2020 Hong Kong Emission Inventory Report

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Environmental Protection Department

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The Government of the Hong Kong Special Administrative Region

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CONTENT

Annexes

1 INTRODUCTION

1.1. The Environmental Protection Department (EPD) compiles the Hong Kong Air Pollutant Emission Inventory annually to analyze the quantity of local air pollutant emissions and their major emission sources for supporting the formulation of effective air quality management strategies in Hong Kong. It also provides necessary data for carrying out air quality impact assessments. The emission inventory for Hong Kong was first published on EPD's website in March 2000.

1.2. This report presents the 2020 Hong Kong Emission Inventory. It covers:

(i) the emission inventory by source category in 2020 (Chapter 3);
(ii) the emission trends from 2001 to 2020 for six major air pollutants (Chapter 4);
(iii) the sectoral analyses for six emission source categories (Chapter 5); and
(iv) the emissions from hill fires (Chapter 6).

2 SCOPE OF EMISSION INVENTORY

2.1. The emission inventory comprises estimates of emissions from seven source categories for six major air pollutants, namely: sulphur dioxide (SO_2), nitrogen oxides (NOx), respirable suspended particulates (RSP or PM_{10}), fine suspended particulates (FSP or $PM_{2.5}$), volatile organic compounds (VOC), and carbon monoxide (CO). Emission sources covered in the inventory include public electricity generation, road transport, navigation, civil aviation, other combustion sources, non-combustion sources, and hill fires.

2.2. Other combustion sources are those sources where emissions are originated from fuel combustion, other than public electricity generation, road transport, navigation and civil aviation. Major contributing sources include non-road mobile machinery operating in construction sites and container terminals and other fuel using equipment in commercial and industrial sectors.

2.3. Non-combustion sources are those where emissions are not originated from fuel combustion and the primary air pollutants are VOC, RSP and FSP. The major emission sources for VOC include paints and associated solvents, consumer products and printing, whereas those for RSP and FSP include paved road dust, cooking fumes, construction dust and quarry production.

2.4. In Hong Kong, hill fires are one of the sources of particulates. As most of the hill fires in Hong Kong are caused by human negligence or accidents and are sporadic in nature, their emissions cannot be reduced through emission control measures like other pollution sources. In order to enable more meaningful comparison on the emission trends of controllable pollution sources and the effectiveness of local emission control measures, hill fires are reported separately in Chapter 6. The total emissions of air pollutants in Section 3.1 and Annex I are presented into two total emission figures, one with hill fires and the other without.

3 2020 EMISSION INVENTORY

3.1. Like other countries, the local activities have been affected by the outbreak of COVID-19 in 2020. Coupled with the implementation of air quality improvement measures, emissions of six major air pollutants in 2020 decreased by 2% to 43%, as compared with 2019. The changes in emissions between 2019 and 2020 are shown in **Annex 1**. The table below shows a breakdown of air pollutant emissions by source category in 2020.

Breakdown of 2020 Emission Inventory

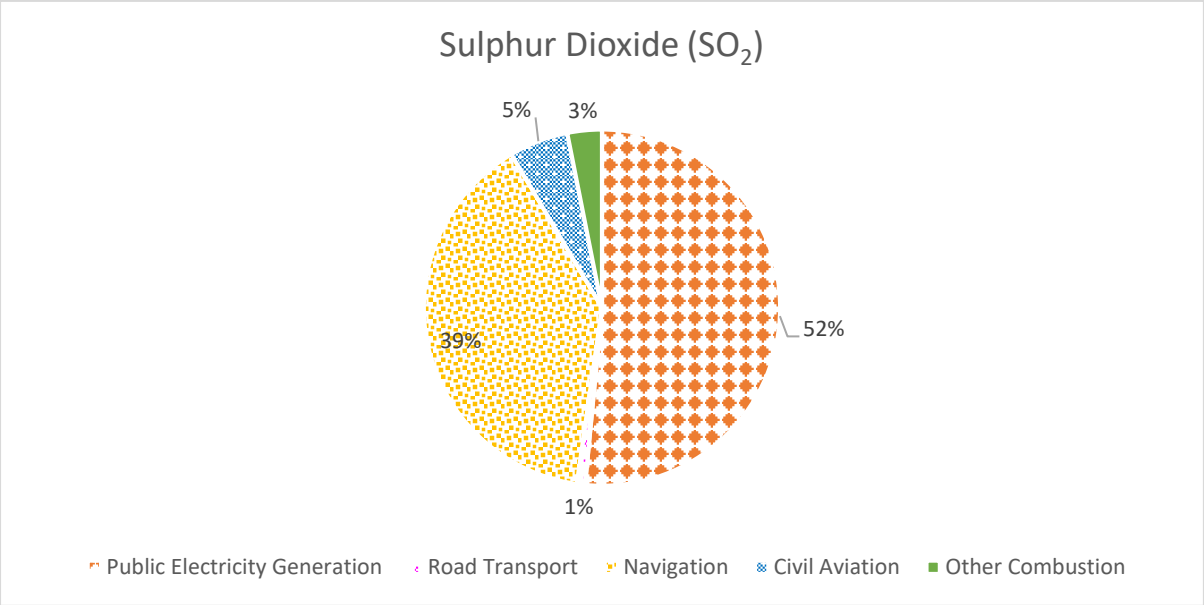
Pollution Sources	Emissions (Tonnes)					
	SO_2	**NOx**	**RSP**	**FSP**	**VOC**	**CO**
Public Electricity Generation	2,550	13,840	390	250	320	2,600
Road Transport	40	10,800	280	250	5,100	27,000
Navigation	1,940	20,500	860	800	3,590	21,160
Civil Aviation	270	3,550	30	30	250	1,670
Other Combustion	150	7,980	630	590	760	5,370
Non-combustion	N/A	N/A	740	370	11,890	N/A
Total Emissions (without Hill Fires)	4,940	56,680	2,930	2,290	21,910	57,810
Hill Fires	20	110	1,380	1,130	290	3,170
Total Emissions (with Hill Fires)	4,960	56,790	4,310	3,410	22,200	60,970

Notes:
- All figures, except those for Road Transport, are rounded to the nearest ten. For Road Transport, the figures smaller than 1,000 are rounded to the nearest ten and the remaining figures are rounded to the nearest hundred.
- "N/A" denotes not applicable.
- There may be slight discrepancies between the sums of individual items and the total emissions shown in the table because of rounding.

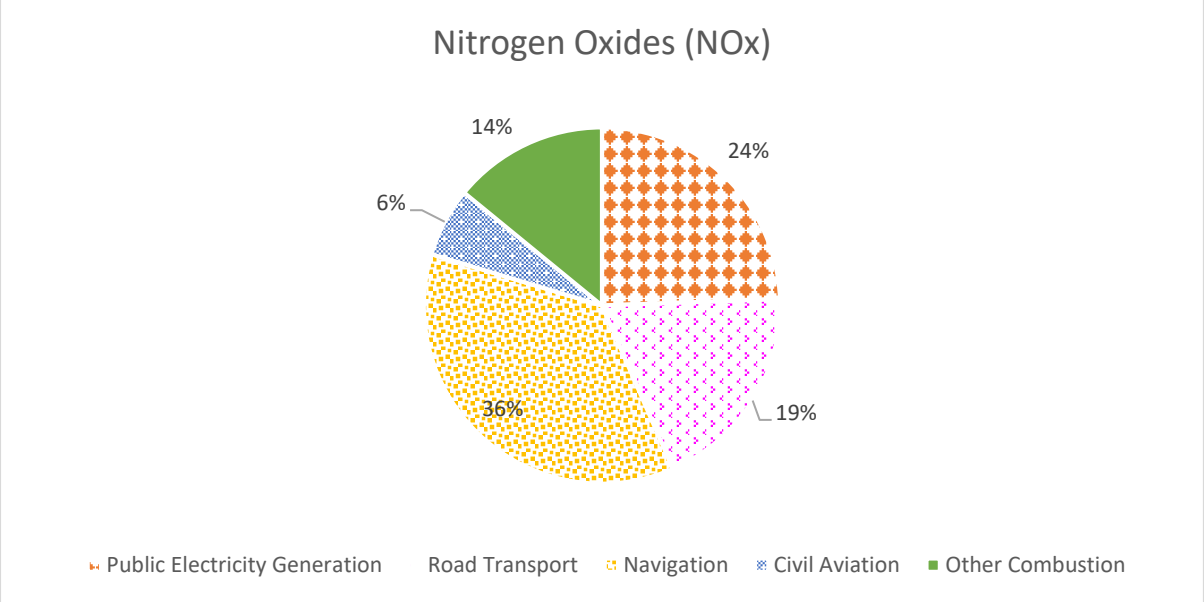
3.2. A summary of updates to the emission inventories is appended at **Annex 2**.

3.3. The following pie charts show the percentage share of emissions by source category (excluding hill fires) for each pollutant in 2020.

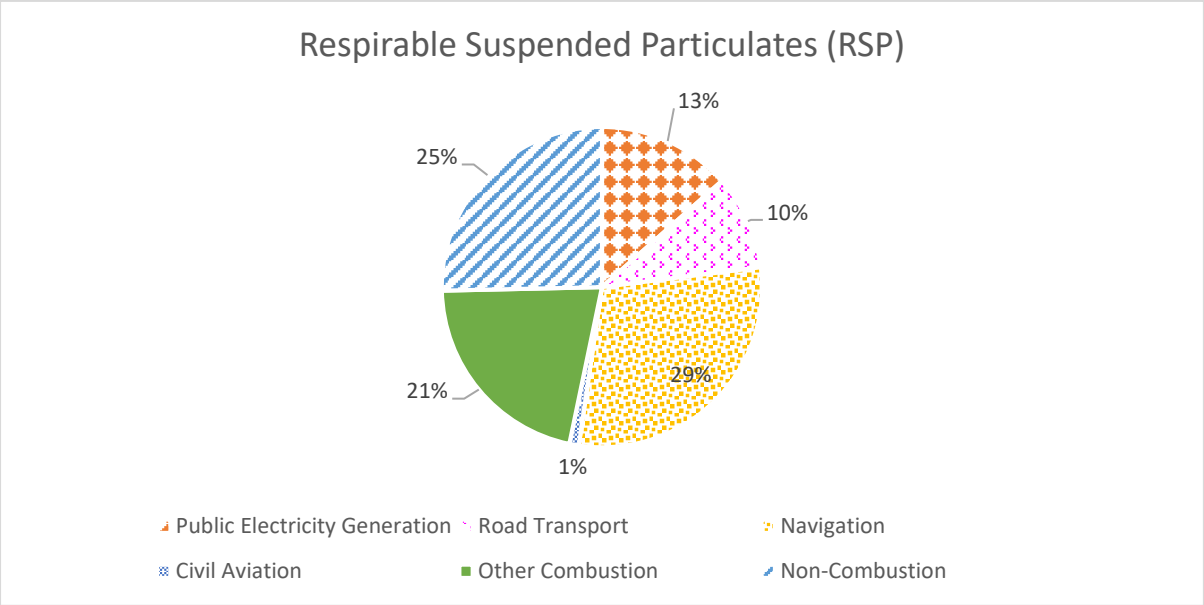
Total SO_2 emissions = 4,940 tonnes



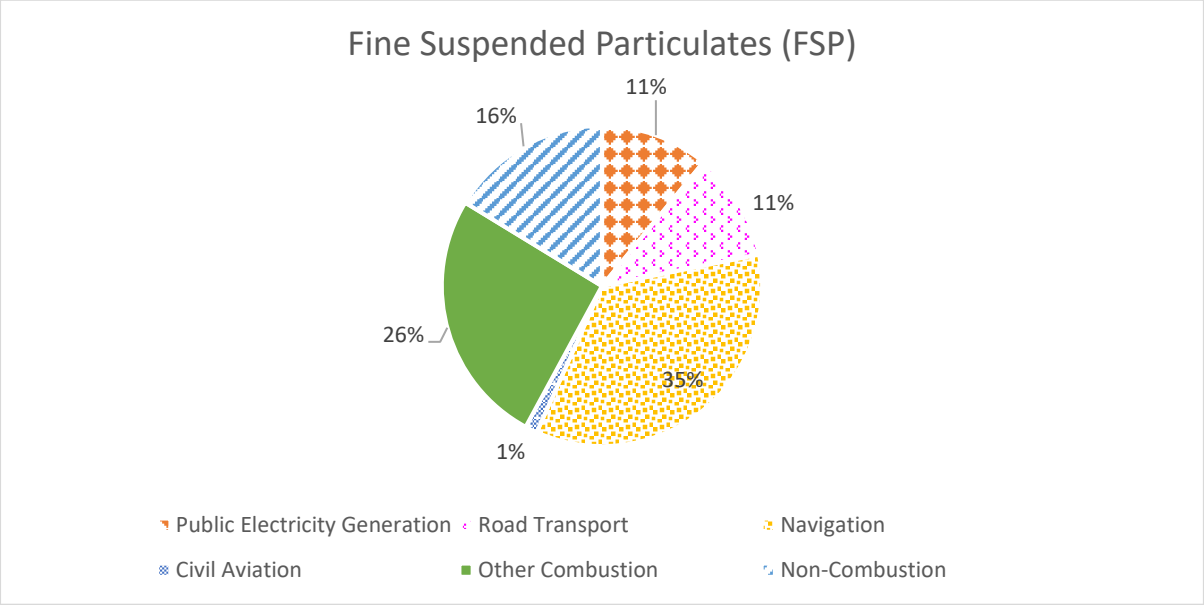
Total NOx emissions = 56,680 tonnes



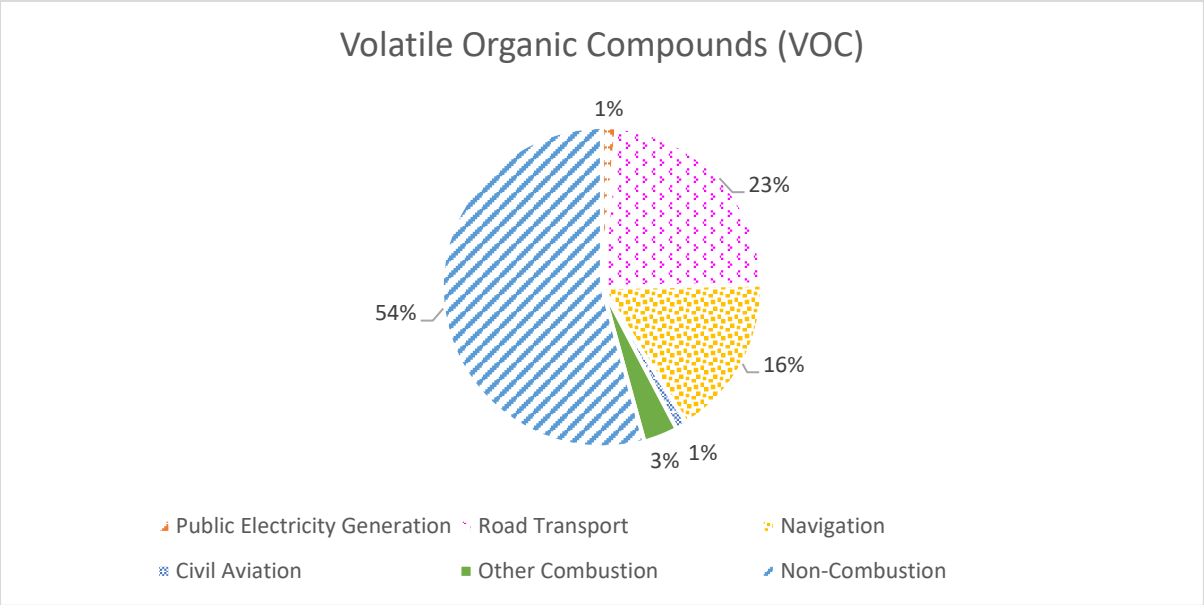
Total RSP emissions = 2,930 tonnes



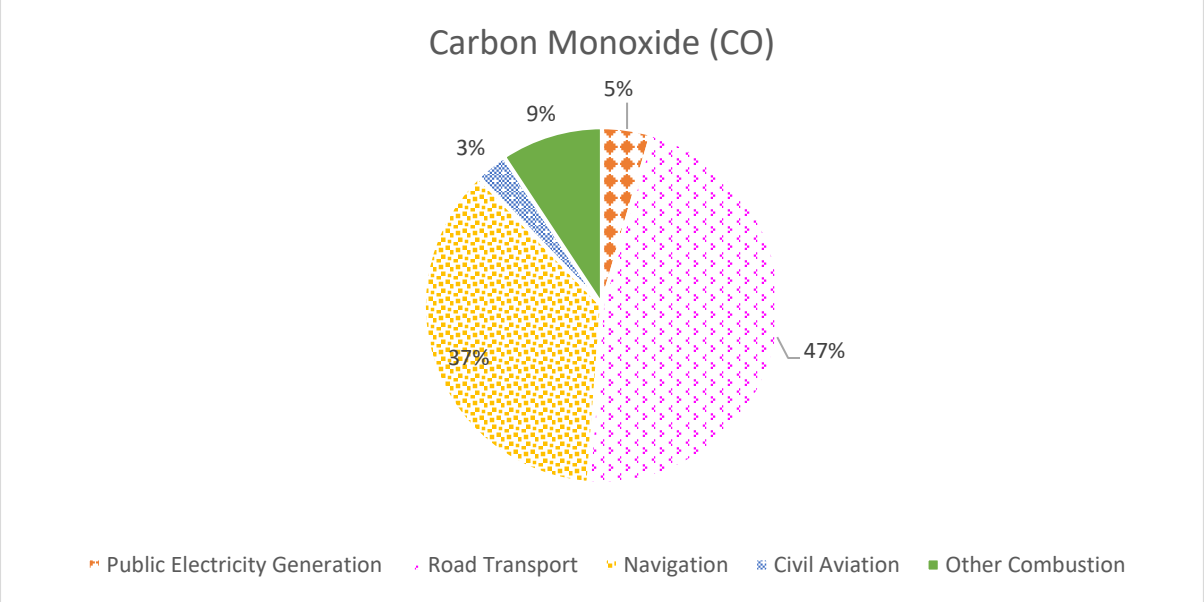
Total FSP emissions = 2,290 tonnes



Total VOC emissions = 21,910 tonnes



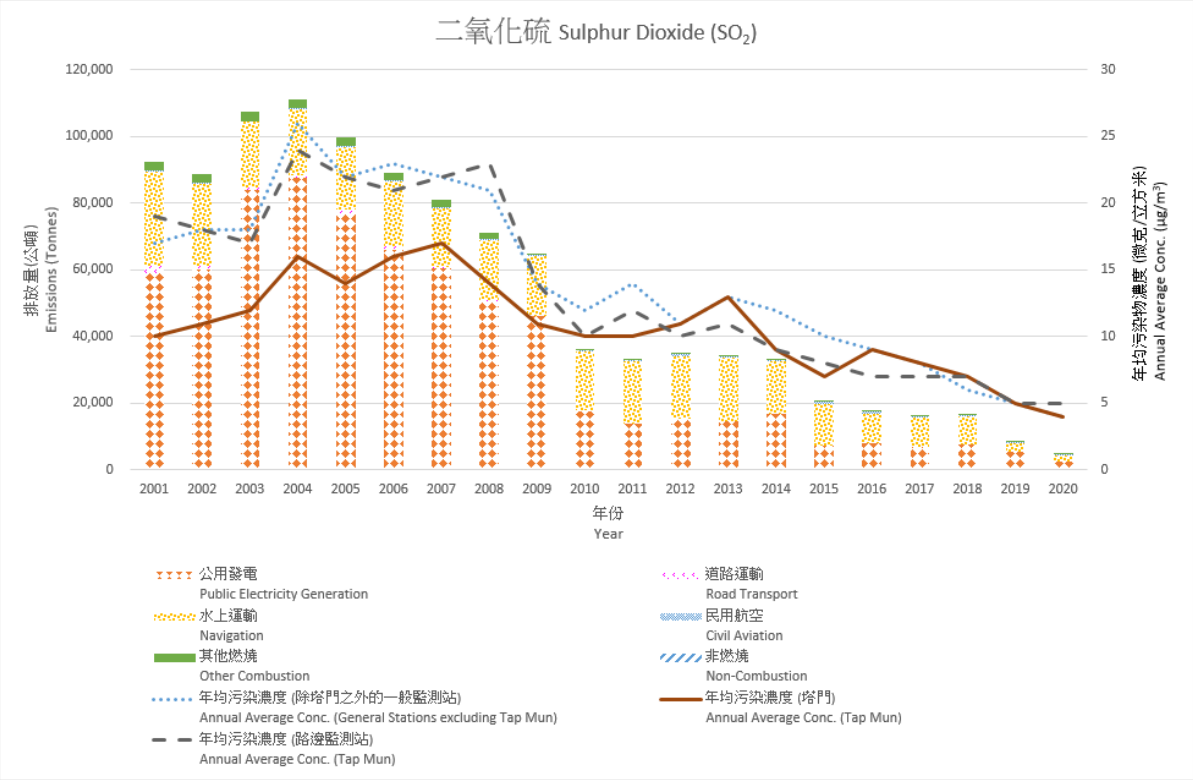
Total CO emissions = 57,810 tonnes



4 EMISSION TRENDS FROM 2001 TO 2020

To illustrate the changes in air quality over the years with respect to emissions, annual average concentration of air pollutants recorded at EPD's air quality monitoring stations were also shown on the emission trends. The concentration levels recorded at general air quality monitoring stations, excluding the one at Tap Mun, reflected the overall ambient pollution level in Hong Kong. Tap Mun is an island situated at the far northeastern part of Hong Kong and the concentration levels in general represented the background pollution level due to regional air pollution. The concentration levels at roadside air quality monitoring stations, on the other hand, reflected pollution level at street canyons with busy traffic.

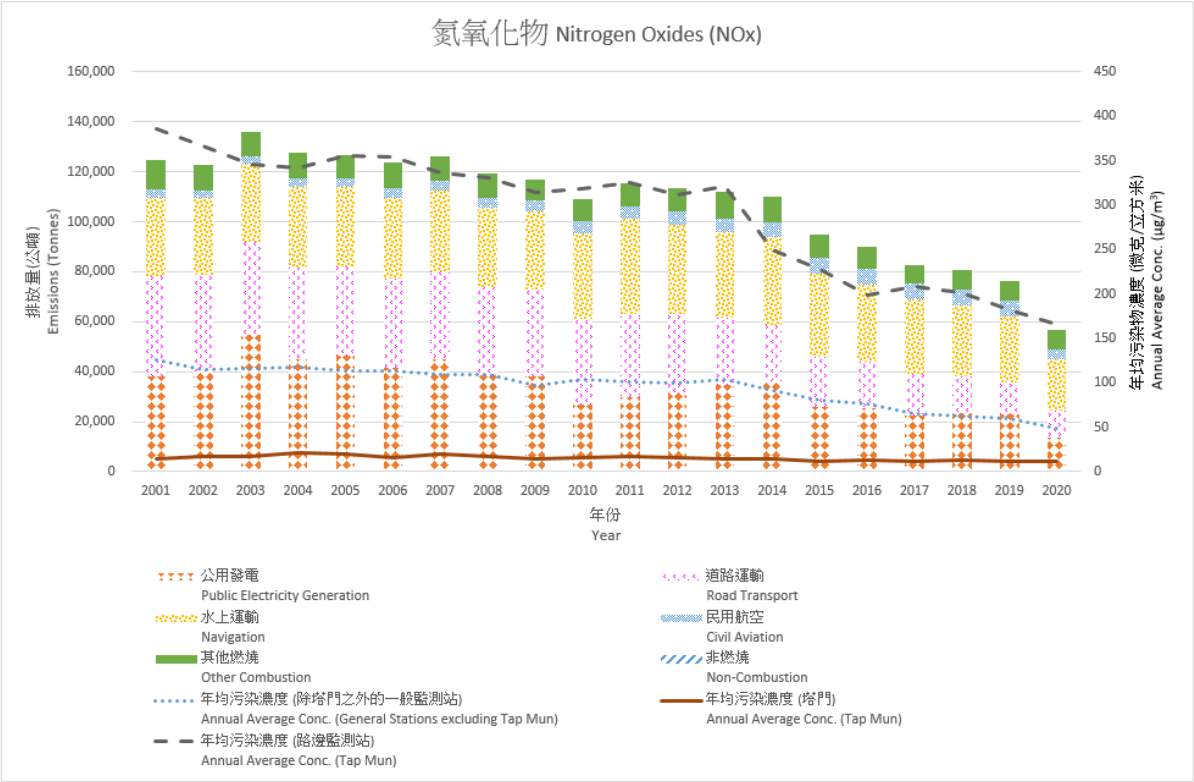
SO_2 Emission and Concentration Trends



4.1. Between 2001 and 2020, SO_2 emissions decreased by 95% mainly due to the significant reductions from the public electricity generation and navigation sectors. Nevertheless, public electricity generation and navigation sectors remained the top two emission sources, accounting for 52% and 39% of the total SO_2 emissions in 2020, respectively.

4.2. During the same period, SO_2 concentration levels measured at the EPD's general air quality monitoring stations by and large followed the SO_2 emission trend.

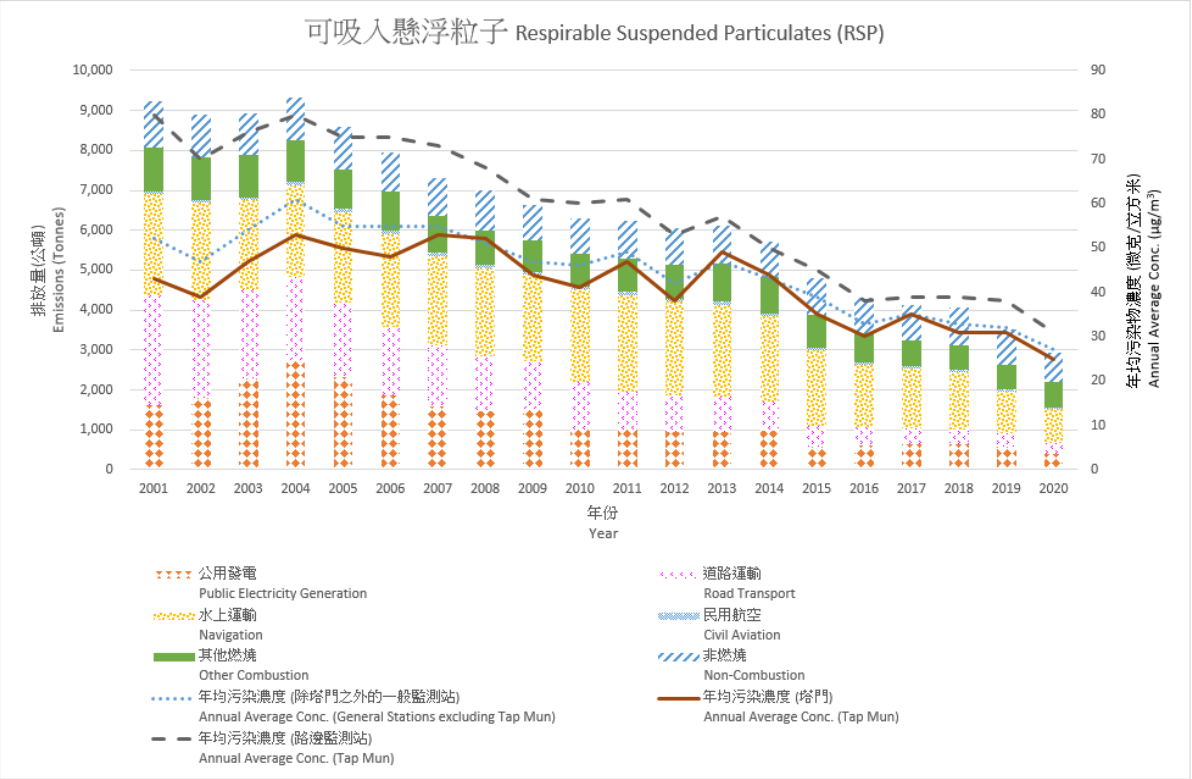
NOx Emission and Concentration Trends



4.3. Between 2001 and 2020, NOx emissions decreased by 55% in which reductions from road transport and public electricity generation played a significant role. Navigation, public electricity generation and road transport sectors were the top three emission sources, accounting for 36%, 24% and 19% of total NOx emissions in 2020, respectively.

4.4. The background NOx concentration levels measured at the Tap Mun rural air quality monitoring station over the past years have been very low. Hence the NOx concentrations measured in Hong Kong are mainly due to local emission sources. During the same period, NOx concentration levels measured at the EPD's roadside air quality monitoring stations by and large followed the NOx emission trend.

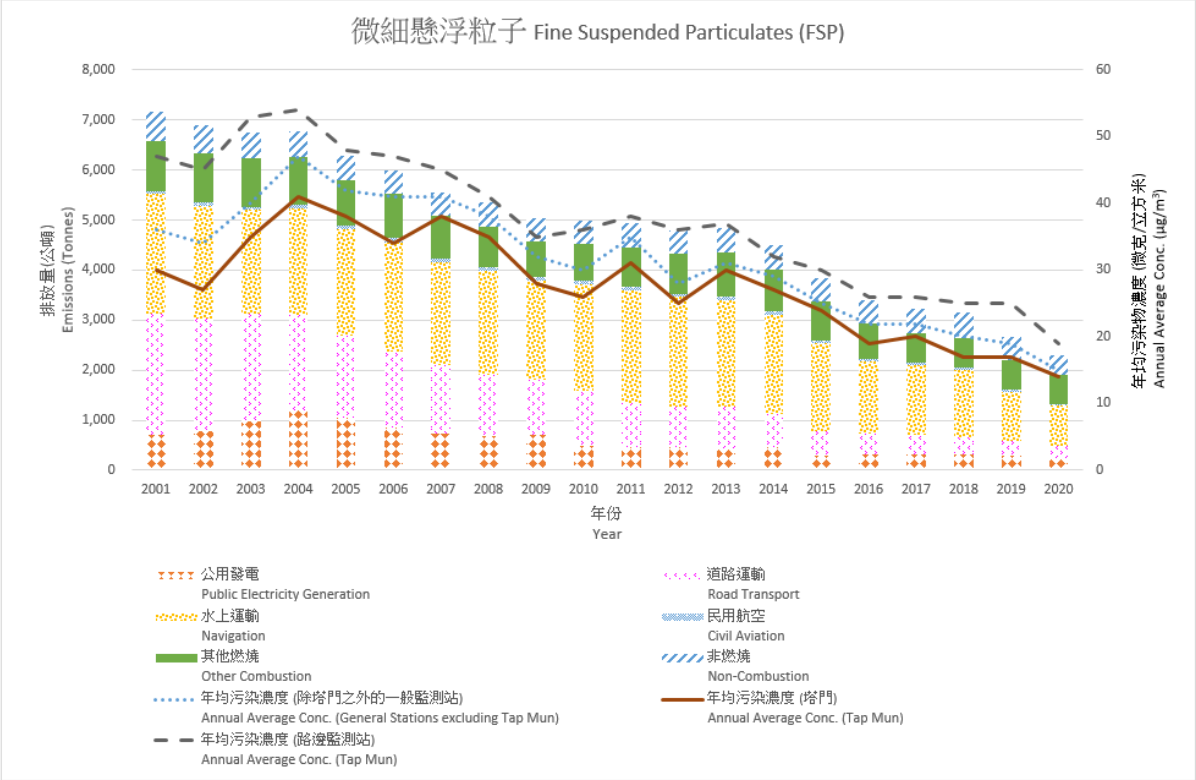
RSP Emission and Concentration Trends



4.5. Between 2001 and 2020, RSP emissions decreased by 68% mainly due to reductions from road transport, public electricity generation and navigation sectors. Navigation, non-combustion and other combustion sectors were the top three emission sources, accounting for 29%, 25% and 21% of total RSP emissions in 2020, respectively.

4.6. The background RSP concentration levels measured at the Tap Mun air quality monitoring station over the years have been close to those measured at the general air quality monitoring stations, reflecting that RSP concentration levels in Hong Kong are not only affected by local sources but also subject to strong regional influence. The gap between roadside and general (ambient) RSP concentration levels has been narrowing, indicating that RSP emissions from vehicles have been significantly reduced over the years.

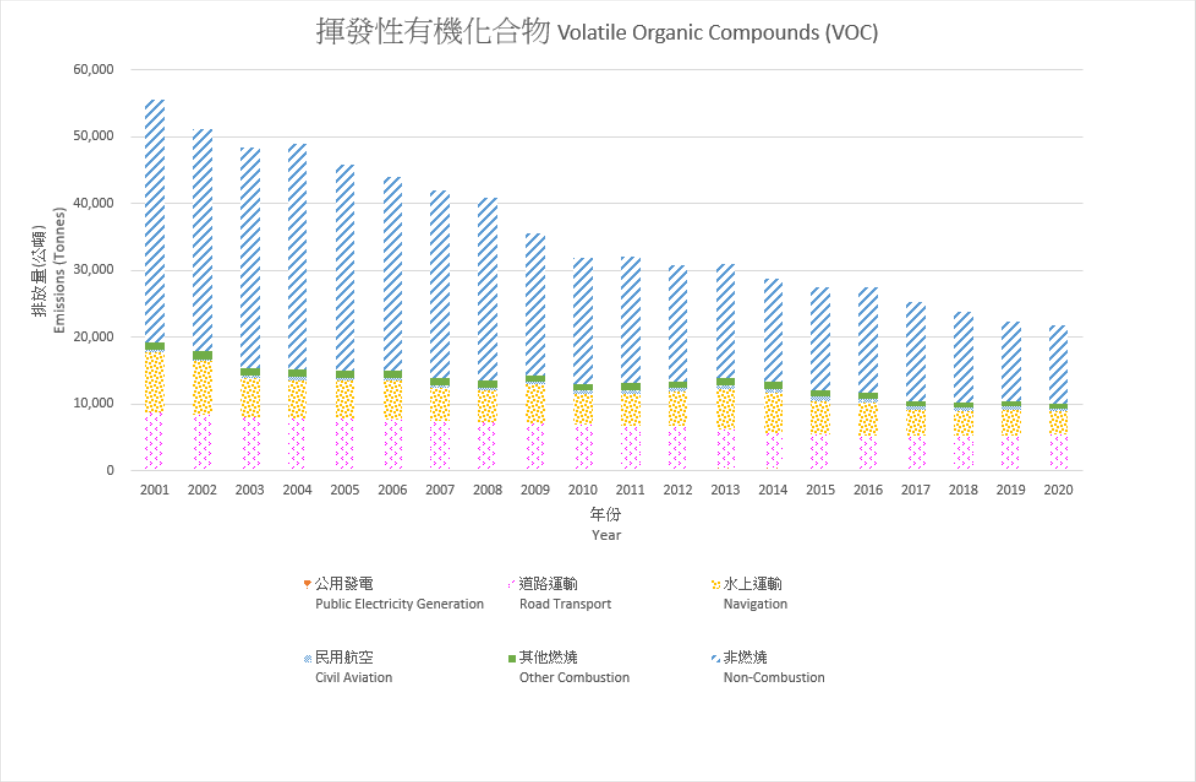
FSP Emission and Concentration Trends



4.7. FSP is a fraction of RSP and therefore the emission sources and trends are similar to each other. Between 2001 and 2020, FSP emissions decreased by 68%. Navigation, other combustion and non-combustion sectors were the top three emission sources, accounting for 35%, 26% and 16% of total FSP emissions in 2020, respectively.

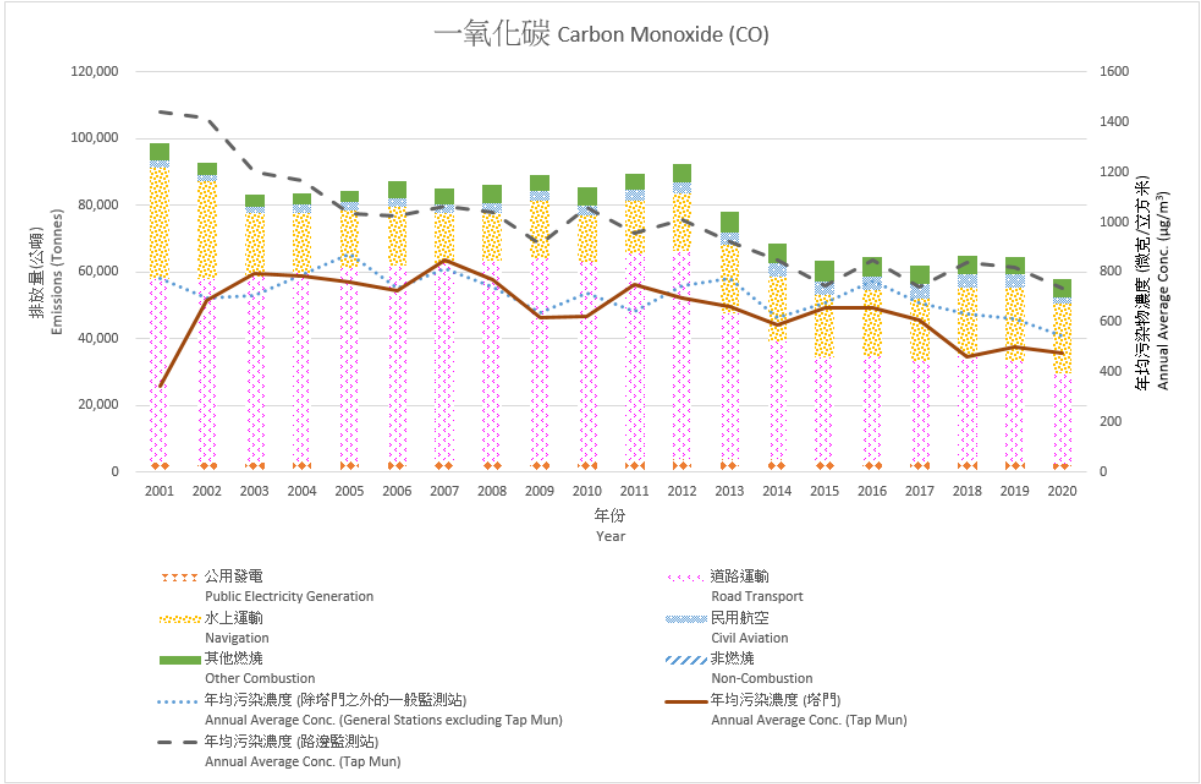
4.8. Similar to RSP, FSP concentration levels in Hong Kong are also subject to strong regional influence. The gap between roadside and general (ambient) FSP concentration levels has been narrowing, indicating that FSP emissions from vehicles have been significantly reduced over the years.

VOC Emissions Trend



4.9. Between 2001 and 2020, VOC emissions decreased by 61% mainly due to reductions from the non-combustion sector. Non-combustion, road transport and navigation sectors were the top three emission sources, accounting for 54%, 23% and 16% of total VOC emissions in 2020, respectively.

CO Emission and Concentration Trends

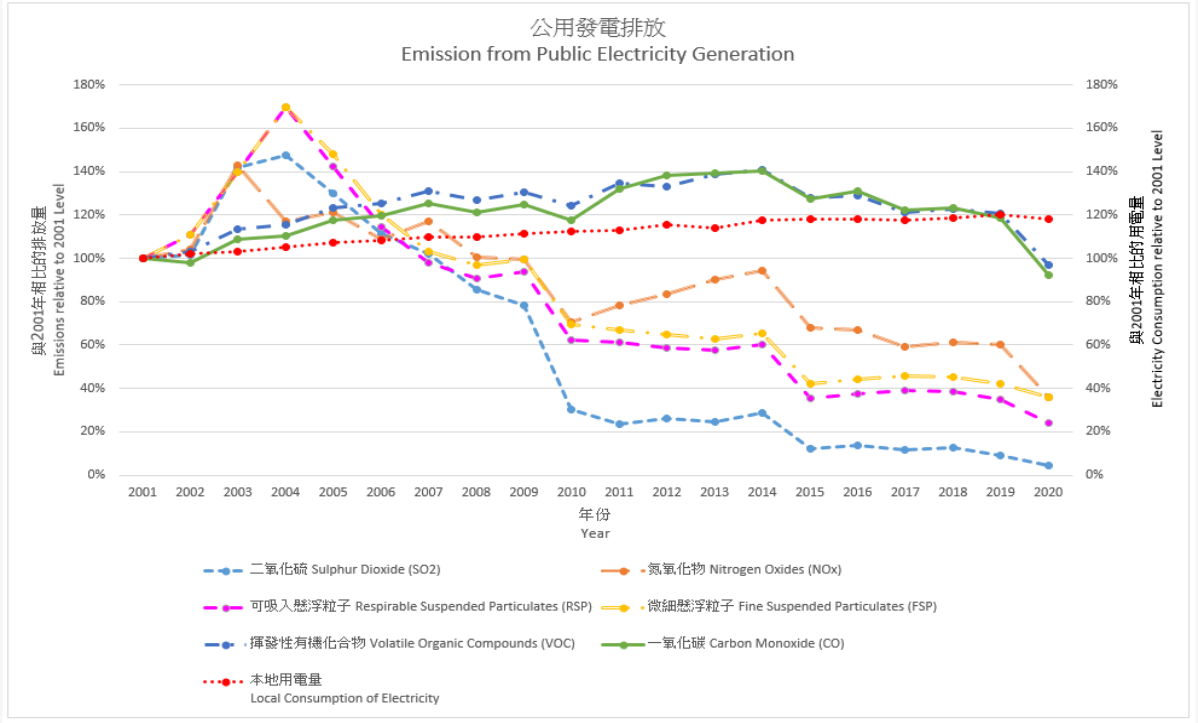


4.10. Between 2001 and 2020, CO emissions decreased by 41% mainly due to reductions from the road transport sector. Road transport and navigation sectors were two major emission sources, accounting for 47% and 37% of the total CO emissions in 2020, respectively.

4.11. During the same period, the gap between the CO concentration levels measured at the EPD's roadside and ambient air quality monitoring stations has narrowed, indicating that CO emissions from vehicles have been reduced.

5 SECTORAL ANALYSES

Sectoral analysis for "Public electricity generation"



5.1. Electricity sector was a major contributor to SO_2 and NOx emissions. The Government has been implementing vigorous measures to reduce emissions from power plants, including banning new coal-fired power generation units since 1997 and the imposition of statutory emission caps on power plants set out in the Technical Memorandum (TM) for Allocation of Emission Allowances in respect of Specified Licenses.

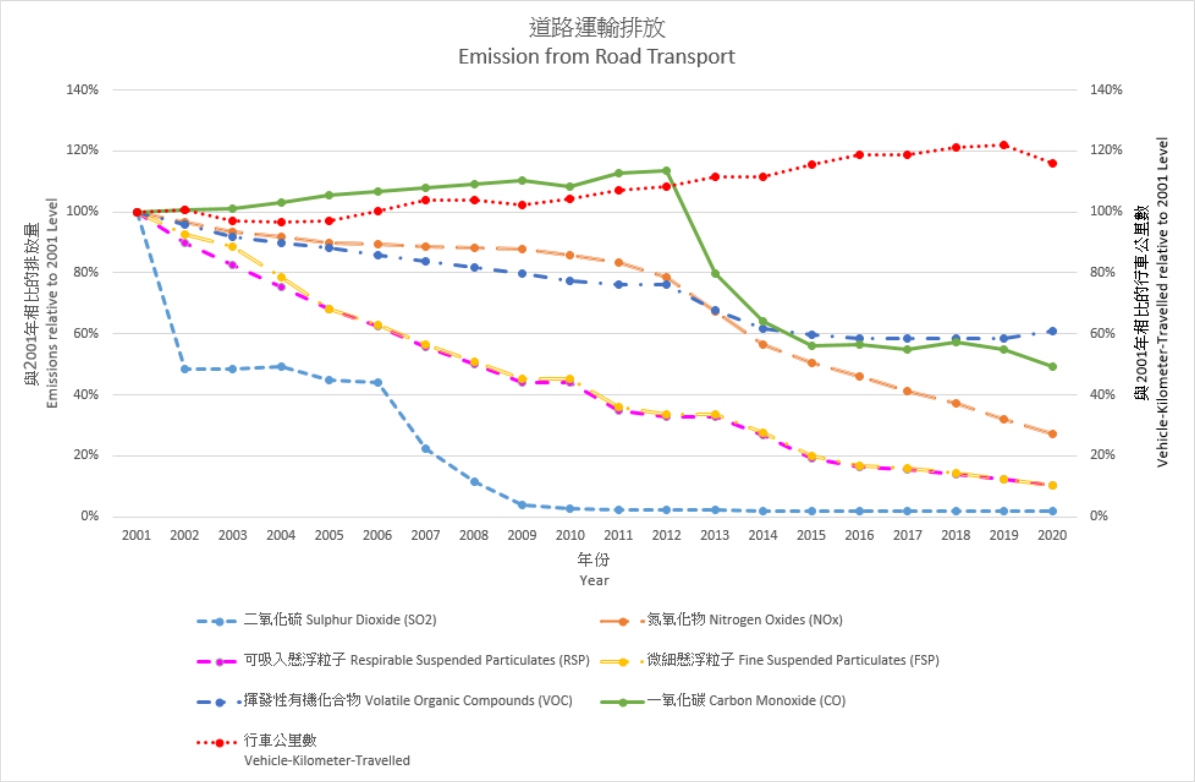
5.2. The Government has progressively tightened the emission caps via the promulgation of new TM and the latest one (i.e. the Ninth TM) was issued in June 2021 to further tighten the emission caps for 2026 and onwards.

5.3. To meet the emission caps, power companies have retrofitted existing coal-fired generation units with emission reduction devices such as flue-gas desulphurisation and denitrification systems where practicable, and increased the use of low-emission coal and natural gas. As compared with 2001, SO_2 emissions in 2020 reduced substantially by 96%, NOx emissions by 64% and RSP emissions by 76%, despite an increase in electricity consumption of 18%. In 2020, the emissions of SO_2 and NOx accounted for 52% and 24% of the total emissions respectively.

5.4. Under the Hong Kong's Climate Action Plan 2050[1], the Government will decarbonise electricity generation by increasing the use of natural gas and zero-carbon energy in the generation fuel mix which is conducive to further reducing emissions from power plants.

[1] The "Hong Kong's Climate Action Plan 2050" is accessible at https://www.eeb.gov.hk/sites/default/files/pdf/cap_2050_en.pdf.

Sectoral analysis for "Road transport"[2]



5.5. Road transport was a major emission source of NOx, VOC and CO, accounting for 19%, 23% and 47% of the total emissions in 2020, respectively. Overall, the emissions from road transport decreased by 39% to 98% from 2001 to 2020, despite an increase in vehicle-kilometer-travelled of 16% during the same period.

5.6. The substantial decreases in emissions of different pollutants from 2010 to 2020 could be attributed to a series of vehicle emission control programmes, which included strengthening the control of emissions from petrol and liquefied petroleum gas (LPG) vehicles by deploying roadside remote sensing equipment to identify vehicles emitting excessively; retrofitting Euro II and Euro III franchised buses with selective catalytic reduction (SCR) systems; progressively phasing out about 80,000 pre-Euro IV diesel commercial vehicles (DCVs) and tightening the emission standards for first registered vehicles to Euro VI in phases according to vehicle classes from 1 July 2017. It is anticipated that emissions from this sector will decrease further due to a further programme launched in October 2020 to progressively phase out about 40,000 Euro IV DCVs by the end of 2027; and tightened the vehicle emission standards of first registered motorcycles to Euro 4 from 1 October 2020 and the first registered light buses (design weight of more than 3.5 tonnes) and buses (design weight of not more than 9 tonnes) to Euro VI from 1 March 2021.

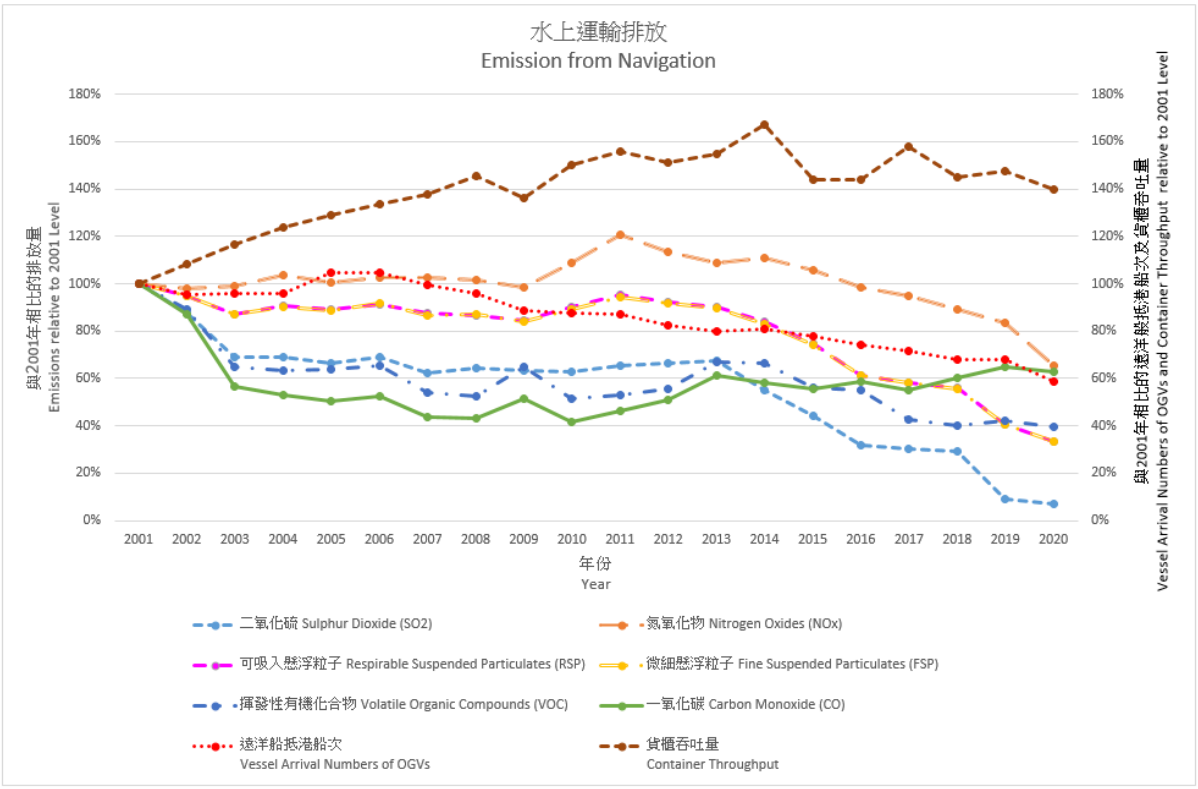
5.7. Besides, the Government has been promoting the use of electric vehicles (EVs) by offering first registration tax concession arrangements for EVs with the "One-for-One

[2] Except SO_2, emissions of major air pollutants for 2001, 2003, 2005, 2009 and 2010-2020 were calculated based on actual data, while interpolated figures were used for the remaining years. Vehicle-Kilometer-Travelled was provided by the Transport Department.

Replacement" Scheme to promote the transition to EVs without stimulating vehicular growth; allocating funding for franchised bus companies to purchase electric buses for trial runs; installing EV chargers at government car parks; providing gross floor area concessions to car parks of new buildings that have EV charging infrastructure installed; and subsidizing the installation of EVs charging-enabling infrastructure in car parks of existing private residential buildings. In addition, the Hong Kong Roadmap on Popularisation of Electric Vehicles (the Roadmap) announced in 2021 set out the long-term policy objectives and plans to promote the adoption of EVs and their associated supporting facilities in Hong Kong. The Roadmap will guide Hong Kong's future direction to attain zero vehicular emissions before 2050.

5.8. As for SO_2, the vehicle emissions stayed at a very low level in the past few years because of the introduction of Euro V diesel in December 2007, which capped the sulphur content at 0.001%.

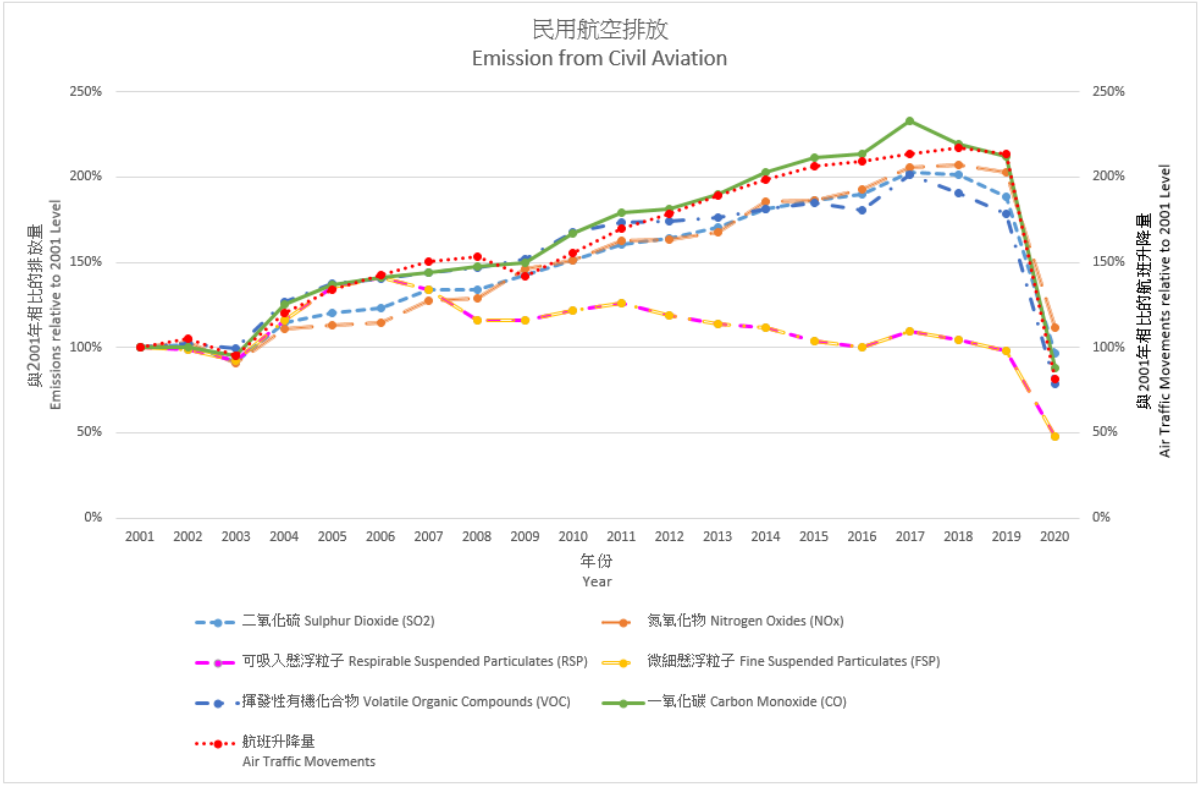
Sectoral analysis for "Navigation"



5.9. With the significant reduction in emissions from the electricity and road transport sectors over the past years, marine emissions have now become the major emission source in Hong Kong. Nonetheless, the emissions of SO_2, RSP and FSP from vessels decreased substantially by 67% to 93% from 2001 to 2020. In 2020, the emissions of SO_2, NOx, RSP and FSP from marine vessels accounted for 39%, 36%, 29% and 35% of the total emissions, respectively.

5.10. The SO_2, RSP and FSP emissions from marine vessels have been progressively reduced since 2014 through a range of marine control measures over the years. The sulphur content of locally supplied marine light diesel has been capped at 0.05% since 1 April 2014. Since 1 July 2015, ocean-going vessels have been required to switch to use low sulphur fuel (with sulphur content not exceeding 0.5%) while berthing in Hong Kong waters. Starting from 1 January 2019, all vessels, irrespective of whether they are sailing or berthing in Hong Kong waters, have been required to use compliant fuel, including low sulphur fuel or liquefied natural gas. At the same time, river-trade vessels and Pearl River Delta ferries have been required to use marine light diesel with sulphur content not exceeding 0.001% to comply with the requirements in the Mainland.

Sectoral analysis for "Civil aviation"

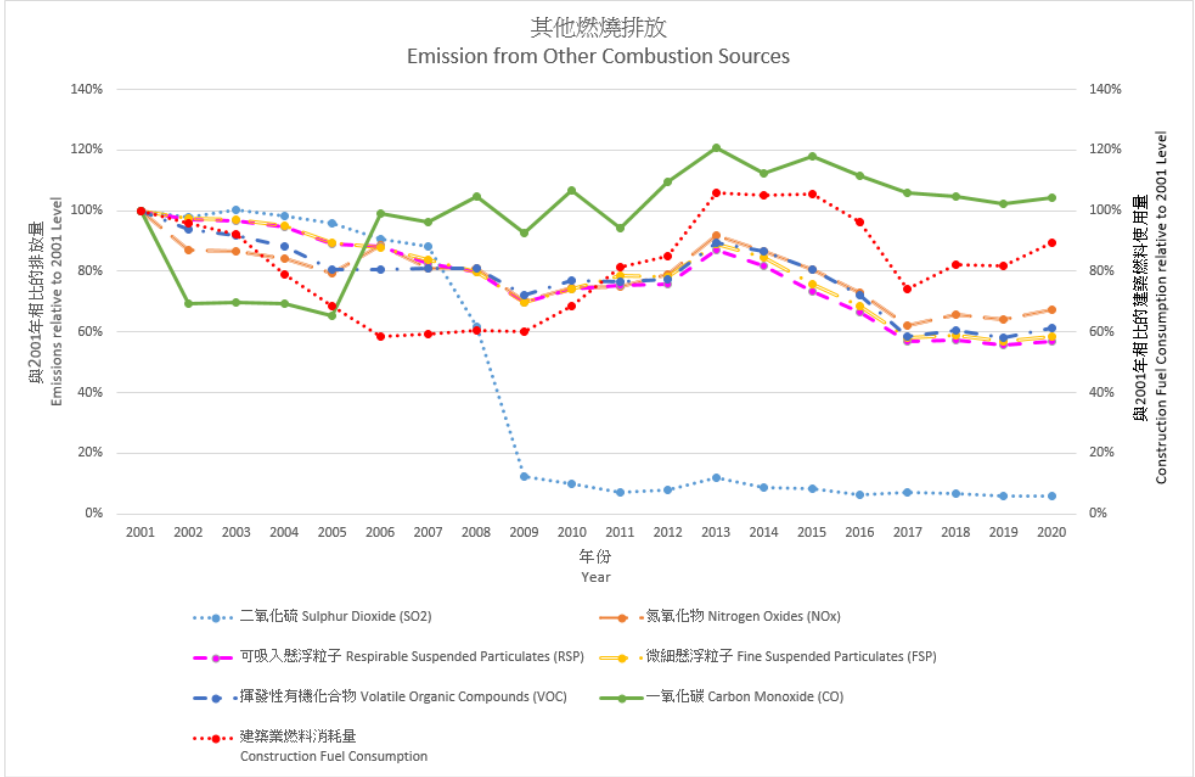


5.11. Emissions from civil aviation accounted for less than 6% of the total local emissions of air pollutants in 2020. Due to the COVID-19 pandemic in 2020, the overall air traffic movements reduced substantially by 62% and hence the emissions from civil aviation decreased by 45% to 59%, as compared with 2019.

5.12. Since December 2014, the Airport Authority Hong Kong banned the use of onboard fuel combustion auxiliary power generation units in aircraft at frontal stands in the Hong Kong International Airport (HKIA). Such measures reduced the emissions from burning jet fuel.

5.13. The Civil Aviation Department (CAD) has adopted the standards set out at Annex 16 to the Convention on International Civil Aviation, Volume II, Part III, Chapter 2 to certify the engines installed on aircraft using the HKIA in order to reduce their emissions. This document specifies the standards for four types of emissions that an aircraft engine has to meet, including NOx and CO. Taking advantage of the latest development in satellite navigation technologies, CAD has conducted enhancements of the air route system which enabled shortened travelling distances and more aircraft to fly at optimum and fuel-efficient altitudes, thereby achieving fuel savings and a reduction of carbon dioxide emissions.

Sectoral analysis for "Other combustion"

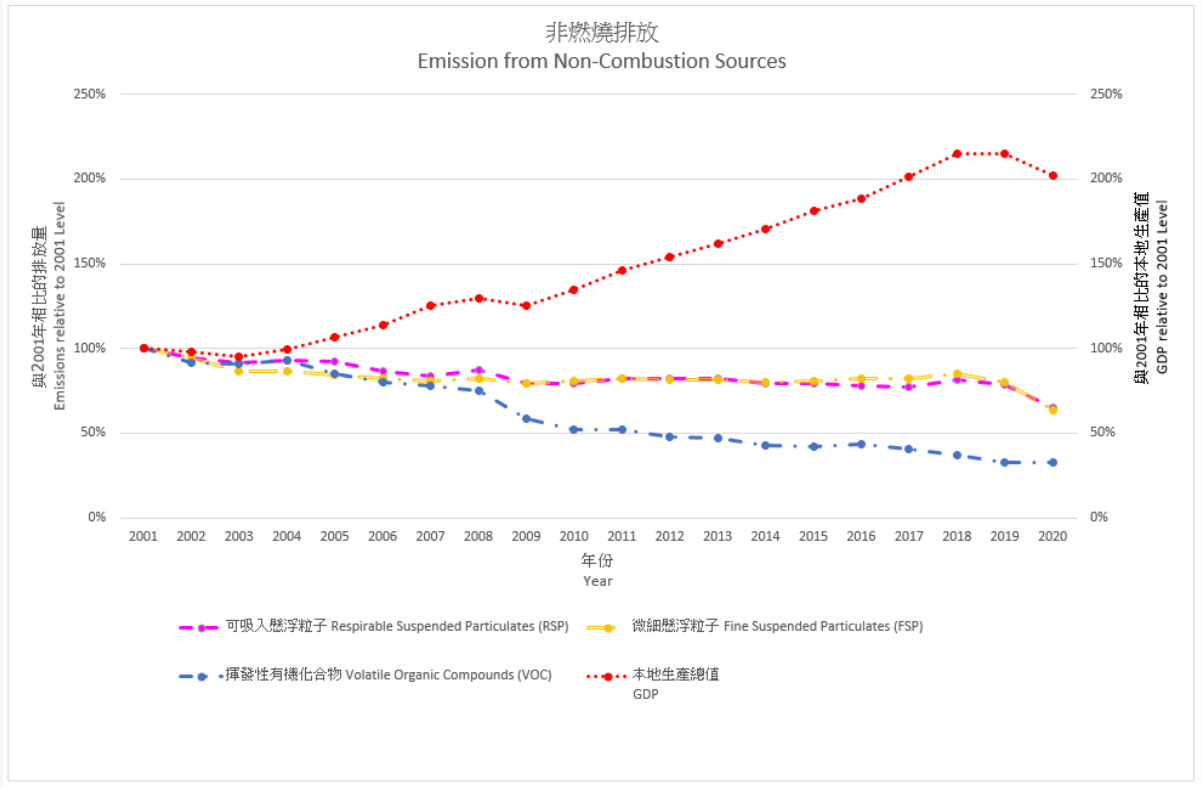


5.14. Other combustion sector is one of the important sources of RSP and FSP emissions, accounting for 21% and 26% of total emissions in 2020 respectively. Overall, the emissions of the major air pollutants from other combustion sources decreased by 32% to 94% from 2001 to 2020.

5.15. Major contributing sources in this sector are non-road mobile machinery (NRMMs), especially construction machinery, which accounted for 57%, 57% and 59% of RSP, FSP and NOx emissions from other combustion sources respectively in 2020. The emission trends from other combustion sources from 2010 to 2020 by and large followed the fuel consumption change in construction projects. To reduce the emissions from NRMMs, prescribed emission standards for newly approved NRMMs have been stipulated in the Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation since 1 June 2015. In January 2019, the emission standards for newly registered non-road vehicles (including goods vehicles, petrol private cars, buses with design weight of more than 9 tonnes and light buses with design weight not exceeding 3.5 tonnes) and non-road diesel private cars were tightened to Euro VI and California LEV III respectively.

5.16. The SO_2 emissions from this sector have been reduced to a very low level since the implementation of the Air Pollution Control (Fuel Restriction) Regulation in October 2008, which tightened the cap on the sulphur content of diesel used in industrial and commercial sectors from 0.5% to 0.005%. Since January 2009, Euro V diesel (with sulphur content not exceeding 0.001%) has been imported for industrial and construction use.

Sectoral analysis for "Non-combustion sources"

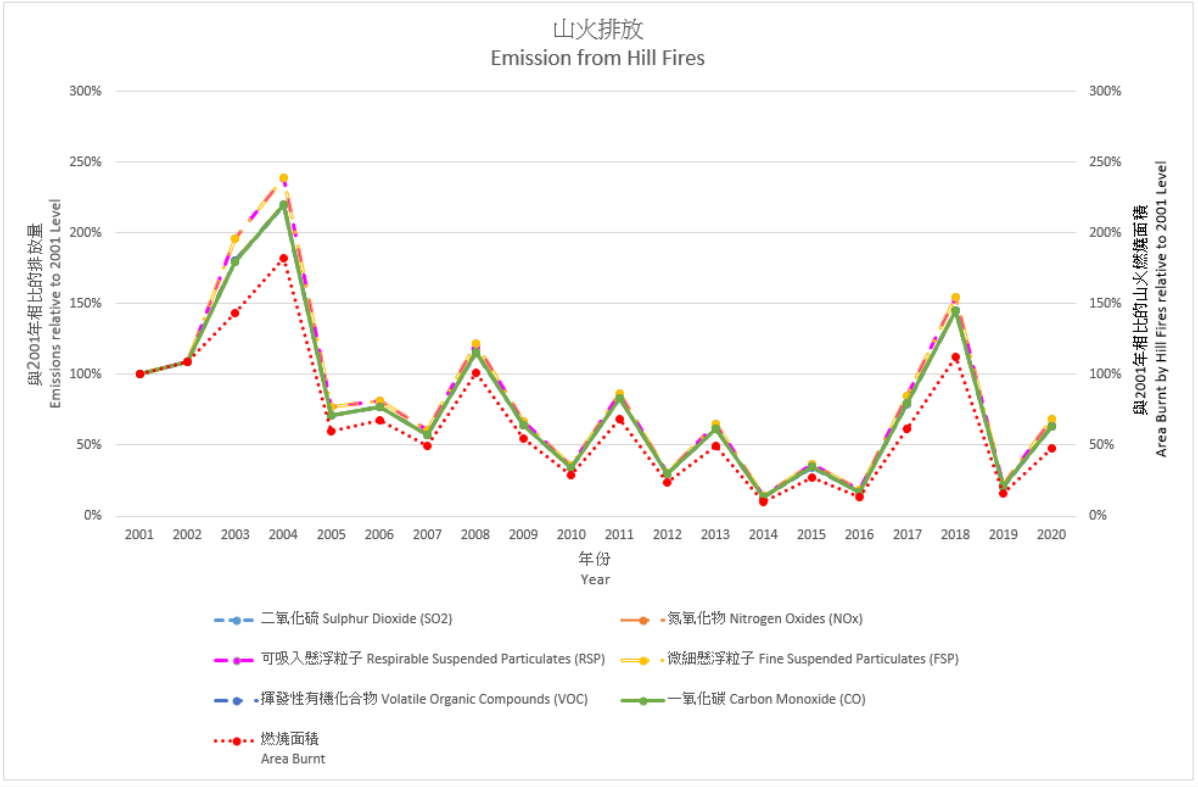


5.17. Non-combustion sources contribute considerably to local VOC emissions, accounting for 54% in 2020, whereas its contributions to local RSP and FSP emissions in 2020 were 25% and 16% respectively. Overall, the emissions of the sector decreased by 35% to 67% from 2001 to 2020, despite the growth of Gross Domestic Product by 102%.

5.18. The use of paints, consumer products, adhesive and sealants continued to be the major contributing sources, accounting for 81% of non-combustion sources VOC emissions in 2020. As compared with 2006, the VOC emissions from non-combustion sources decreased by 59% in 2020 as a result of the introduction of the VOC control programme under the Air Pollution Control (Volatile Organic Compounds) Regulation since 2007. The Regulation prohibits the import and local manufacture of regulated products with VOC contents exceeding the prescribed limits and controls emissions from lithographic heatset web printing machines. The regulated products include 6 broad categories of consumer products, 51 types of architectural paints, 7 types of printing inks, 14 types of vehicle refinishing paints, 36 types of vessel and pleasure craft paints and 47 types of adhesives and sealants. The Regulation was extended to cover fountain solutions and printing machine cleaning agents in 2018.

5.19. For non-combustion sources of RSP and FSP, the major contributing source was paved road dust from "Brake, Tyre & Road Surface Wear", accounting for 78% and 83% of non-combustion RSP and FSP emissions respectively in 2020.

6 EMISSIONS FROM HILL FIRES



6.1. Emissions from hill fires is a major contributor to RSP and FSP emissions, accounting for 32% and 33% of total local RSP and FSP emissions in 2020, respectively.

6.2. The Agriculture, Fisheries and Conservation Department attaches great importance to the management of country parks and the publicity and education on the prevention of hill fires. With the collaboration of the public, the number of hill fires and their emissions have generally been reduced over the past two decades, except a rebound in 2018.

Annex 1 – Breakdown of Emission Inventory by Source Category from 2019 to 2020

Pollutant	Source Category	Emissions (Tonnes)	
		2019	**2020**
SO_2	Public Electricity Generation	5,340	2,550
	Road Transport	40	40
	Navigation	2,560	1,940
	Civil Aviation	520	270
	Other Combustion	160	150
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	8,620	4,940
	Hill Fires	10	20
	Total (with Hill Fires)	8,630	4,960
NOx	Public Electricity Generation	23,160	13,840
	Road Transport	12,700	10,800
	Navigation	26,250	20,500
	Civil Aviation	6,470	3,550
	Other Combustion	7,590	7,980
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	76,170	56,680
	Hill Fires	40	110
	Total (with Hill Fires)	76,200	56,790
RSP	Public Electricity Generation	570	390
	Road Transport	330	280
	Navigation	1,040	860
	Civil Aviation	60	30
	Other Combustion	610	630
	Non-combustion	900	740
	Total (without Hill Fires)	3,510	2,930
	Hill Fires	450	1,380
	Total (with Hill Fires)	3,960	4,310
FSP	Public Electricity Generation	300	250
	Road Transport	300	250
	Navigation	970	800
	Civil Aviation	60	30

Pollutant	Source Category	Emissions (Tonnes)	
		2019	**2020**
	Other Combustion	570	590
	Non-combustion	470	370
	Total (without Hill Fires)	2,660	2,290
	Hill Fires	360	1,130
	Total (with Hill Fires)	3,030	3,410
VOC	Public Electricity Generation	400	320
	Road Transport	4,900	5,100
	Navigation	3,830	3,590
	Civil Aviation	560	250
	Other Combustion	710	760
	Non-combustion	11,910	11,890
	Total (without Hill Fires)	22,320	21,910
	Hill Fires	100	290
	Total (with Hill Fires)	22,420	22,200
CO	Public Electricity Generation	3,350	2,600
	Road Transport	30,100	27,000
	Navigation	21,920	21,160
	Civil Aviation	4,040	1,670
	Other Combustion	5,260	5,370
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	64,670	57,810
	Hill Fires	1,040	3,170
	Total (with Hill Fires)	65,710	60,970

Notes:
- All figures, except those for Road Transport, are rounded to the nearest ten. For Road Transport, the figures smaller than 1,000 are rounded to the nearest ten and the remaining figures are rounded to the nearest hundred.
- "N/A" denotes not applicable.
- There may be slight discrepancies between the sums of individual items and the total emissions shown in the table because of rounding.

Annex 2 – Summary of Updates to the Emission Inventory

1. To provide more accurate emission data to facilitate the management of air quality, EPD continuously updates the methodologies and emission factors to compile emission inventories. By making reference to the practices of international environmental agencies, we will recalculate historical emission inventories whenever emission estimation methods or emission factors are updated, and therefore the current data from 2001 to 2019 may be different from the estimates provided in the past.

2. Recalculation of historical emission inventories is widely adopted by environmental agencies such as European Environmental Agency of the European Community, California Air Resources Board (CARB), United Nations Environment Programme (UNEP), Intergovernmental Panel on Climate Change (IPCC), etc. when methods are changed or refined, when new sources categories are included in the inventory or when assumptions used in the estimates are revised.

3. Since the publication of the emission inventory on EPD's website in 2000, EPD have made a number of updates to the emission compilation and recalculated the historical emissions.

4. Major updates to the emission inventories are highlighted below.

i. EPD commissioned a comprehensive study on the marine emission inventory in 2008, which was completed in 2012. The study collected extensive local vessel activity data and reviewed the latest emission compilation methodologies of advanced places such as the Port of Los Angeles of the USA. The study concluded that these latest emission compilation methodologies can provide more realistic estimates of marine emissions. Based on the study findings, we updated the previous emission inventories for marine vessels. The updated emissions from vessels were higher than the previous ones.

ii. EPD have been conducting emission measurements for on-road vehicles by means of remote sensing equipment and advanced portable emission measurement systems (PEMS). The measurements have provided a more robust basis for us to estimate vehicle emissions. We made use of the findings to update our vehicle emission estimation model and compile the vehicle emission inventory.

iii. Since the implementation of the Air Pollution Control (Volatile Organic Compounds) Regulation in April 2007, we have used the sales report data submitted by importers under the Regulation to compile VOC emissions of regulated products including six broad categories of consumer products (air fresheners, hairsprays, multi-purpose lubricants, floor wax strippers, insecticides and insect repellents), printing inks and architectural paints. In October 2009, we amended the Regulation to further regulate the VOC contents of vehicle refinishing paints, marine paints (vessels and pleasure craft paints), adhesive and sealants and started to compile the VOC emissions from these products based on their sales report data. Emissions from cleansing solvents during the application of paints have also been estimated. The Regulation was extended to cover fountain solutions and printing machine cleaning agents in 2018. To compile VOC emissions for the non-regulated products, we also made reference to EPD's studies on printing industry, VOC-containing products and solvent usage for coatings, and survey data for marine paints to assess emissions from VOC-containing products.

iv. Following the implementation of the Air Pollution Control (Ocean Going Vessels) (Fuel at Berth) Regulation in July 2015 and the Air Pollution Control (Fuel for Vessels) Regulation in January 2019, the sulphur content of marine fuels obtained from ocean-going vessels has been adopted for emission estimation.

5. Updates to the emission inventories over the past 7 years are summarized in the table below. Based on the latest updates, we have recalculated historical emission inventories from 2001 to 2019. Comparisons between the previous and recalculated inventories are shown in **Annex 3**.

Update Date	**Emission Inventory Revised**	**Revisions and Updates**
January 2016	2001-2014	• Emissions from asphalt production plants were estimated. • Emissions from Sludge Treatment Facility (STF) were estimated. • Emissions from landfill gas flaring were estimated. • Emissions from hill fires were estimated. • Other Fuel Combustion sector was renamed as Other Combustion sector to better reflect the nature of the sources covered. • Radar data from CAD and chock-on chock-off data from AAHK were obtained to refine the emission inventory for Civil Aviation sector. • Used updated version of EMFAC-HK (version 3.1.1) for estimating the emissions from Road Transport sector.
January 2017	2001-2015	• A mixing height of 3000 ft (915 m), as recommended by International Civil Aviation Organisation, was adopted to compile the emissions for Civil Aviation sector. • Used updated version of EMFAC-HK (version 3.3) for estimating the emissions from Road Transport sector.
January 2018	2001-2016	• Adopted updated version of EMFAC-HK (version 3.4) for estimating emissions from Road Transport sector. • Adopted the sulphur content of marine fuels obtained from Port Facilities and Light Dues Incentive Scheme for estimating emissions from ocean going vessels. • Adopted Aviation Environmental Design Tool (AEDT) version 2c for estimating emissions from Civil Aviation sector. • Adopted the emission factors from EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 for estimating emissions from non-road mobile machineries. • Emissions from cigarette smoking were estimated and included in Other Combustion sector.

Update Date	Emission Inventory Revised	Revisions and Updates
January 2019	2001-2017	• Adopted updated version of EMFAC-HK (version 4.1) for estimating emissions from Road Transport sector. • Adopted the sulphur content of marine fuels obtained from Port Facilities and Light Dues Incentive Scheme for estimating emissions from ocean going vessels. • Updated power rating and age profiles of non-road mobile machines based on the registered information in the Non-Road Mobile Machinery database. • Updated the VOC emissions of unregulated VOC-containing consumer products based on the latest VOC study.
February 2020	2001-2018	• Adopted updated version of EMFAC-HK (version 4.2) for estimating emissions from Road Transport sector. • Updated the emissions from local vessels equipped with outboard engines (OBE) based on the latest OBE study.
June 2021	2001-2019	• Adopted updated version of EMFAC-HK (version 4.3) for estimating emissions from Road Transport sector. • Adopted Aviation Environmental Design Tool (AEDT) version 3c for estimating emissions from Civil Aviation sector.
May 2022	2019-2020	• Adopted the latest requirement in the Mainland on the use of marine light diesel with sulphur content not exceeding 0.001% in river-trade vessels and Pearl River Delta ferries.
June 2022	2001-2020	• Updated the emissions from local vessels based on statistics of the number of diesel and petrol outboard engine from Marine Department. • Adopted Aviation Environmental Design Tool (AEDT) version 3d for estimating emissions from Civil Aviation sector.
June 2022	2020	• Adopted the sulphur content of marine fuels obtained from ocean-going vessels for estimating their emissions.

Annex 3 – Comparison between the Previous and Recalculated Inventories (without Hill Fires) from 2001 to 2019

Table A3-1. Changes in SO_2 emission inventories from 2001 to 2019

Year	SO_2 (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	80,790	92,590	15%
2002	79,340	88,800	12%
2003	103,480	107,430	4%
2004	108,080	111,110	3%
2005	97,530	99,750	2%
2006	86,820	89,230	3%
2007	79,760	81,190	2%
2008	69,520	71,070	2%
2009	62,840	64,970	3%
2010	35,560	36,310	2%
2011	32,110	33,230	3%
2012	32,810	34,940	6%
2013	31,360	34,540	10%
2014	32,510	33,230	2%
2015	20,360	20,590	1%
2016	17,510	17,730	1%
2017	16,140	16,350	1%
2018	16,440	16,700	2%
2019	8,430	8,620	2%

* Figures are rounded to the nearest ten.

Figure A3-1 SO_2 emissions trend from 2001 to 2019

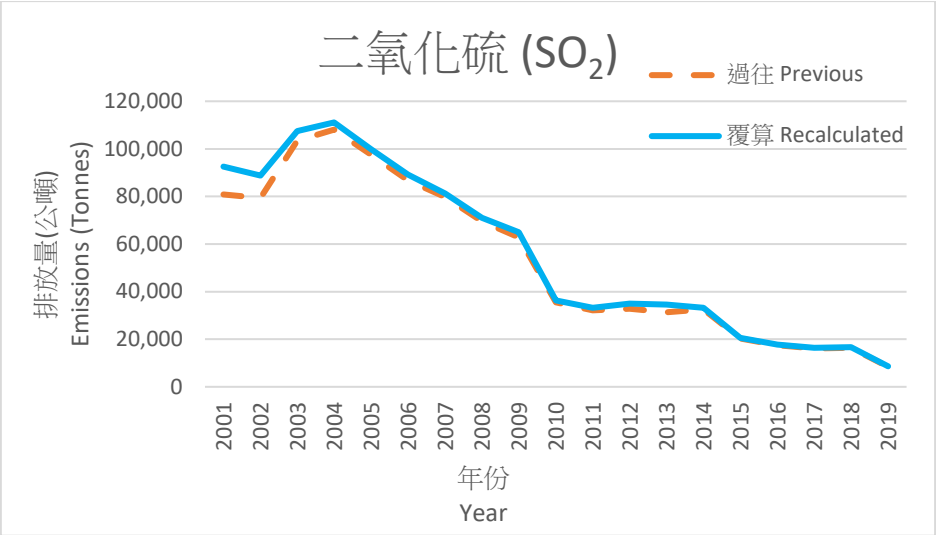


Table A3-2. Changes in NOx emission inventories from 2001 to 2019

Year	NOx (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	130,170	124,590	-4%
2002	127,420	122,940	-4%
2003	138,070	136,200	-1%
2004	128,970	127,560	-1%
2005	127,930	126,890	-1%
2006	124,830	123,710	-1%
2007	126,800	126,210	0%
2008	119,970	119,340	-1%
2009	117,860	116,970	-1%
2010	109,290	109,100	0%
2011	115,790	115,230	0%
2012	114,560	113,470	-1%
2013	113,780	111,870	-2%
2014	110,920	109,820	-1%
2015	95,920	94,870	-1%
2016	90,760	89,760	-1%
2017	83,710	82,810	-1%
2018	81,800	80,700	-1%
2019	77,620	76,180	-2%

* Figures are rounded to the nearest ten.

Figure A3-2 NOx emission trend from 2001 to 2019

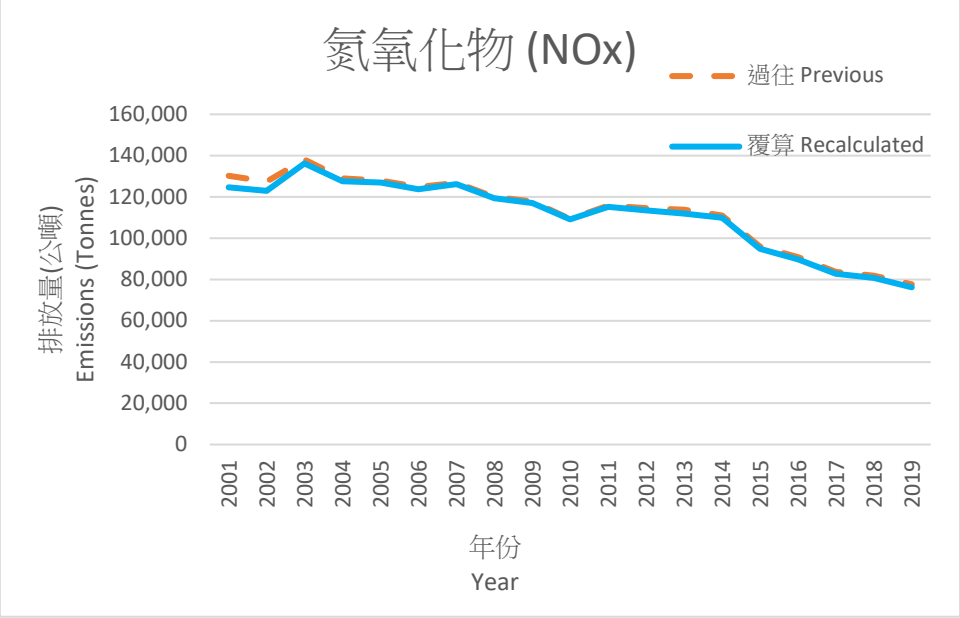


Table A3-3. Changes in RSP emission inventories from 2001 to 2019

Year	RSP (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	8,890	9,230	4%
2002	8,630	8,900	3%
2003	8,810	8,940	1%
2004	9,200	9,320	1%
2005	8,490	8,590	1%
2006	7,860	7,960	1%
2007	7,240	7,310	1%
2008	6,940	7,010	1%
2009	6,570	6,640	1%
2010	6,270	6,310	1%
2011	6,200	6,230	0%
2012	5,990	6,060	1%
2013	6,000	6,110	2%
2014	5,670	5,740	1%
2015	4,740	4,790	1%
2016	4,270	4,320	1%
2017	4,080	4,120	1%
2018	4,020	4,070	1%
2019	3,480	3,520	1%

* Figures are rounded to the nearest ten.

Figure A3-3 RSP emission trend from 2001 to 2019

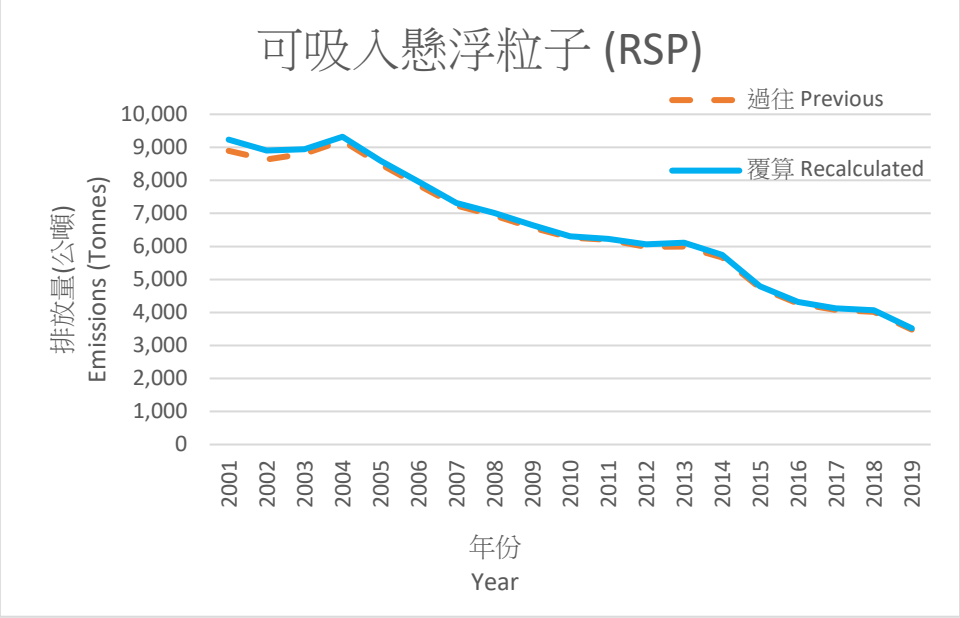


Table A3-4. Changes in FSP emission inventories from 2001 to 2019

Year	FSP (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	6,850	7,170	5%
2002	6,620	6,890	4%
2003	6,620	6,750	2%
2004	6,670	6,780	2%
2005	6,200	6,290	1%
2006	5,910	6,010	2%
2007	5,490	5,560	1%
2008	5,290	5,350	1%
2009	4,960	5,040	2%
2010	4,970	5,000	1%
2011	4,900	4,940	1%
2012	4,730	4,800	1%
2013	4,730	4,850	3%
2014	4,430	4,490	1%
2015	3,780	3,840	2%
2016	3,360	3,410	1%
2017	3,200	3,240	1%
2018	3,100	3,150	2%
2019	2,630	2,670	2%

* Figures are rounded to the nearest ten.

Figure A3-4 FSP emission trend from 2001 to 2019

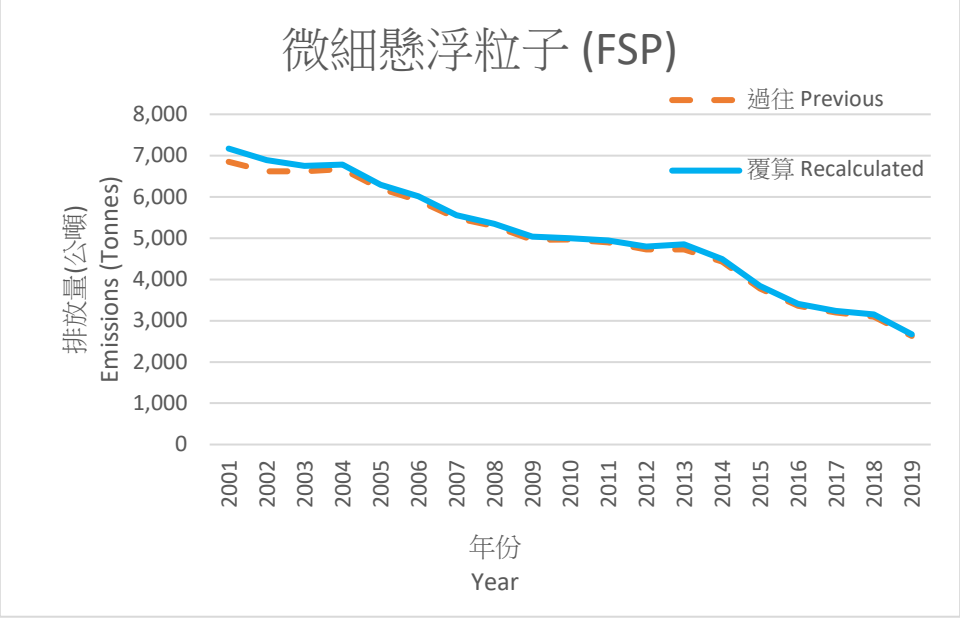


Table A3-5. Changes in VOC emission inventories from 2001 to 2019

Year	VOC (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	50,380	55,590	10%
2002	46,900	51,110	9%
2003	46,440	48,440	4%
2004	47,220	48,900	4%
2005	44,400	45,790	3%
2006	42,500	44,110	4%
2007	40,840	42,060	3%
2008	39,630	40,820	3%
2009	34,250	35,660	4%
2010	31,160	32,000	3%
2011	31,020	32,010	3%
2012	29,210	30,730	5%
2013	28,650	31,010	8%
2014	27,060	28,790	6%
2015	25,690	27,440	7%
2016	25,990	27,590	6%
2017	23,930	25,220	5%
2018	22,460	23,760	6%
2019	21,130	22,330	6%

* Figures are rounded to the nearest ten.

Figure A3-5 VOC emission trend from 2001 to 2019

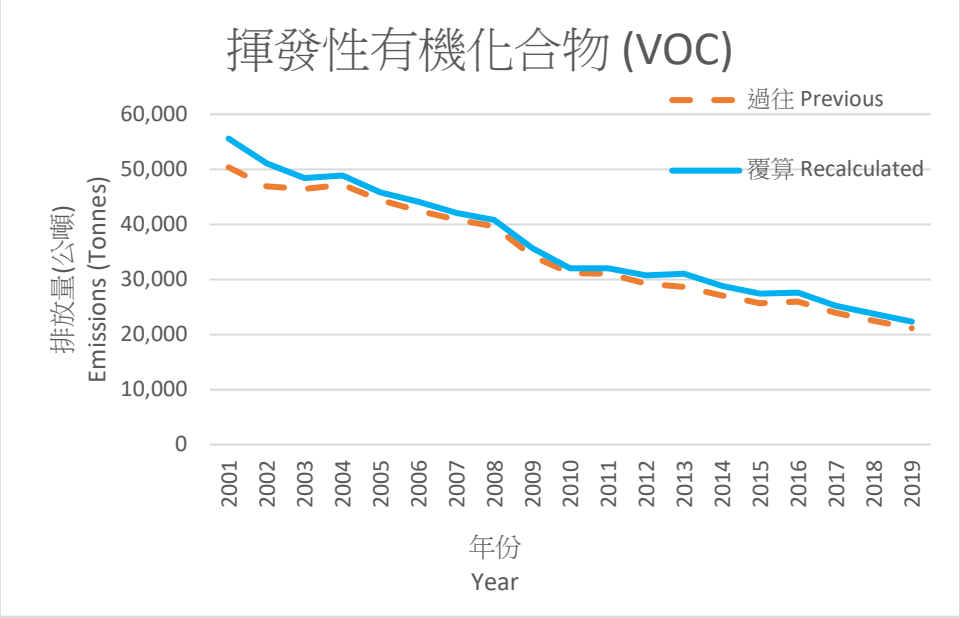


Table A3-6. Changes in CO emission inventories from 2001 to 2019

Year	CO (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	76,200	98,560	29%
2002	74,790	92,820	24%
2003	75,180	83,220	11%
2004	77,320	83,770	8%
2005	79,260	84,300	6%
2006	81,750	87,400	7%
2007	81,390	85,290	5%
2008	82,170	86,140	5%
2009	84,100	89,130	6%
2010	83,230	85,600	3%
2011	86,610	89,570	3%
2012	87,580	92,630	6%
2013	70,410	78,250	11%
2014	62,960	68,440	9%
2015	57,960	63,290	9%
2016	59,490	64,450	8%
2017	57,640	61,910	7%
2018	60,230	64,900	8%
2019	60,440	64,680	7%

* Figures are rounded to the nearest ten.

Figure A3-6 CO emission trend from 2001 to 2019