas, G Neil & Peiris, Joseph S & Wong, Tze Wai & Hedley, Anthony & Lam, Tai-Hing. (2008). The Effects of Air Pollution on Mortality in Socially Deprived Urban Areas in Hong Kong, China. Environmental health perspectives. 116. 1189-94. 10.1289/ehp.10850.

[60] Currently, there is a lack of a uniformed mechanism that measures the standard of global cities and major metropolises in terms of air pollution. The closest we can find is from WHO Breathelife campaign. However, it is based on 2016 statistics. Breathelife's website: https://breathelife2030.org/

[61] Environment Bureau (March 2021), Hong Kong Roadmap on Popularisation of Electric Vehicles, https://www.enb.gov.hk/sites/default/files/pdf/EV_roadmap_eng.pdf. Accessed 26 March 2021.

[62] The UK: the UK Government website (November 2020),The Ten Point Plan for a Green Industrial Revolution, https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title. Accessed 30 March 2021.

Singapore: Land Transport Authority website (Mar 2021), Factsheet: Accelerating Nationwide Deployment of Electric Vehicle Charging Points, https://www.lta.gov.sg/content/ltagov/en/newsroom/2021/3/news-release/Accelerating_nationwide_deployment_of_electric_vehicle_charging_points.html. Accessed 30 March 2021.

[63] Ibid.

[64] Simon K W NG (2013). 'Green Ports and Shipping in Asia'[Power Point presentation at 7th UNCRD EST Forum]. https://www.uncrd.or.jp/content/documents/7EST-P5-3.pdf. Accessed 30 March 2021.

[65] Transport & Environment (September 2019), Low-Emission Zones are a success - but they must now move to zero-emission mobility, https://www.transportenvironment.org/sites/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf. Accessed 30 March 2021.

[66] The Healthy Streets Approach and the 10 Indicators of a Healthy Street were developed by Lucy Saunders, a specialist in public health and transport. These were first included in TfL policy in the first Health Action Plan in 2014 and TfL has been working on how to deliver this Approach in London. Transport For London website, Healthy Streets, https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets. Accessed 30 March 2021.

[67] Financial Times (Jan 2020), How children and parents are reclaiming UK streets, https://www.ft.com/content/9738fe70-218b-11ea-92da-f0c92e957a96. Accessed 30 March 2021.

[68] "Social Lab" approach was used around the world to provide a relatively low risk medium for multiple stakeholders to participate and address social issues.

A similar approach was adopted by the innovative organization Make a Difference Institute to conduct a tri-sector participatory programme 'Healthy Street Lab' in Sham Shui Po. The purpose of the 3-month programme was to explore how a street could be re-designed to encourage citizens to walk longer and healthier on the street. CAN was the Research Partner which provided the evidence and perspectives on the link between walking environment, transport demand management, and the air quality and public health gain.

The programme attracted participation from Government officials (Transport Department), the experts on transport and urban planning, the residents and civic organizations. The Healthy Street Lab was further extended in 2020 and was participated by the Government and District Council.

Healthy Street Lab@Sham Shui Po

http://www.mad.asia/programmes/mad-social-lab/224

Healthy Street Lab 2.0@Sham Shui Po

http://www.mad.asia/programmes/mad-social-lab/657

[69] Indoor Air Quality Information Centre website, New IAQ Objectives, https://www.iaq.gov.hk/en/iaq-certification-scheme/newiaqo.aspx. Accessed 30 March 2021.

[70] Indoor Air Quality Information Centre website, IAQ in Public Transport Facilities, https://www.iaq.gov.hk/en/publications-and-references/practice-notes.aspx. Accessed 30 March 2021.

[71] HKSAR Government website (May 2018), LCQ19: Air quality in Public Transport Interchanges, https://www.info.gov.hk/gia/general/201805/16/P2018051600309.htm?fontSize=1. Accessed 30 March 2021.

[72] Examination of Estimates of Expenditure 2019-20, HKSAR Government (2019). Reply Serial No. ENB107. https://www.legco.gov.hk/yr18-19/english/fc/fc/w_q/enb-e.pdf. Accessed 30 March 2021.

[73] HKSAR Government website (December 2017), Guangdong and Hong Kong release mid-term review results on PRD air pollutant emission reduction targets for 2015 and 2020, https://www.info.gov.hk/gia/general/201712/15/P2017121500417.htm. Accessed 30 March 2021.

ENDNOTES

[74] Ibid.

[75] The Bay Area Air Quality Management District (Air District) is a public agency that regulates the stationary sources of air pollution in the nine counties of California's San Francisco Bay Area of the United States. It shows examples of how a regional air pollution control agency could work.

Bay Area Air Quality Management District (April 2017), Spare the Air, Cool the Climate, A Blueprint For Clean Air and Climate Protection in the Bay Area,

https://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/attachment-a_-proposed-final-cap-vol-1-pdf.pdf?la=en. Accessed 30 March 2021.

[76] Environment Bureau website, Green Schools 2.0, https://www.energysaving.gov.hk/en/competitions/green_schools_2.html. Accessed 30 March 2021.

[77] Department of Health (2007), GUIDELINES FOR IMPLEMENTING A HEALTHY CITIES PROJECT IN HONG KONG,https://www.chp.gov.hk/files/pdf/building_healthy_cities_guidelines.pdf. Accessed 30 March 2021.

[78] National Environment Agency of Singapore website, How does Singapore monitor its ambient air quality? https://va.ecitizen.gov.sg/CFP/CustomerPages/NEA_google/displayresult.aspx?MesId=1068830&Source=Google&url=va.ecitizen.gov.sg. Accessed 30 March 2021. Seoul Solution, Air Pollution Monitoring Network, https://seoulsolution.kr/en/node/6540. Accessed 30 March 2021. Anna Font, Lionel Guiseppin, Marta Blangiardo, VÃ©ronique Ghersi, Gary W. Fuller,

A tale of two cities: is air pollution improving in Paris and London?, Environmental Pollution, Volume 249, 2019, Pages 1-12, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2019.01.040. Accessed 30 March 2021.

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